BISCAYNE BAY PARTNERSHIP INITIATIVE

SURVEY TEAM
FINAL REPORTS

BISCAYNE BAY
PARTNERSHIP INITIATIVE

CONTENTS

PREFACE

Dear Friends,

This document is the accompaniment to *A Bright, Great Bay,* which was developed by the Biscayne Bay Partnership Initiative's Policy Development Team. The reports contained in this volume were prepared by the Initiative's four survey teams, each of which addressed one of the following themes: social and economic values, science, management, and regulation. In addition, one minority report is included in this compilation.

The survey teams spent over one year assessing the status of Biscayne Bay and its resources. The team reports reflect the outcome of that assessment. In addition, the reports include recommendations for actions to protect, improve, and enhance the bay's resources, its social, economic, and natural values, and its ecological health.

The number of individuals who contributed their time and expertise to this effort are too many to name. In particular, many thanks are due to the co-chairs of each of the survey teams: their dedication and leadership were important to the success of this project. A list of survey team co-chairs and members are part of each report found in this volume.

We would also like to thank Bill Matuzeski, Director, US EPA Chesapeake Bay. As "special advisor" to the Initiative, he offered welcome and valuable advice, perspective, and humor. Finally, we would like to thank the Biscayne Bay Partnership Initiative's Coordination Team. These are the people who kept the project moving forward, and without whom it would have never been possible. Coordination Team members who worked throughout the life of the project are listed in the back pages of the Policy Development Committee's report. Others deserving of our thanks for getting the project off the ground include: Melissa Bialczak, Jenny May, John O'Brien, and Maya Compton.

Biscayne Bay is a beautiful and important resource for our community, our state, and our world. It is our hope that the efforts of the *many* talents that contributed to the production of these documents will bear fruit in continued and improved health for the bay—a bay that can be enjoyed by all.

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FINAL REPORT

BISCAYNE BAY
PARTNERSHIP INITIATIVE

BISCAYNE BAY PARTNERSHIP INITIATIVE

CONTENTS

IINTRODUCTION

THE BAY AND ITS IMPORTANCE TO THE COMMUNITY

Biscayne Bay is one of the world's great water bodies and a defining feature of life in Miami-Dade County. The Social and Economic Survey Team has proceeded from a conviction that the preservation and enhancement of the Bay must be a central priority for policymakers.

The Bay is important, first and foremost, as a marine ecosystem of extraordinary diversity. Within easy reach of the towers of international finance, tropical reefs teem with jewel fish, green moray eels, brain corals, arrow crabs, conch, eagle rays, and hundreds of other species. Manatees and dolphins swim near causeways, cruise ships, and sports stadiums. Suspended at the edge of our sprawling community, mangroves shelter infant game fish and provide nesting sites for sea birds. Few cities in the world have such a variety of life so interwoven with the urban fabric.

Biscayne Bay is also one of the premier recreation spots in the world. Every day of the year, Bay waters are dotted with sails and crisscrossed by pleasure boats. Beaches, sandbars, and parks provide the settings for leisurely access to its calm waters. And anglers enjoy its bounty.

At the same time, the Bay supports vital economic activity. The Port of Miami is the cruise ship capital of the world and handles nearly seven million tons of cargo every year. To see this level of commerce in such close proximity to beaches, coral reefs, and mangroves is indeed remarkable.This juxtaposition of corals reefs and skyscrapers, cruise ships and manatees, wind surfers and mangroves, causeways and sea turtle nests makes Biscayne Bay unique, but it also poses a great challenge for our community. The Bay provides us with a forum for international trade, world-class diving, and peaceful reflection, but maintaining a balance among these activities will only become more difficult as we grow. Because that combination of work and play, of modern metropolis and natural beauty, makes us who we are, we are compelled to seek ways to preserve, restore and enhance the Bay – or risk losing it.There was a time, not so long ago, when we did not treat the Bay with the reverence and care it deserves. Within living memory, large stretches of the Bay were too polluted for swimming. Only in the last three decades has our commitment to water quality and environmental diversity matched the responsibility presented by this resource. Although we once used it as a dilution basin for sewage, we have – thankfully – seen the greater value of a clean, healthy Bay and made the necessary investments to realize that goal. No longer is raw sewage a problem; it now remains for us to address other forms of pollution that foul the Bay and endanger its future. Because we are growing as a community – adding as many as half a million residents in the coming decade – we must now take the steps to insure that growth will not damage the Bay.

Our commitment to Biscayne Bay must therefore extend well beyond maintaining what we have; preservation is not enough. It is too important, and too threatened by growth, for us to settle for the status quo. Instead, we envision a Bay that is not only cleaner, but also more pristine – which means removing the scars of human activity, rendering future uses compatible with environmental revitalization, and increasing habitat to its highest possible quality and fullest possible scope. Achieving these goals may well take fifty or a hundred years; it is therefore imperative to start now.This will no doubt require citizens and public officials to resolve conflicts among what appear to be competing values – public access, economic use, and environmental restoration. But we believe that those conflicts can be managed through vigorous public effort, education, and a collective commitment to a long-term vision of the Bay, not only as it is now, but as an even more impressive natural setting interwoven with a great metropolis.

OUR VALUES

We recognize that a healthy environment and a healthy economy need to go hand in hand. The challenge is to encourage those environmentally compatible economic activities that protect and enhance the Bay while discouraging those activities that would cause environmentally adverse impacts to the Bay.

The future of Biscayne Bay and the protection of its resources cannot be considered outside the larger context of human interactions, social values and the regional economy. Within this context:

- we value the Bay, and believe it must become healthier;
- we value the economy in the region, and want to protect and enhance it;
- we value access to the Bay and an educated public who will use it carefully;
- we want a management system that allows us to manage conflicts among these three values.

Below, we discuss these values further in order to describe a broad framework for managing the Bay in a manner that will provide for economic activity and recreation while at the same time promoting environmental restoration and protection of Biscayne Bay.

"We value the Bay, and believe it must become healthier."

This value sets an immutable parameter that the natural resources throughout Biscayne Bay must be improved. This is particularly important in the northern part of the Bay, where these resources have been most impacted, but there are important improvements that must be made in central and southern Biscayne Bay as well. In particular, this improvement throughout the Bay will include the following.

1. A gain in miles of natural shoreline.
2. A spatial increase in marine habitat.
3. A significantly improved diversity and abundance of fisheries.
4. Elimination of all sources of contamination that degrade natural conditions or affects human enjoyment and use.
5. Restoration of more natural quantities and flows of clean water into the Bay.

We believe the efforts to improve hydrology, water quality and habitat quality, particularly the restoration projects, should be guided by these goals.

"We value the economy in the region, and want to protect and enhance it."

Our long-tem goal must be a stronger economy and a pristine Bay. This means encouraging economic activity that is environmentally sensitive, but also developing a regulatory framework that provides clarity, assurance, and predictability. It seems prudent to prohibit new activities that would damage the Bay. We must seek creative ways to allow for the maintenance of existing uses in ways that are compatible with the long-term goal of returning the Bay to a more nearly pristine condition. This value implies the following.

- Highly valuable, but environmentally adverse, existing economic activities associated with the Bay cannot be summarily prohibited, but their negative impacts must be minimized and fully mitigated.
- In the long term, some economic activities associated with the Bay may need to be phased out because they have an adverse environmental impact on the Bay.

- In the long term those sections of the Biscayne Bay/Miami River shoreline that are currently intensely developed will be transformed into space for water related and/or water dependent, job producing commercial activities and greenways that enhance habitat and public access.

We believe efforts to improve physical development, economic development and commercial uses of the Bay, shoreline and watershed should be guided by these principles.

"We value access to the Bay and an educated public who will use it carefully."

We believe that an informed general public with an enlightened stewardship ethic—and their elected officials—are our primary force for improving Biscayne Bay. Harm to the Bay due to public ignorance *must be* eliminated! We also believe that all people must have safe access and opportunities for responsible use of the Bay, regardless of their economic or social circumstances. Public lands along the shoreline should provide maximum opportunity for public recreational and education experiences, which will build a sense of community pride, stewardship and ownership of Biscayne Bay. While we acknowledge a "carrying capacity" for various parameters of Biscayne Bay, the impacts on these parameters must be reconciled equitably among the various users. This value implies the following.

- All school programs in Dade County should provide education about and awareness of the legacy of the Bay and include regular visits to the Bay.
- Public information programs for new residents and tourists should be developed in non-traditional educational avenues, including radio, television and billboards.
- Public, non-governmental and private lands around the Bay that are used for access should provide education and be managed to provide safe access and responsible use of the Bay.
- Existing public access opportunities, sites and facilities along the Bay shoreline should be preserved, protected and enhanced.
- Visual access to the Bay should be valued and improved.
- Access must be respectful of the need to protect the Bay's natural resources.
- Water dependent uses and facilities should be preserved along the Bay shoreline.
- From a public access standpoint, Biscayne Bay should be Miami-Dade County's equivalent of New York's Central Park.

We believe efforts to improve public education, awareness and access for Biscayne Bay should be guided by these principles.

"We want a system that allows us to manage conflicts among these three values."

We believe that there cannot be unlimited use of the Bay and its resources. There should be maximum opportunity for human enjoyment of Biscayne Bay, provided that the sum of all human interaction with the Bay allows the continual improvement in the health of Biscayne Bay. The Bay should be managed in a manner that provides flexibility in addressing the inevitable conflicts between preservation and use of the Bay. The management and regulatory systems must be integrated among the various agencies – local, state and federal – with jurisdiction involving the Bay in support of common goals. We seek public and private sector managers with a positive approach and attitude. We seek a world in which the conflicts among our values can be achieved in a broader cooperative management framework, while preserving the safeguards of our existing environmental laws. Finally, we seek regulatory compliance and enforcement systems that reward good stewards and fairly and vigorously deal with the bad. The integration system must be open, with broad and inclusive access for the public. This value implies:

- An inter-governmental mechanism or forum for joint goal development and improved integration—led by the key agencies.
- Regulatory and management approaches that emphasize a balance between education and awareness with prohibitions and penalties.
- A regulatory system that minimizes costly and ineffective conflicts between local, state and federal regulations.
- A regulatory system that produces cumulative mitigation that is greater than cumulative impact.

We believe efforts to improve coordinated management and regulatory approaches for Biscayne Bay should be guided by these principles.

RECOMMENDATIONS

1. We recommend the development of a Biscayne Bay Master Plan:

We recommend that the Florida Legislature provide $1.5 million to fund the development of a Biscayne Bay Master Plan that would guide efforts to balance appropriate economic use, improved public access, and increased habitat restoration and environmental protection.

1. The Bay Master Plan should create linkages between major segments of the population and shoreline sites that currently provide, or could provide, desired uses. Priority should be given to sites that could potentially provide the most environmentally compatible desired shoreline uses and facilities for the largest number of people. A dedicated source of funds should be sought to maintain all existing public shoreline in public ownership and to provide for proper upkeep and security at all public shoreline areas. Adequate infrastructure, including parking, should be provided to support existing Bay access opportunities.
2. The Bay Master Plan should promote links among shoreline activities (e.g. restaurants, attractions, boat tours), Bay access sites, and transportation modes (e.g. bus, water taxis, boats, bicycles).
3. The Bay Master Plan should provide mechanisms for managing and funding Bayfront park/Bay access.
4. The Bay Master Plan should provide a long-term strategy to maintain and improve existing public access points and to make more of the Bay shoreline publicly accessible especially in currently developed shoreline areas that have little public access, but it should not have environmental regulatory authority.
5. The Bay Master Plan should evaluate ways to limit the liability of parks, public recreation facilities, and School Boards to allow more and better programming for Bay education and access.
6. The Bay Master Plan should seek ways to increase public access opportunities at privately owned facilities.
7. The Bay Master Plan should encourage public/private partnerships and develop economic incentives that will promote environmentally compatible uses of the Bay and its urban shoreline and engender a sense of volunteerism and community stewardship to protect and improve Bay access.
8. The Bay Master Plan should encourage the use of waterfront property (along the Bay and along the Miami River) for habitat restoration, public access, or, where appropriate, job-producing commercial activity that is compatible with environmental protection and enhancement. To achieve this goal, we recommend that public officials in all jurisdictions purchase Bay front property whenever willing sellers appear. Where property bordering the Bay remains in private hands and is used for residential purposes, local governments should undertake beautification efforts that encourage waterfront landscaping, rather than the use of such property for parking, storage, or utilities.

The plan should be developed by a Task Force involving all governmental agencies currently involved in the management and regulation of the Bay or Bay-related activities. The Biscayne Bay Master Plan Task Force will, at a minimum:

1. Conduct a comprehensive study assessing all economic activities affecting or affected by Biscayne Bay. This study would identify the value of commercial activities and residential property, the age and condition of structures, zoning regulations, and land use plans around Bay waters, as well as the environmental impacts of all these activities.

2. Survey all existing publicly owned shoreline sites to determine their present condition and the types and amounts of public access that each facility currently provides. Needed improvements in infrastructure, amenities, programming, signage and public transportation to the Bay access points should be identified. The master plan should recommend potential uses and facilities that could be constructed at each site, taking into consideration natural and physical constraints (e.g. submerged and shoreline vegetation, surrounding land and in-water uses, public transportation access to site, roadway and in-water access to the site and space for parking).

2. We recommend the following projects be funded as initial steps toward the completion of the Biscayne Bay Master Plan:

Although the Biscayne Bay Master Plan Task Force will create additional projects to be carried out in the near and distant future, the Social and Economic Survey Team has already identified several projects that increase public access to the Bay or improve environmental protection. Since they contribute substantially to the achievement of our long-term goals for access to the Bay, we recommend the funding of these projects as an initial approach to achieving those goals.

1. We recommend that the Florida Legislature provide $5.8 million to fund the Miami River Greenway project, as described in the Miami River Greenway Action Plan.

2. We recommend that the Florida Legislature provide $3.0 million to fund the initial increment of the "River to Bay" Overtown Safewalk.

3. We recommend that the Florida Department of Transportation seek support from US DOT funding programs for federal highway mitigation funds to support the "River to Bay" Overtown Safewalk.

4. We recommend that the Florida Legislature provide $5 million to build the first phases of a Julia Tuttle Causeway access project, including a fishing pier, picnic facilities, non-motorized boat launch, and safe ingress and egress along the north side of the Causeway, and a bike path along the L31E levee in south Bay.

5. We recommend that the Florida Legislature provide the Biscayne Bay Master Plan Task Force and the Miami-Dade Public Schools with $2 million to create educational materials that will create an awareness of Biscayne Bay as our heritage and teach users about our environment, history and cultural ties to the Bay. These materials would be available at all access points used by the general public.

3. We recommend that the Miami-Dade County Public School System create a comprehensive Bay education program for all school children. This program would have a public outreach and education component.

1. We recommend that the Florida Legislature provide funds for Miami-Dade County Public Schools to develop a comprehensive environmental education experience (outdoors on the Bay) for each student some time during grades three through six of their elementary school career. This program would include camping sessions at Bay sites involving youth living and working together to enhance Bay environments through service projects. Water and terrestrial trails should be designed and built to enhance bay learning opportunities.

2. We recommend that Miami-Dade County Public Schools establish a permanent environmental education public awareness task force (with a professional coordinator) to oversee the comprehensive Bay education program.

3. We recommend that the Florida Legislature provide Miami-Dade County Public Schools with $1 million to initiate a community (BBPI, local, state and federal government) effort to help establish a top quality science research high school through acquisition of the Burger King property on Biscayne Bay (see Draft Concept Paper: FERM-Florida Environmental Research Magnet).

4. We recommend that the Florida Legislature provide $2.8 million to build two Environmental Education Centers (Science Research Outposts) at Oleta River State Preserve and Bill Baggs Cape Florida State Park. These centers should have laboratories where natural science can be studied using scientific methodology.

SURVEY OF SOCIAL AND ECONOMIC ISSUES

INTRODUCTION

Along with our subtropical climate, the Everglades and ocean beaches, Biscayne Bay defines Miami-Dade County. The Bay is entwined in the daily lives of thousands of people as they commute over the causeways or live or work within walking distance of the shoreline. Thousands more work in water dependent or water related sectors or frequently include a Bay activity within their recreational time. Visitors who come to Miami-Dade County specifically for the purpose of fishing or boating may also form close bonds with the Bay.

For the past one hundred years there has been a strong relationship between the economy and quality of life in Miami-Dade County and Biscayne Bay. The importance of the Port of Miami to Miami-Dade County's economy is well documented. Far less well known is the aggregate contribution of the water dependent facilities along the Miami River, shoreline attractions such as the Miami Seaquarium and Bayside, tour and party boats, charter boats, guided fishing trips, shoreline restaurants and water related activities such as boat sales and repairs. Taken altogether, Bay related activities and facilities may account for approximately 15% to 20% of the local economy. Of potentially even greater impact is the market and tax value of shoreline real estate. However, the exact extent of the Bay's overall importance to the local and south Florida economy is not well documented.

SOCIAL ISSUES – INTRODUCTION

The way in which people relate to Biscayne Bay is dependent on their ease of access, and it is also a function of their awareness of the Bay and its resources. Miami-Dade County is a complex multi-ethnic community in transition. With its mixed ethnicity and large percentage of people from other parts of the United States as well as from other countries, it presents unique challenges and opportunities. Some people come here with a strong tradition of water use, while others arrive with little exposure to marine communities. New arrivals with close bonds to the water sometimes bring with them expectations and patterns of use that are not appropriate for Biscayne Bay or allowable under current laws. Therefore, the relationships between the County's population and the Bay are both dynamic and sometimes little understood. We believe that it is essential to foster a sense of stewardship for the Bay through increased and enhanced public access, awareness and education.

B.1 Access

Access to Biscayne Bay has been an issue ever since captains of deep draft ships learned they were unable to pass across the shallow water of the Bay to anchor at the mouth of the Miami River. By the early 1900s, the struggle for Miami's waterfront involved extensive legal wrangling for land access, notably between the Flagler forces and a host of local residents who sought to tear down a waterfront fence that kept people and goods from the water and far away markets. (The anti-Flagler forces won an important State Supreme Court decision, often known as the Worley Case.) In recent years, issues of public access have involved struggles over public parkland, port development, the legitimacy of individual watercraft and the sanctity of the environment. Questions about public access to our Bayfront go to the heart of our identification as a region, the democratic nature of our political culture and our sensitivity to the environment.

Public access to Biscayne Bay has itself dramatically changed within the past century. Originally, local attention was focused on the Bay as a place to fish and trade, attract visitors and new residents. Yet with technological and scientific advances, the magnitude of immigration as well as economic and population growth, the use and perception of the Bay has been altered. We need to know that history as we plan for the future. Environmental concerns over pollution and preservation of natural habitats are important to thousands of local residents who appreciate the interconnected quality of the decisions of our daily lives with our relationship to the Bay and our water systems.

From a public access standpoint, Biscayne Bay should be Miami-Dade County's equivalent of New York's Central Park, but thousands of residents and visitors to south Florida do not have adequate access to the Bay. Appropriate, environmentally compatible Bay access is essential if we are to foster a sense of community pride and ownership of Biscayne Bay.

Access to the Bay may be described in terms of water dependent or water-related activities or in terms of views and vistas. Water dependent activities, by definition, require direct physical access to the water or shoreline. Popular activities in and adjacent to Biscayne Bay include shoreline fishing, boating, water skiing, wind surfing, jet skiing, canoeing, swimming and snorkeling. Water-related activities are less precisely defined, and certainly less easily quantifiable in economic terms, but may include things such as picnicking or nature photography that may be enhanced if they occur near the shoreline, or activities such as boat sales and repair. They provide critically important links to nature, romance and spiritual values.

Access can also be considered in terms of visual corridors. The Rickenbacker and Julia Tuttle Causeways and some high rise buildings provide spectacular vistas of the Bay. The many images and moods of the Bay can be seen from parks along the shoreline. Relatively few streets run for any length along the Bayshore, but occasional glimpses between buildings may provide beautiful or even awe inspiring views of the dawning or setting sun or thunder clouds over Biscayne Bay.

B 1.2 Existing Access

At first glance, there appears to be significant public access to Biscayne Bay. Table 1 summarizes access opportunities at more than 40 shoreline parks. The table also summarizes information on public transportation and bike path access to these facilities and opportunities for picnicking and viewing.

Many other facilities (e.g. commercial marinas, boat rental facilities, yacht and sailing clubs, fishing and charter boats, tour and party boats shoreline restaurants and shoreline attractions) provide important physical and visual access to the Bay.

B. 1.3 Current Plans to Improve Public Shoreline Access

Plans to recapture the waterfront are being developed in many areas of Miami- Dade County. The City of Miami Beach has plans for greenways along the Collins Canal and Indian Creek and for a wading beach and kayak launch at Pine Tree Park. In North Bay, the City of North Miami is working to create a new regional park at Munisport. North Miami is also partnering with the Florida Department of Environmental Protection to create an education/recreation center at the old Blue Marlin fish-camp site on the Oleta River. Also on the Oleta River, a primitive campsite and a canoe trail are being planned for the old Terama site.

The City of Miami has formed a Parks Advisory Board to oversee its parks and to plan and redesign Bicentennial Park. An ambitious undertaking has been initiated with the creation of the Bicentennial Park / Waterfront Renewal Committee which will strive to link the shoreline from Pace Park to the mouth of the Miami River with a public shoreline walkway and to link Bicentennial Park with Park West and Overtown. The Trust for Public Land has spearheaded an important effort to build a greenway along the Miami River and across town to the Bay. Across the Bay on Virginia Key, a task force is developing a plan to reopen the park and include new nature trails and a civil rights interpretative center while the Army Corps of Engineers on will mitigate environmental conditions caused by shoreline erosion and degradation of the coastal hammock and dune system. The City of Miami has also received a grant from the U. S. Army Corps of Engineers to develop a restoration and public access plan for five spoil islands at Dinner Key.

In south Dade, plans have been developed for a bike path that would link Homestead Bayfront Park with Black Point Park along the L-31E levee. Trail design is 30% complete. Spurs from the bike path will reach the Bay at the Mowry and C-102 canals. Parking and fishing facilities will replace the informal ad hoc access that presently exists at these canal mouths. The County Parks Department is working with the Solid Waste Department to lease a property that will function as a trailhead in the Lakes by the Bay area. A new general plan is being developed for the Deering Estate. It will integrate all new County acquisitions alon¡g the Bay and along Old Cutler Road and include Bay access improvements in the form of canoe launches, docks and picnic areas.

Over the years there have been dozens of plans to improve Watson Island and Virginia Key, which have been zoned and deeded as parkland. Today, these areas represent unrealized opportunities on a grand scale. The proposed location of two cruise ship berths, coupled with the proposed relocation of Parrot Jungle and planned construction of the Miami Visitors and Convention may leave very little publicly usable waterfront shoreline on Watson Island. The City of Miami and the County have a responsibility to make sure that extensive waterfront parkland is enhanced in ways that reflect the language of their own 1997 Master Plan. It may not be too late to develop a new master plan for Watson Island that integrates the plans for each of these facilities and maximizes public shoreline access, but there is little time to waste.

B.2 Education and Public Awareness

The Greater Miami population is now close to 2.2 million. In another decade, it is estimated to reach over 2.5 million. However, most of our young people and adults lack first hand exposure to Biscayne Bay and its dynamics. Successful projects such as those listed below, are being studied to help amplify our ideas about educational design:

- Indian River Lagoon
- St. Lucie Estuary
- Charlotte Harbor
- Appalachacola Bay
- National Estuary Program
- Chesapeake Bay Foundation

B.2.1 Existing Environmental Educational Activities and Resources

Miami-Dade County public schools serve 360,000 students with no less than 10,000 entering the system each year. At present the following environmental education programs are carried out by the public and private schools, environmental organizations, federal and state agencies**.** While these programs are often of very high quality, they reach only a fraction of the student population in Miami-Dade County in any given year. Their focus is also typically broader than Biscayne Bay. There is still a great need for environmental education activities and resources focused specifically on the Bay directly and reaching all students and residents.

Activities

C. **Contemporary Issues In Science Forum** is a program that involves 200-300 middle and high school students in selected schools in conducting research on current critical environmental issues. The students meet with adult resource personnel and other interested students to develop potential solutions in a large forum where resolutions are made on how to cope with these problems both on the local and global level.

D. **The Everglades Institute** is a week -long program that involves high school students in decision-making concerning critical environmental concerns of South Florida.

E. **The Earth Day Planting Activities** involve students in removing exotic trees and plants from designated areas while replacing them with native trees and plants that have been purchase by the student groups or donated from a variety of sources.

F. **The Center for Environmental Education** introduces approximately half of the fifth graders each year to environmental concerns and basic ecological concepts. The center also has a high school program that involves advanced environmental and ecological studies.

G. **The Everglades National Park Program** introduces elementary school students to the wonders of the everglades with student activities done at the park with the national park staff educators. Students learn about the interrelationships of the organisms that inhabit the park.

H. **Enviro-Cops** is a program created and organized by the ARISE Foundation that involves elementary students in identifying waste pollution areas and potential pollution sources and in taking positive action to clean up the environment. The motto is to "arrest waste wherever possible."

I. **The Florida International University Environmental Awareness Conference** is conducted each year to train high school students in dealing with environmental issues facing the world today. Several hundred students from school ecology clubs participate annually.

J. **The Biscayne Nature Center** conducts environmental programs on weekends for students and interested adults using a volunteer staff composed partially of Center for Environmental Education teachers and working out of the Center.

K. **The South Florida Chapter of The Explorers Club** gives a $2100 dollar scholarship for a student to attend a summer research program.

Initiatives

L. **The District-wide School Recycling Program** involves all the Dade County Public Schools. Pickup bins have been placed at all sites for aluminum cans and office paper. Additionally, about 50 sites also recycle cardboard.

M. **A Mathematics, Science, Computer Education, and Environmental Education Task Force** has been created to make recommendations concerning these areas. The Task Force has addressed the Systemic Statewide Initiative of the Florida Department of Education which is developing a K-12 science curriculum with environment as its main theme.

N. **The K-12 Environmental Scope and Sequence Writing Team** is developing an environmental curriculum complete with resources that can be used to inset environmental concepts into all levels of the science curriculum from grades K-12.

Curricula

O. **The 4R's Recycling Curriculum** from the Florida Department of Education has been distributed to all schools. It contains hands-on student activities to promote n awareness.

P. **The Biological Diversity Curriculum** deals with one of the major problems in South Florida, which is disposing of all the wastes we, produce. This curriculum is designed as activities for K-12 students in solving these problems.

Q. **Dade County Environmental Story** is a historical perspective of the environmental situation in South Florida and how it has changed drastically since the turn of the century. This is a reference book in addition to providing activities for students K-12.

R. **The Companion Reader to the Dade County Environmental Story** is a compendium of environmental stories relative to South Florida. It supplements student environmental resources concerning Dade County.

S. **The South Florida Water Management District Water Curriculum** is supplementary material on water and environmental concerns that has been produced and targeted for specific grade levels in the elementary, middle and senior high school. The material was given to the Dade County Public Schools and distributed free of charge to thousands of students.

B.2.2 Current Plans to Improve Environmental Education Outreach

Biscayne Area Science Research Outposts

Over several decades, a series of field study facilities (science research outposts) will be established throughout the Biscayne Bay area. Each station, built on stilts, will include an upper level laboratory, accommodating computers, aquariums, microscopes, weather and solar energy instrumentation. Stored at ground level will be canoes/kayaks, bicycles, life jackets, science field equipment, an electric golf cart and a small safety boat with a motor.

Outposts will be placed where they will not adversely affect natural resources. Each facility will serve teams of talented, high interest and/or academically gifted high school juniors and seniors who will utilize scientific method to solve environmental problems.

An experienced science research teacher assigned by Miami-Dade County Public Schools will help design, supervise and monitor all activities. University interns will aid inprogram implementation.

Sites should be within city, county, state or federal public lands (parks) which feature a diversity of terrestrial and marine communities. It is hoped that a pilot program and facility can by operational by the 2003 school year.

Investigation has shown that local park systems (city, county, state and federal) do not have the funding to carry out needed ongoing science research in their natural areas. There are not adequate science research programs in our public schools offering science students experience in field studies utilizing scientific methodology.

Resulting research data should serve the various park systems in continually analyzing natural area dynamics. In addition to giving working student scientists real life experience, it is believed that their close involvement with solving Biscayne Bay area problems will gain them in-depth knowledge and a heightened sense of place.

As the result of their investing their interest, talent and time in the enterprise, students will become the well-informed business people, elected officials, voters and possibly scientists of our community. Their work should generate positive attitudes toward conservation of our valuable natural resources in the Biscayne Bay area, among other citizens in Miami-Dade County.

The Florida Environmental Research Magnet (FERM)

This concept is currently being considered by the Miami-Dade School Board. The FERM program would consist of an entire school where all of its students would be involved in different aspects of environmental research and occupations. There are numerous environmental programs in the district and throughout the state but they are usually small programs with limited numbers of students nestled within a larger school setting. The Florida Environmental Research Magnet (F.E.R.M.) is a concept whose time has come.

This environmental magnet school would involve the community, local industry, and the public schools for the purpose of providing environmental impact, social management and science research studies of Biscayne Bay and connected estuaries. The school would have a partnership with Biscayne National Park and would use the resources of the Park and its staff to utilize the natural environment as an extended classroom and have students interacting with park rangers and researchers in conducting research as part of the curriculum. Students attending the school would also have the opportunity to participate in a full range of secondary school course offerings.

Biscayne National Park would provide students with an open laboratory, literally in the school's backyard. The researchers in the park could actually become laboratory directors for students conducting research as a part of the school's program. In addition to the Biscayne National Park Partnership, a consortium of institutions of higher education consisting of the University of Miami, Florida International University, and Miami-Dade Community College, among others would collaborate to provide research and educational programs at the F.E.R.M. school.

The science resources center, co-located with the school, would be the site of a teacher education center that would provide model professional development programs for teachers. The research laboratory would be similar to the University of Maryland Center for environmental and Estuarine Studies (UMCES).

In addition to the regular facilities of a typical high school FERM should house an amphitheater and video production center with the possible inclusion of a small science museum and an exhibit area focussing on South Florida and Biscayne Bay. FERM is a unique concept that has the potential for becoming a demonstration site for national and international visits form people interested in developing other environmental schools and research programs.

B.3 Contemporary Issues and Opportunities in Access and Awareness

This century has seen much of the urban shoreline of the Bay become privatized and lined with residences. Access is not equitably distributed along the Bay shoreline. The location and amount of access is generally not tied to population centers. Where roads end at the Bay, the rights of way have often been vacated and incorporated into the adjacent private land holdings. The idea of providing public access at street ends or causeways has often met with resistance from surrounding landowners. Many members of the public are unaware of existing Bay access points, because they are not well marked or accessible from public transportation.

The continuing trend toward gated communities has also decreased public shoreline access, or created a perception that access to public shoreline parks within those areas has become restricted. In some instances the public shoreline has been fenced off for security purposes. Also, some of the shoreline walkways that have been approved by the County's Shoreline Development Review Committee have been gated or eliminated after the project has been built ostensibly over security concerns. Under the Shoreline Development rules, a Baywalk is a typical form of mitigation if there is encroachment into the shoreline setback or view corridor. Recently, however, some developers have asked to pay a mitigation fee in order to have the access placed outside of their development or for some other form of off-site mitigation. While this idea may be viewed with skepticism by some, it may provide a funding mechanism that can be used to augment public access and environmental education opportunities in presently underused public areas.

From Matheson Hammock south most of the Bay shoreline is lined with mangrove forests. South of the Deering Estate, most of the Bay shoreline is within the boundary of Biscayne National Park. However, the only maintained access points are at Matheson Hammock, the Deering Estate, Black Point, Homestead Bayfront and the Biscayne National Park headquarters at Convoy Point. The Snapper Creek, C-100, Black Creek, C-102, Military Canal and C-103 outlets afford some additional access for fishing or launching of small boats.

In recent years, several water dependent shoreline uses have been converted to non-water dependent uses. Marine commercial and industrial areas along the Dumfoundling Bay Canals and along the Miami River are becoming multifamily residential. Commercially zoned unused lots on the Miami River are being proposed for residential multifamily. At least one commercial waterfront property at the upstream end of the River is being proposed for a hotel near the edge of a very industrialized area. Some of the proposed changes could augment public shoreline access. For example, some marine industrial properties are proposed for shopping and restaurants and it seems highly likely that some restaurant type uses will overtake the marginal terminals like the ones trading with Haiti.

A hotly contested issue has been the use of dedicated public parks and other publicly–owned property along the shoreline, for commercial purposes, limiting future opportunities for public access and recreation. Important public access opportunities have been lost in recent years as areas that were "supposed" to be bought and used for public park and access purposes were not. The lack of government oversight in the process of protecting public land needs to be addressed and questions need to be raised about why the press has not functioned more effectively as "watchdogs" over public lands and waterfront access. A good example is the property adjacent to the Barnacle, which is now the Cloister's development. Also, parcels that were historically intended or used as open space parks or for water dependent purposes (or in some cases both) have been proposed for sale or development. The most obvious recent example being the development of the American Airlines Arena on the old FEC site adjacent to Bicentennial Park. Another example is Alice Wainwight Park where reductions in public parking, and neighborhood concerns for safety have significantly eroded the public's ability to visit the waterfront.

There are many other ways in which public access to the Bay is limited, appropriately and inappropriately:

- Environmental restrictions such as the banning of personal watercraft in Biscayne National Park, restriction in numbers of new powerboat slips for manatee reasons and the no entry zone in Virginia Key Coastal Wildlife Area decrease certain types of access.
- Access may also be limited for members of the community who have historically had very little contact with the Bay. For many years, access to the Bay was largely non-existent, then limited to the beach on Virginia Key for most African Americans. Consequently, many people did not grow up with a strong tradition of Bay use. Today there are people living within a few miles of the Bay who have never been boating or swimming in the Bay.
- The forms of public transportation taking people to the waterfront and around the Bay limit the ability of many to enjoy the water or constrain the tourist industry's ability to present a more comprehensive experience of our region. People who do not live or work near the Bay shore frequently do not have adequate access to the water.
- The unfriendly or dangerous condition of waterfront parks can inhibit the desire for people to come to the Bay.
- The lack of overall planning for public development of museums and attractions, and the maintenance of Bayfront land clearly inhibits the integration of the urban waterfront as a coherent attraction possessed by cities such as Baltimore, Charleston, Chicago or New York.

Along the urban Bay shoreline, access to and through park areas is directly related to the type of facilities, upkeep, security and programming that each park provides. If they have a choice, most people will avoid areas with piles of trash and debris, facilities in disrepair, poor security or limited parking. To be successful, Bay access points must be safe and actively used, attractive, properly maintained, and have infrastructure and amenities that are tied to user needs.

At many of the most heavily used ramps, the number of parking spaces limit the number of trailered boats that can be launched on busy weekends. In other areas, the number of power boats launched may be limited by the length of time people will have to travel through no wake zones to reach their desired destination. However, these limitations must be viewed in the context of the Bay's carrying capacity.

There are more than fifty miles of publicly owned Bay shoreline, many of the shoreline parks are heavily used, but others are notably underused or closed. The infrastructure at many shoreline parks is outmoded, inappropriate and in a state of disrepair. Successful parks, such as Kennedy Park in Coconut Grove stand in stark contrast to Bicentennial Park or Jose Marti Park that have poor security, design problems and little active use.

The Rickenbacker Causeway provides opportunities for picnicking, swimming, windsurfing, dog walking and other activities in a non-park setting. It is available to all with access to a car or the bus fare. In contrast, the Julia Tuttle Causeway provides little more than beautiful Bay views.

B.4 General Principles for Providing Public Access and Awareness

- Over-Arching Concept: Access creates recreational and education experiences which will build a sense of community pride, stewardship and ownership of Biscayne Bay. From a public access standpoint, Biscayne Bay should be Miami-Dade County's equivalent of New York's Central Park.
- Everyone, regardless of economic status, is entitled to visual access to the Bay from public lands and to physical access to the Bay provided that the types and intensities of access are safe and compatible with protecting the Bay's natural systems and threatened or endangered species.
- As a general principle we should preserve, protect and enhance all existing public access opportunities, sites and facilities along the Bay shoreline. Adequate infrastructure, including parking, should be provided to support existing Bay access opportunities Any reduction in acreage or accessibility to public land near the Bay should take place only for an overriding purpose of public necessity.
- Public access should be used to create an awareness of Biscayne Bay as our heritage and to teach users about our environment, history and culture. It should result in a positive experience of the Bay.
- All public land along the shoreline should be accessible to all. However, it is also essential to understand that parklands have an inherent carrying capacity and that unlimited access and overuse may diminish the value of the Bay experience and negatively impact the Bay resources that we value as a community.
- Public access should be equitable; All segments of the population, including those who are not familiar with the Bay, should have access to Bay-related programs and opportunities. Every child should access the Bay at least once a year through an educational / recreational experience. Ideally, every resident in the county should be able to access the Bayfront within one hour of travel time.
- Access points should be linked using a variety of economic and commercial activities (e.g. shoreline restaurants and attractions, boat tours) and transportation modes (e.g. bus, water taxis, bicycles, boats). People should be made aware of access points via improvements in signage and information about public transportation to the Bay access points.
- Visual access to the Bay should be valued and improved whenever possible. This is especially true today when passive recreational activities such as walking are very popular. Access should be provided at both the neighborhood and regional levels
- Access needs should not be allowed to override the paramount need to protect environmental values. Access must be respectful of the need to protect the Bay's carrying capacity.Access must not be allowed to negatively impact the Bay's natural values or reduce the value of the Bay use experience. As more people use the Bay, it may become necessary to extend additional protection to sites of high environmental value through limits on types, times, or number of users. It may also become necessary to impose use restrictions such as the recently established clear zone around cruise and cargo ships traversing Government Cut Channel in order to prevent life threatening conflicts with other Bay users.

- Water dependent uses and facilities should be preserved along the Bay shoreline. Local governments should adhere to existing adopted policies in their comprehensive plans that set waterfront use priorities.

ECONOMIC ISSUES – INTRODUCTION

Biscayne Bay is the most prominent feature of Miami-Dade County's landscape, extending for almost the entire length of the County from Haulover Inlet in the north to the upper reaches of Key Largo in the south. The majority of the County's 2.1 million residents live within a few miles of the bay. While the relationship between Biscayne Bay and Miami-Dade's people, economy and overall quality of life is undeniable, with the exception of the economic contribution of the Port of Miami, businesses along the Miami River, and other water-dependant establishments, there is very little definitive understanding of the magnitude, breadth, or extent of the bay's economic contribution to the community. Likewise, the adverse impacts of certain segments of the economy on the bay are not well understood.

This section will provide some background on the demographics and major economic sectors of Miami-Dade County. The County's economy, which is highly dependant on international trade and tourism, and its continual population growth, rely on the use, and place taxiing demands on, the environs surrounding and within Biscayne Bay. A better understanding of these issues will help us realize more definitively the relationship between the economy and the bay and will help us identify the areas where additional information is needed to expand on this understanding. Better awareness of the economic role of the bay will assist policymakers as they attempt to preserve and enhance the quality of the environment, and will provide greater insight into which economic sectors or activities should be promoted in the development of the area's economy.

C.1 Demography

During the coming decades, population growth will make it more difficult to preserve and enhance Biscayne Bay. Florida is a growing state, South Florida is a growing region, and Miami-Dade is a growing County; this means an increasing demand for access to the bay and more human activity surrounding the bay – with potentially adverse environmental consequences. Perhaps most importantly, if current trends persist, much of our population growth will come from outside Florida and outside the United States; Miami-Dade County will thus continue to become home for citizens who are not familiar with the bay ecosystem and who will need to be educated about its value to our community.

With a population close to 15 million, Florida is the fourth most populous state in the nation. It is also one of the fastest growing, and is expected to increase by 6 million people by 2025. Florida is expected to replace New York as the third most populous state by 2020 (U.S. Census: 1997).

Miami-Dade County has experienced tremendous population growth since 1900 and will continue to do so (see Figure 1). With a population of 2.1 million, Miami-Dade County accounted for 13.9% of Florida's total population in 1999 (FL Consensus Estimating Conference: 2000). By 2010, Miami-Dade's population will reach almost 2.5 million (BEBR, 1999A).

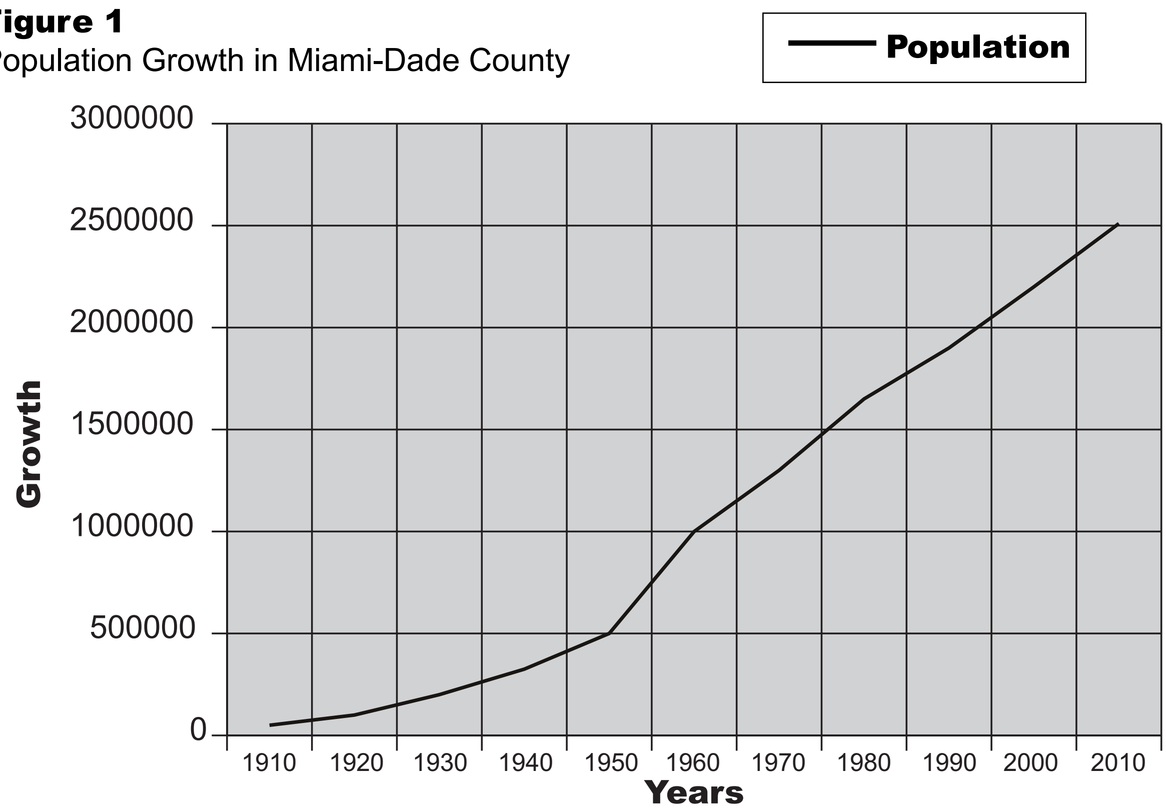
Many municipalities in Miami-Dade County border Biscayne Bay. A list of some of these (along with their 1998 estimated population) includes: Miami Beach (93,464), Aventura (20,349), Bal Harbour (3,151), Coral Gables (41,624), Key Biscayne (9,471), Miami Shores (10,199), North Miami (50,422), and North Miami Beach (36,727). Additionally, a large portion of the City of Miami's 364,765 residents live near the shores of Biscayne Bay (BEBR, 1999B).

The County is rich in ethnic and cultural diversity. One-third of the County's 1990 population was foreign-born. In 1998, 55% of Miami-Dade's population was Hispanic (U.S. Census, 1999). The County is also home to many people of Caribbean, non-Hispanic decent.

Figures 2 and 3 give a detailed description of the components of the demographic changes in Miami-Dade County between 1980 and 1999. A prominent feature during both decades is the large figure for international migration, especially in the Hispanic and Black populations. During 1997 for instance, of the 45,707 international immigrants to Miami-Dade County almost 25,000 were from Cuba. Other significant immigrations (in descending order) in that year came from Haiti, Nicaragua, Colombia, Jamaica, Honduras and Peru. At the same time, there has been a significant out-migration of the County's population. In 1996 for example, the State had a positive net migration of almost 120,000 persons, while Miami-Dade County had a negative net migration of almost 25,000 (BEBR, 1999B).

Although Miami-Dade has traditionally been the home to a large retired population, the growing County, coupled with immigration and in-migration figures is younger than the adjacent counties with 35% of the population aged 24 or younger. This compares to the South Florida average of 31% (Florida Consensus Estimating Conference, 2000). As for the older population, in 1998, 13.7% of the County's population was 65+, compared to the State average of 18.4%.

Figure 1
Population Growth in Miami-Dade County



Source: U.S. Bureau of the Census, U.S. Census of Population, Vol. 1, Characteristics of Population, Part 11, & FL Consensus Estimating Conference, 2000 & BEBR, 1999.

Figure 2
Components of Population Change in Miami-Dade from 1980-1990

Components of Change	Hispanics	Blacks	Non-Hispanic Whites	Total Population
1980 Census Results	581,000	282,000	775,945	1,626,000
Births (+)	110,000	95,000	78,075	280,000
Deaths (-)	70,000	25,000	79,425	173,000
Natural Increase	40,000	70,000	-1,350	107,000
In-Migration (+)	200,000	50,000	253,750	500,000
Out-Migration(-)	120,000	72,000	410,880	600,000
Net Domestic Migration	80,000	-22,000	-157,130	-100,000
Irurnigration (+)	220,000	90,000	4,650	310,000
Emigration (-)	5,000	5,000	5,150	15,000
Net Foreign Migration	215,000	85,000	-500	295,000
Net Total Migration	295,000	63,000	157,630	195,000
Total Change	335,000	133,000	-158,980	302,000
Population Estimates for 1990	916,000	415,000	616,965	1,928,000

Source: Boswell, Thomas D. and James R. Curtis, April 1991.

Figure 3
Components of Change, Miami-Dade County and Florida, 1990-1999

Component	Miami-Dade	Florida
1990 Population	1,937,194	12,938,071
1999 Population	2,175,634	15,111,244
Births 90–99	301,761	1,781,648
Deaths 90–99	172,737	1,370,234
Net International Migration	337,174	640,109
Net Domestic Migration	-236,078	1,108,514
Population + or –	238,440	2,173,173
Births minus Deaths	129,024	411,414
% growth from natural increase	54.11%	18.93%
% growth from Int'l migration	141.41%	29.46%
% growth from Domestic migration	-99.01%	51.01%

Source: Population Estimates Program, Population Division, U.S. Census Bureau, Washington, DC, 2000

C.2 *Economy and Employment*

With so many newcomers streaming into the region, there will be greater pressure on the local economy and local politicians for jobs, housing, and recreational facilities. Even after the longest economic expansion in American history, Miami-Dade County's economy remains relatively weak. Although several of the communities bordering on the bay are fairly well-to-do, Miami-Dade County and the City of Miami in particular continue to have very high rates of poverty, sluggish job growth, and large (and growing) population of unskilled workers. This means that public officials must focus on economic growth as a public priority.

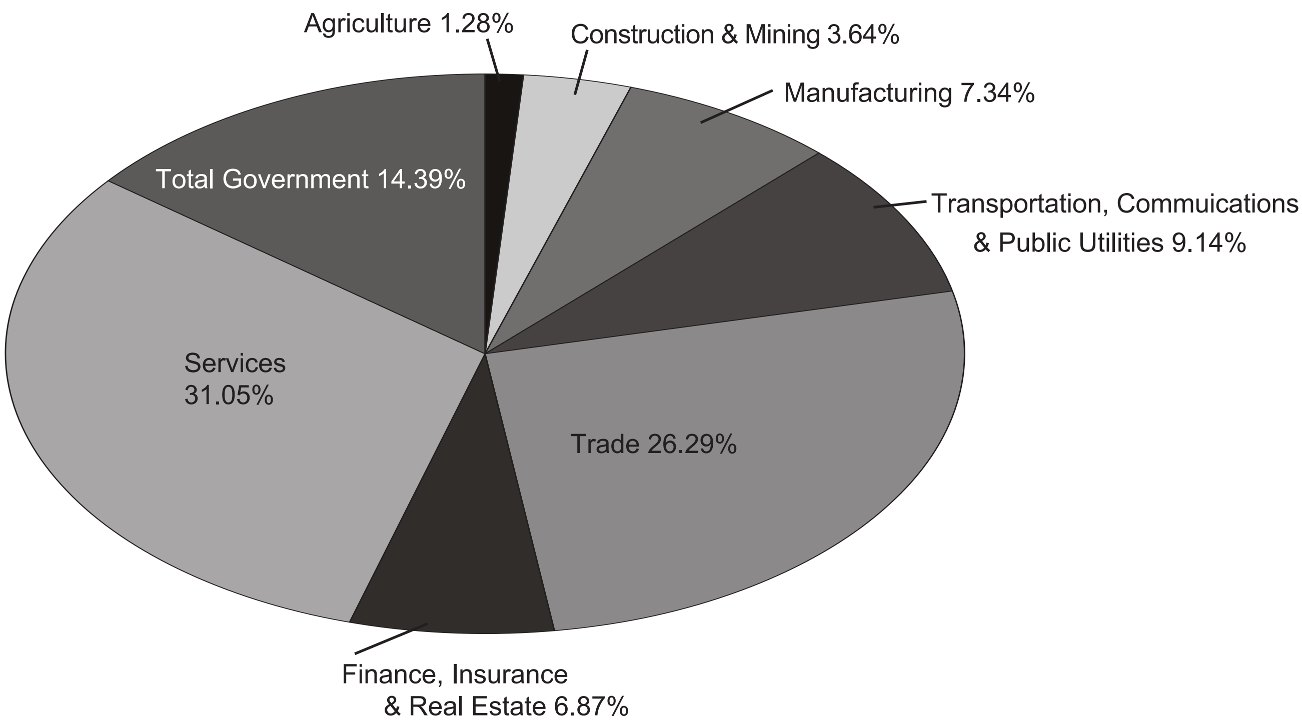
Traditionally, the economy of Florida and Miami-Dade County has been dominated by construction, agriculture, tourism, and the service demands of a rapidly increasing resident base. The current trend, however, is for growth of more service-oriented industries including banking, real estate, accounting, legal, and retail enterprises. Overall the service industry is the largest employer sector in the County, followed by trade, and government (32%, 26% and 14% respectively) (FDLES, 2000) (See Figure 4a). This compares to Figure 4b, which shows the employment makeup for the entire State. Seventy-eight percent of Florida's minority-owned firms are located in South Florida, and 52% of the total are in Miami-Dade (U.S. Dept. of Commerce, 1992).

Miami-Dade County's workforce consists of 1,204,996 full-time and part-time employees (U.S. Dept. of Commerce, 2000). Average wages in the County are $30,899 and the median household income is $33,375 compared to the State's of $29,998 (BEBR, 1999B). (Miami-Dade's per capita personal income, though, is $21,000 which is lower than the State average of approximately $24,500 (FDLES, 1998). This low per capita income is due to the County's large population of young individuals, age 0-24, who earn little or no income, and have a high poverty rate.

Florida's unemployment rate, at 4.3%, mirrors the national average of 4.5% (Rust, 1998). Miami-Dade County's unemployment rate, at 5.3%, ranks above the State and national average (FDLES, 2000). A contributing factor to the County's employment problems is that there are not enough low-skilled positions for all the people that need jobs – South Florida has reached a saturation point in low-skilled employment. The problem is compounded by the large number of people coming off welfare and joining the workforce, and the large numbers of immigrants, who need entry-level, low-skilled positions that are just not available (Rust, 1998).

Figure 4a

Miami-Dade Total Employment by Major Industry Categories–1999



Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics, 2000.

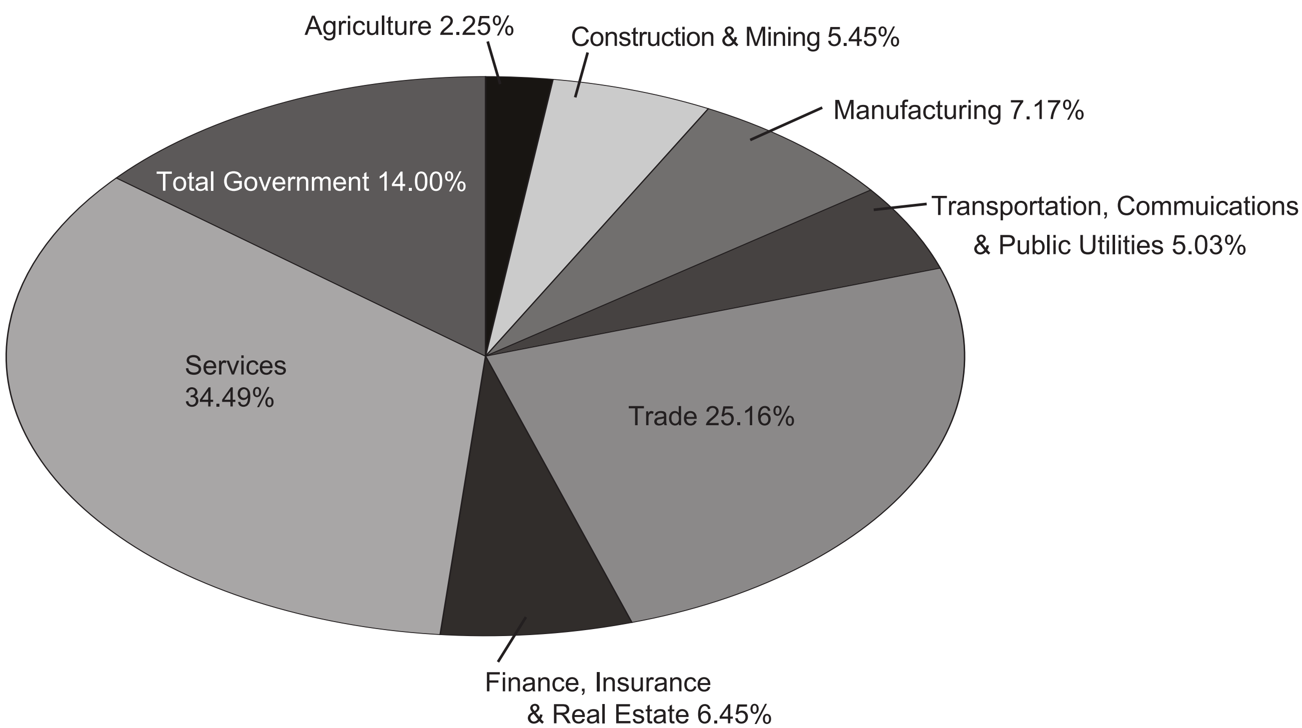
In 1995, approximately 2.2 million people in Florida lived in poverty. Of these, 22% lived in Miami-Dade County. Almost 24% of Miami-Dade County is characterized as poor, including 32.3% of children living in poverty (BEBR, 1999B). In 1998, the Florida homeownership rate was 66.9% compared to the City of Miami at 53.1%, the lowest of all the Florida large metropolitan statistical areas. The estimated daily homeless for the County (1997-98) was 5,260 individuals (BEBR, 1999B).The Challenge for the County and the environs surrounding Biscayne Bay will be to increase employment and wages, while maintaining or enhancing the Bay and its natural and economic attributes. Increased education and skill levels of the labor force could improve income distribution. Improved education and skill levels would help attract industries to the County (FDLES, 2000).

C.3 *Economic Sectors*

Miami-Dade County is an international trading crossroads with imports and exports rising rapidly. Reflecting South Florida's strategic location, dozens of global companies have located their regional headquarters for Latin America and the Caribbean in Miami-Dade County. Manufacturers, banks, wholesale trading firms and service companies are among the types of global businesses with operations in the area (Beacon Council, 2000). Miami Dade, and the South Florida region in general, is considered a tourism mecca. The region is also an important agricultural center.

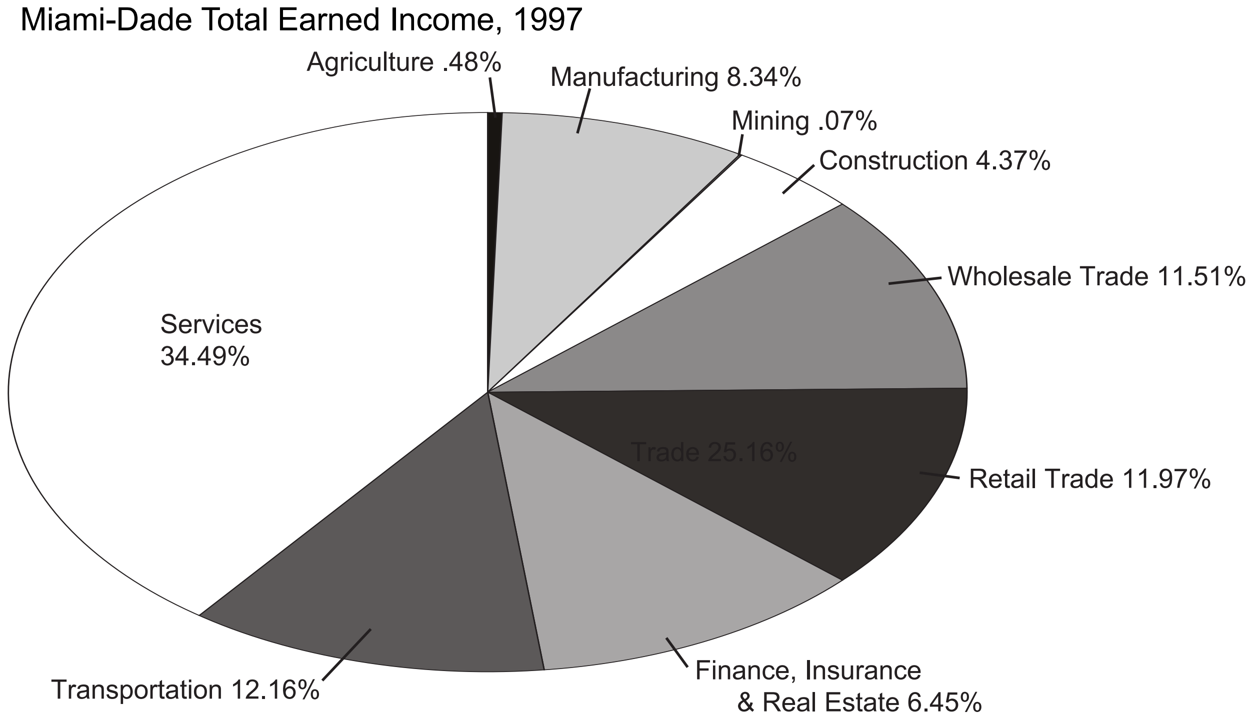
Figure 4b

State of FloridaTotal Employment by Major Industry Categories–1999



Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics, 2000.

Figure 5a



Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics, 2000.

Although Miami-Dade County's economy is fairly diverse – including services, transportation, tourism, trade, and agriculture – growth has been concentrated in relatively low-paying service sector jobs. And while Miami-Dade benefits greatly from both international trade and tourism, these dynamic sectors have not allowed the County to keep pace with the State.

Figures 5a and 5b depict the earned income from the economic sectors for Miami-Dade County and for the State.

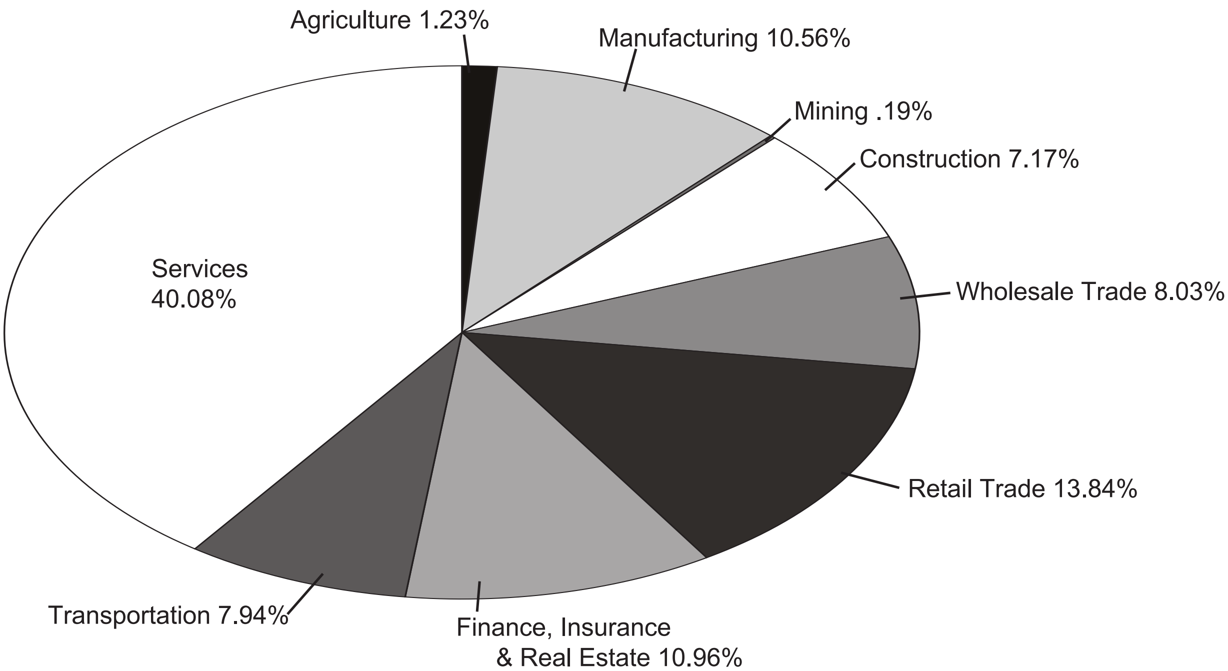
For both the County and the State, the services sector comprises approximately 40% of the earnings for the respective jurisdictions followed by the trade sector with 22- 24%. Appendix I contains additional economic data charts for Miami-Dade County.

Figure 6 shows the percent change in employment by major industry sectors for Miami-Dade County and Florida for the period 1990-1999. Between 1990 and 1999, employment in the major industrial sectors in Florida grew by 30%, compared to Miami-Dade County's diminished rate of 9.2%. The data shows some significant differences in job growth between the County and the State for the period. While the number of jobs in agriculture, construction/mining, and FIRE (finance, insurance, real estate) increased for the State, Miami-Dade had a decrease in these sectors. Additionally, employment in manufacturing decreased more dramatically in Miami-Dade County (-20.5%) than it did in the State as a whole (-5.9). Lastly, the services sector had the greatest growth with over 60% for the State, but only 23.9% for the County. However, this sector was the fastest growing in both State and County levels for the period (FDLES, 2000).

The Service Industry

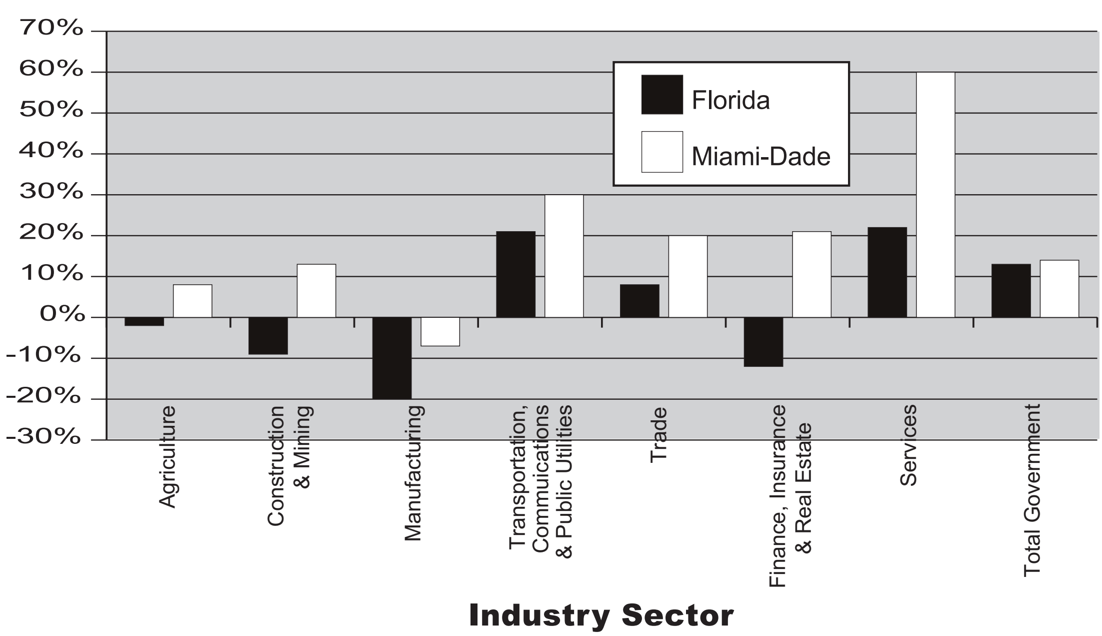
The service sector is a broad sector, ranging from professional services such as doctors, dentists, teachers and technicians to mechanics and repairmen to secretaries, truck drivers, laborers and fast food workers. This sector is also sensitive to tourist-related establishments such as lodgings, amusements and recreation activities. Overall, the sector employed 432,492 persons

Figure 5b
State of Florida's Total Earned Income, 1997



Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics, 2000.

Figure 6
Percent Change in Employment by Major Industry Sector for Miami-Dade and Florida, 1990-1999



Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics, 2000.

in Miami-Dade County in 1998, compared to 76,566 for manufacturing, 51,438 for construction, and 281,785 for wholesale and retail trade (U.S. Dept. of Commerce, 2000).

Employment is expected to continue to increase, shifting from the goods producing sector as manufacturing declines due to international competition (Rust, 1998). Employment in manufacturing and goods-producing industries have historically provided significantly higher wages than those in service-oriented enterprises (GCSSF, 1995). Average annual salaries in South Florida for 1997 were about $25K for jobs in the service sector, compared to $33K for manufacturing, $36K for mining, and $27K for construction (FDLES, 1997).

Trade

South Florida has emerged as a leading hub for trade within the global economy and as a result growth in international trade and port activity has accelerated significantly. Trade also includes food stores, eating and drinking establishments and miscellaneous retail - all of which are tourist-related. While trade between South Florida and Latin America remains substantial, emerging trade with Europe and the Far East provides a critical juncture for global distribution of goods through South Florida ports (Loiry, 1995). Miami, in particular, has emerged as a leading city and "gateway" for trade within this hemisphere and the greater global economy. The Florida Department of Commerce estimates that each additional $1 billion of foreign trade creates approximately 16,000 additional jobs (University of Massachusetts, 1994).

Transportation

The Port of Miami, located on Biscayne Bay and known as the "Cruise Capital of the World," is home to nearly 20 cruise ships, the largest home-ported cruise fleet in the world. The port also handles more "megaships" — vessels capable of transporting more than 2,000 guests — than any other port in the world (Beacon Council, 2000). In 1999, the Port of Miami handled 6.9 million tons of cargo and over 3 million passengers, representing a total economic impact of over $8.7 billion to the local economy, and providing 45,000 jobs (Port of Miami and Beacon Council, 2000).

Tourism and trade depend on the ability of Florida's airports to attract goods and passengers to the State. South Florida's airport facilities have experienced growth into the 1990's, largely due to merchandise trade between the South Florida region and Latin American/Caribbean markets (University of Massachusetts, 1994). Miami International is the fifth largest cargo airport and the ninth busiest passenger airport in the world (GCSSF, 1995 and Beacon Council, 2000). Airports are critically important to the region's tourist economy. Ninety-seven percent of Miami-Dade County's overnight visitors arrive in South Florida by air (GCSSF, 1995). Miami International Airport's economic impact on the County is approximately $13.2 billion (Beacon Council, 2000).

Tourism

Since the 1920s, tourism has been highly visible and constituted a major component of the South Florida economy. Although the annual growth in visitors began to decline in the 1990's, South Florida continues to attract millions each year. In 1994, southeast Florida attracted 13.4 million out-of-state visitors, or 33% of Florida's total 41 million visitors (Florida Consensus Estimating Conference, 1995). In 1996, tourism and recreation related taxable sales in Miami-Dade County alone amounted to almost $4.5 billion dollars (Joint Legislative Management Committee, 1998). Miami-Dade County collected over $20 million in 1997-98 in local option tourist development taxes (BEBR, 1999B). Miami-Dade County alone attracted 9.4 million visitors who spent $8.4 billion (Working Group, 1998).

Water-based attractions, businesses and activities in Miami-Dade County offer a unique experience, many of which are Biscayne Bay-related. There are over 40 shoreline parks in Miami-Dade along Biscayne Bay and its tributaries. In the five years prior to Hurricane Andrew, Biscayne National Park averaged 500,000 visitors a year. In 1994, this figure dropped to 29,700 due to damages caused by Andrew. This small number of visitors generated $13 million in economic benefits to the area (FAU/FIU, 1995). The number of visitors to BNP has increased since then to around 450,000 a year, generating approximately $200 million in economic benefits to the Miami-Dade economy. In addition, Everglades National Park is ranked in the top five tourist destinations the nation, and the Florida Keys National Marine Sanctuary is the number one dive destination in the world (U.S. COE, 1998).Aggressive competition, image and safety concerns, and immigration events in Florida, however, threaten prosperity in tourism. Because tourism plays such a critical role in the economy, even modest decreases in visitors and expenditures can be felt. For every 1,000 international visitors lost, the State loses $1.1 million in tourism spending, 20 area jobs, and $295,000 in local payrolls (Cook, 1993). Figure 7 shows the typical expenditures per day for visitors to Florida by air.

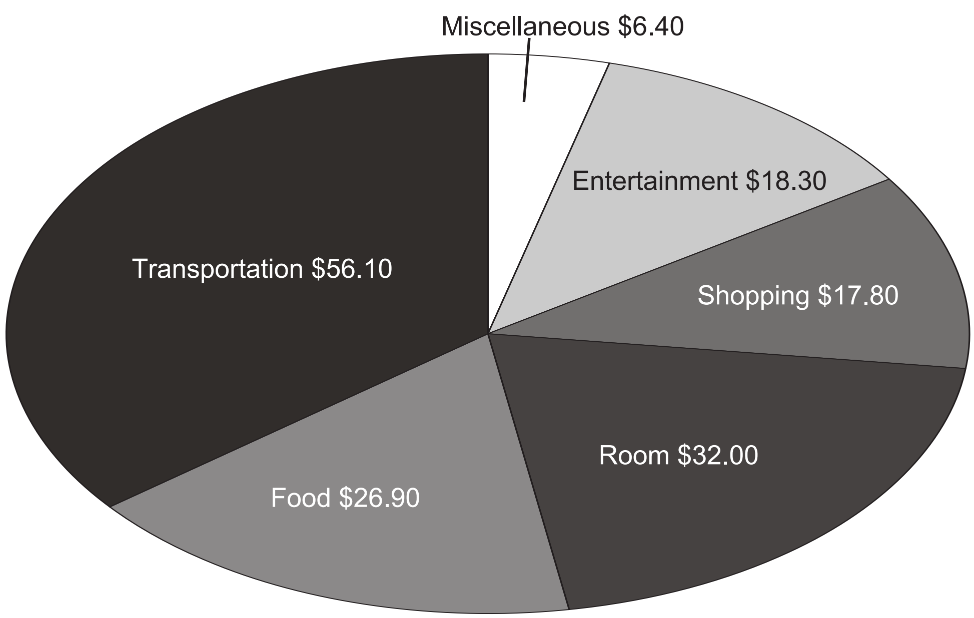
Agriculture

Miami-Dade is the second largest agricultural producing county in the State after Palm Beach, and 39th out of 3,076 nationally, with total annual sales of $416.5 million (USDA, 1997). Agriculture in Miami-Dade has an economic impact of approximately $842 million and employs roughly 23,000 people (Degner, et. al. 1996). The South Dade area is renown for its tropical fruits, container plants and its harvest of corn, tomatoes and other row crops. The region also provides a welcome interruption to the urban landscape of the County by providing a multi-purpose land buffer between Everglades National Park and Biscayne Bay.

Although agriculture contributes billions of dollars to the State's and the region's economy, the industry is facing economic as well as environmental challenges. Agricultural acreage in Florida and across the nation has decreased as local, regional, and state economies have grown and diversified. Between 1982 and 1992, the number of acres designated as agricultural in South Florida has decreased from 12.8 million acres to 10.7 million acres, a loss of 16% (U.S. Dept. of Commerce, 1984, 1994). This reduction stems from increasing urban sprawl, soil subsidence, and the conversion of some

Figure 7

Air Visitors - $157.30



Source BEBR, 1999B.

agricultural lands to other uses (Working Group, 1998).

Agriculture in South Florida has also been negatively impacted, especially the tomato industry, by trade agreements with Mexico and other market factors. The impact of the North American Free Trade Agreement on the competitiveness of domestic products is a critical issue for all of the region's industries. Manufacturers, producers, processors, and shippers warn of unfair advantages and a loss of their current competitive edge. They also express concern for the future normalization of relations with Cuba, especially as that country's products enter the same market arena (FDOC, 1993). In spite of this trend, agriculture continues to demonstrate an ability to adjust by shifting to international markets, specialty products, and domestic niche marketing (GCSSF, 1995).

C.4 *Economic Activities Directly Related to Biscayne Bay*

While the data previously presented corresponds to Miami-Dade County, and at times the entire South Florida region, there exists a need to better understand the relationship between Biscayne Bay and a vibrant, South Florida economy. Examples of economic activities that are directly dependent on a healthy bay ecosystem, and contribute to the local economy, include: 65 fish and seafood establishments, with an annual payroll of $21.9 million; 64 boat dealers, with annual payroll of $14.9 million; and 47 marinas, with annual payroll of $5.9 million (U.S. Census, 1993). Additionally, the 1995 Florida Department of Revenue statistics show that Miami-Dade County had gross sales of boats, motors, and equipment of $290 million, taxable sales of $123 million, and sales tax collected of $7.5 million. In 1991-1992, resident saltwater recreational fishing expenditures in the County amounted to $157 million (FL. Sea Grant, SGR-112). While the expenditures for tourist anglers directly using Biscayne Bay is unavailable, they spent $1.3 billion throughout the State (FL. Sea Grant, SGR-111).

The Miami River is the largest tributary to Biscayne Bay. Economic activities along the Miami River are directly dependent on, and have a direct impact on, Biscayne Bay. There 32 privately owned shipping terminals on the river make it the 5th largest port in State. These businesses handled approximately $4 billion in cargo in 1997, and trade with the Caribbean and Central/S. America is projected to increase steadily. The River helps to generate a large number of direct and indirect jobs related to the marine industry. The Miami River's waterfront is composed of marine industries, including shippers, marinas, boatyards, fishing docks, seafood wholesalers and related services, and residential areas. The River poses an environmental threat to the Bay due to large concentration of toxics in the sediments (Miami River Study Commission, 1998).

Agriculture in Miami-Dade is almost entirely concentrated in the south and west portions of the County. Many of the farms are adjacent to the southern Bay, with a narrow strip of land, part of Biscayne National Park, separating the agricultural lands from the waters of Biscayne Bay. While the economy of agriculture is not directly dependant on Biscayne Bay, agricultural activities do have a direct impact on the Bay's ecosystem. The vast system of canals that drain into the Bay from the inland sections of the County can potentially carry any runoff from farming activities. Likewise, agriculture could indirectly depend on the health and vitality of the entire ecosystem for its own survival. Many of the ongoing restoration efforts in Miami-Dade and throughout South Florida recognize the interdependency between agriculture and a healthy ecosystem.

The Port of Miami not only has a major impact on the County's economy, but it also has an impact on the Bay's ecology and geography. For several decades, the demands of the expanding port have necessitated the dredging of channels, removal of islands, and closing of waterways. The physical dynamics of the Bay are of vital importance to the port's success, and some activities which may be considered to be environmentally unsound will nonetheless be needed to ensure the economic success of the port's activities. Future decisions concerning alterations to the natural system of the Bay will need to weigh the economic impacts on the port with the environmental effects on the ecosystem.

C.5 *Conclusion*

Miami-Dade County's economy, though diversified, is unable to meet the demands of its growing population. The County's population is projected to increase by nearly half a million in the next decade; with continued immigration expected from the Caribbean and Latin America, along with migration from other states, Miami-Dade's population is likely to become larger, poorer, and more diverse. This influx of new citizens will need places to work, live, and play, thus increasing pressure on both the economy and the environment. Today, our economy is unable to provide good jobs for thousands of current residents, making Miami-Dade one of the poorest large counties in the nation. And while we do have important economic engines in the County (especially the airport and seaport), the growth they generate is relatively weak compared to the rest of the State. Perhaps more importantly, what job growth there is tends to be concentrated in the low-paying service sector. It seems clear, therefore, that Miami-Dade's economy will continue to be a major concern for public officials as they try to find ways to accommodate newcomers to our community over the next decade: they will have to create housing for new residents, along with seeking ways to boost our low rate of homeownership; they will have to provide jobs for new residents, along with attempting to improve the quality and availability of jobs for existing residents; and they will have to provide parks, schools, roads and other public facilities for a growing population.

Accommodating population growth and improving our economy will undoubtedly put additional pressure on natural resources, including Biscayne Bay. Although the relationship between Biscayne Bay and the economy of Miami-Dade County is not yet fully understood, some general conclusions are possible. Most obviously, more people living in the County will mean increased demand for water and increased demand for sewage treatment facilities. There will also be greater pressure for access to the Bay, even though this Committee believes that access is inadequate for our existing population. Newcomers will have to be educated about using the Bay without damaging it. And it seems likely that a larger population will mean greater volumes of pollutants, both in the air and on the ground, which may end up in the Bay.

It is also likely that there will be increased pressure to use the Bay for productive economic purposes. Today, it appears as though the most important direct economic impacts on the Bay are those found at the Port of Miami. Taken together, all Bay-related activities in the County (shipping, marinas, boat dealers, river traffic) appear to make up 10 to 15 percent of the economy. Because our economy is weak and the demands facing it quite large, the use of the Bay for these water-related (and in some cases, water-dependent) activities will likely have to continue. Given the importance of these activities to our economy, there will probably be significant pressure to increase their intensity and perhaps their physical scope. However, in so far as that expansion is detrimental to the environment, it cannot proceed on a long-term basis.

This Committee foresees a time in the near future when public officials will pursue an even more aggressive program of environmental restoration than they do now. This means that water-dependant economic activities will have to be made compatible with the enhancement of the Bay ecosystem, or they will have to be discontinued; that can occur only if we find other productive economic activities to supplant water-dependant uses that stand in the way of Bay restoration. Public officials will need to develop long-term management plans, both for the Bay and for the economy, in order to meet this goal.

However, this Committee also strongly believes that public officials should encourage the use of the waterfront for commercial and recreational purposes – especially the development of waterfront entertainment venues that are oriented toward the Bay and in those areas that are already intensely developed – which are compatible with environmental restoration and enhancement. Where economic use is environmentally friendly, waterfront development can create jobs – which are badly needed – and points of access for the public to enjoy the Bay. Other communities – San Francisco, Baltimore, Chattanooga, San Antonio, Boston, to name just a few – have made good economic use of their waterfronts without endangering the environment; we believe that Biscayne Bay provides an even greater opportunity for such development.

There are also economic activities surrounding the Bay which have an impact on the environment and these too may have to change as we move to aggressive environmental improvement. Currently, one of the primary economic uses of the Bay is residential. Most of the waterfront at the northern end of Biscayne Bay has been turned over to homes. Such use generates private wealth (in the form of privately held property) and taxable real estate values for local governments.

Although the transformation of mangroves into waterfront property impacted the Bay, the damage has been done and it would appear as though current residential use has few direct negative impacts on the condition of the Bay ecosystem (aside from a general contribution to non-point-source pollution). However, a privatized waterfront is clearly a barrier to habitat restoration and greater public access. If we are serious about habitat restoration in the northern and central Bay, then public officials should purchase property, on a willing seller basis as such opportunities arise, to make way for mangroves, other natural features, and public access points. This will require a multi-jurisdictional policy of incremental change directed toward our long-term goal of increasing the extent of natural shoreline in the Bay. Although these changes may not occur for several years, policymakers should prepare for them now.

After extensive discussions, this Committee believes that we should look well beyond water quality improvement with an ambitious program to increase natural habitat in broad stretches of the Bay – including the northern and central sections of the Bay. That goal may be compatible with continued use of the Bay for some economic purposes. Where economic use and environmental enhancement cannot be rendered compatible in the long run, however, public officials will need to find ways for the economy to compensate for the loss of water-dependant activities. The current weakness of our local economy is a barrier to this sort of managed trade-off between use and enhancement, since we need as much economic growth as our resources will allow. The longer our economy remains weak, the more difficult it will be to pursue the program we envision. Given the importance of the Bay, therefore, public officials must work strenuously to improve the condition of our economy and set the stage for the transformation of Biscayne Bay to a more pristine condition.

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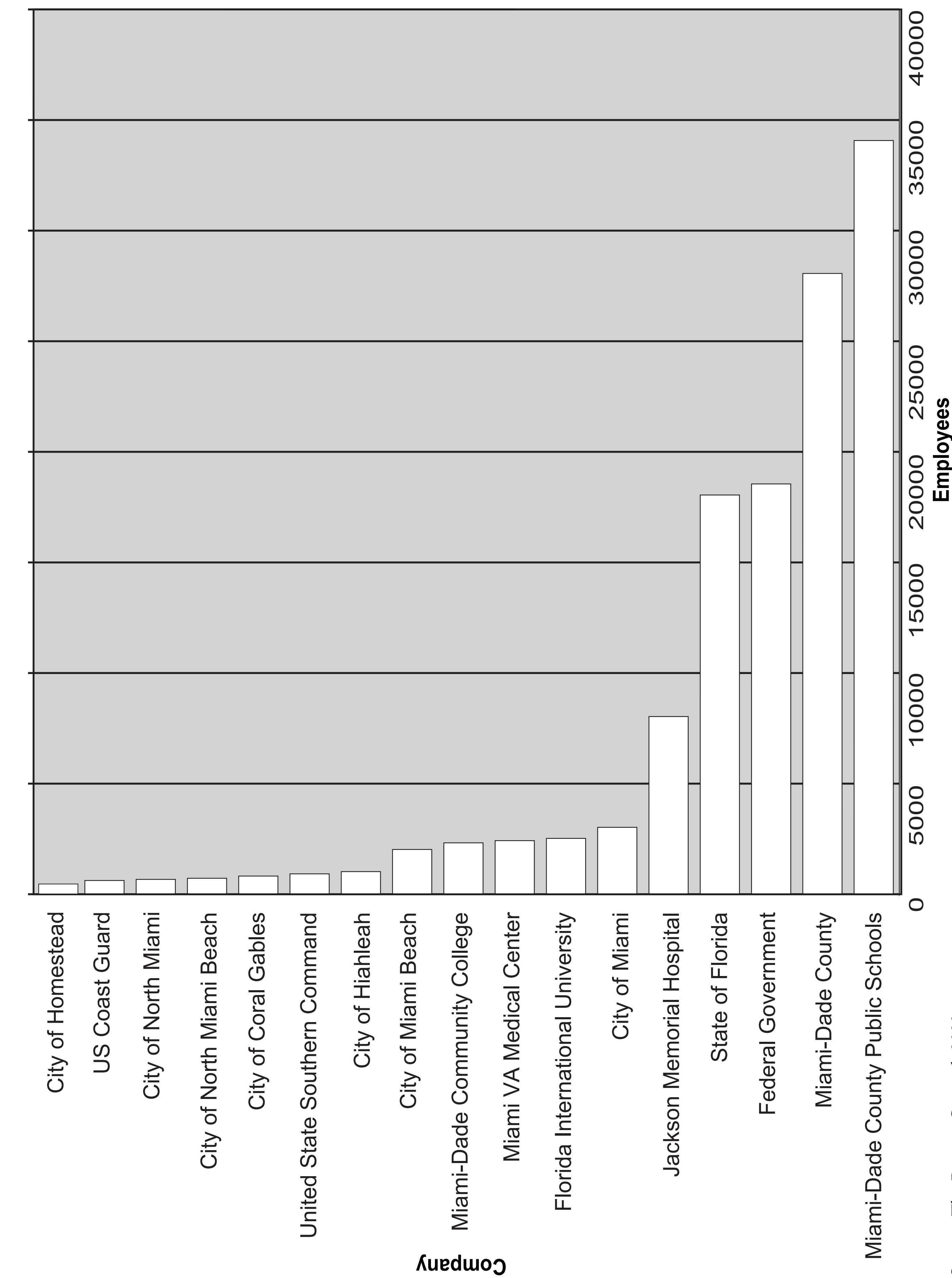
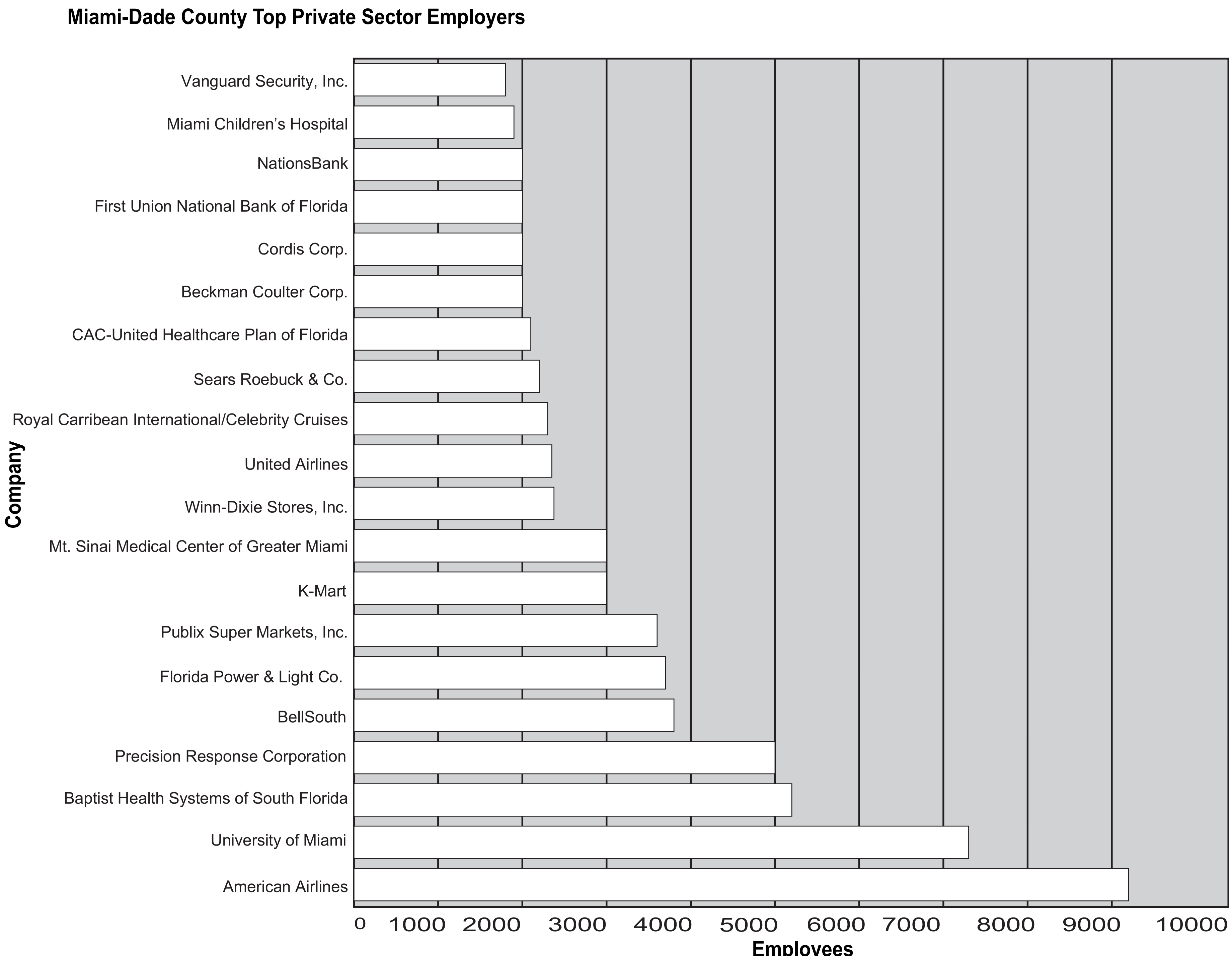
APPENDICES
ECONOMIC INFORMATION TABLES AND GRAPHS

Miami-Dade County Top Public Sector Employers



Source: The Beacon Council, 2000.



Source: The Beacon Council, 2000.

Southeast Florida
Annual Taxable Sales By Major Category ($Millions)
1980-96

County: Miami-Dade County

Year	Total	Autos & Access-ories	Other Durables	Tourism & Recre-ation	Non-durables	Constr-uction	Business Invest-ment
1980	11,391.9	1,651.1	700.3	2,168.2	3,562.1	1,091.1	2,219.1
1981	12 351.8	1,771.7	750.2	2,209.0	3,975.5	1,123.1	2,522.3
1982	11648.5	1,692.5	658.4	2,139.0	3,816.5	1,001.3	2,340.8
1983	12,075.5	1,896.5	686.7	2,192.0	3,941.3	925.5	2,433.5
1984	12,992.8	2,084.0	783.9	2,313.3	4,332.0	953.9	2,525.7
1985	14,018.3	2,255.9	852.6	2,408.4	4,854.7	1,081.3	2,565.4
1986	15,235.3	2,500.0	943.2	2,640.6	5,198.7	1,181.1	2,771.7
1987	17,076.6	2,584.7	1,087.4	2,923.1	5,852.5	1,409.2	3,219.7
1988	17,910.0	2,856.6	1,146.3	3,216.3	5,939.2	1,375.4	3,376.2
1989	18,134.1	2,686.2	1,178.8	3,389.1	6,114.6	1,368.6	3,396.8
1990	18,421.2	2,624.7	1,241.6	3,587.8	6,427.6	1,028.3	3,511.2
1991	18,144.6	2,572.1	1,203.4	3,686.4	6,482.4	904.6	3,295.7
1992	19,929.3	3,050.0	1,407.2	3,963.3	6,991.4	1,116.0	3,401.4
1993	22,060.0	3,426.4	1,700.0	4,114.5	7,625.8	1,450.9	3,742.4
1994	21,524.5	3,344.4	1,584.7	4,088.3	7,580.2	1,188.7	3,738.2
1995	22 465.7	3,547.5	1,650.3	4,260.0	7,901.7	1,153.5	3,952.7
1996	23 559.8	3,710.7	1,888.0	4,469.0	8,2532	1,136.3	4,102.6
Growth 1980-96							
$ millions	12,167.9	2,059.6	1,187.7	2,300.8	4,691.1	45.2	1,883.5
%	206.81	224.74	269.60	206.12	231.69	104.14	184.88

Source. Joint Legislative Management Committee, Division of Economic and Demographic Research. This table prepared by the South Florida Regional Planning Council. Sfmsatax.xls(Annual)/1, 20-08-98

Miami-Dade County
1997 Economic Census
Summary Profile by Economic Sector

NAICS Industry Code	Industry Description	Number of Establishments	Number of Employees	Annual Payroll ($1000)	Shipments/ Sales/Receipts ($1000)
NAICS INDUSTRIES					
31-33	Manufacturing	3,031	66,391	1,663,790	8,523,906
42	Wholesale trade	8,935	70,050	2,235,901	43,604,363
44-45	Retail trade	9,814	110,292	1,995,825	20,720,567
53	Real estate & rental & leasing	3,378	19,793	465,766	2,853,939
54	Professional, scientific, & technical services	7,821	42,781	1,855,966	4,640,043
56	Administrative & support & waste management & remediation service	3,336	71,916	1,319,742	2,867,483
61	Educational services	340	2,412	52,852	188,053
62	Health care & social assistance	6,157	60,718	1,877,500	4,782,531
71	Arts, entertainment, & recreation	546	6,853	222,708	765,145
72	Accommodation & food-services	3,835	75,597	878,468	3,199,453
81	Other services (except public administration)	3,901	22,435	385,773	1,390,964
NON-TAXABLE INDUSTRIES					
54	Professional, scientific, & technical services	36	302	9,744	28,902
61	Educational services	40	316	8,928	23,043
62	Health care & social assistance	454	41,786	1,312,688	2,811,505
71	Arts, entertainment, & recreation	73	2,762	44,676	126,209
81	Other services (except public administration)	988	6,317	130,884	870,023
MERCHANT WHOLESALERS					
42	Wholesale trade	8,171	63,757	1,970,814	35,347,386
MANUFACTURERS' SALES BRANCHES AND SALES OFFICES					
42	Wholesale trade	161	4,231	194,438	6,152,712
AGENTS, BROKERS, AND COMMISSION MERCHANTS					
42	Wholesale trade	603	2,062	70,649	2,104,265

Note: NAICS INDUSTRIES is defined as the taxable portion of the Services sectors, the Type of Operation Totals for the Wholesale sector, and all other sectors in the Economic Census. Excludes data for auxiliaries. Data in this table arc subject to employment-and/or sales-size minimums that vary by geographic level. All survey and census results contain measurement error and may contain sampling error. Information about these potential errors is provided or referenced with the data or the source of the data. The Census Bureau recommends that data users incorporate this information into their analyses as these errors could impact inferences. Researchers analyzing data to create their own estimates are responsible for the validity of those estimates and should not cite the Census Bureau as the source of the estimates but only as the source of the core data. We have modified some data to protect individuals privacy, but in a way that preserves the usefulness of the data.

Source: U.S. Bureau of the Census, 1997 Economic Census.
This table prepared by the South Florida Regional Planning Council 97ect1sf.xls (Miami-Dade)/1, 03-08-00

FASTEST-GROWING INDUSTRIES*
AREA: FLORIDA - MIAMI-DADE COUNTY

	INDUSTRY		EMPLOYMENT BASE YEAR	EMPLOYMENT PROJECTED	CHANGE	
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT
1	89	Miscellaneous Business Services	674	1,119	445	66.02
2	78	Motion Pictures	2,642	4,124	1,482	56.09
3	47	Transportation Services	13,637	18,223	4,586	33.63
4	73	Business Services	69,724	92,017	22,293	31.97
5	62	Security and Commodity Brokers	3,695	4,874	1,179	31.91
6	87	Engineering and Management Services	25,220	32,910	7,690	30.49
7	57	Furniture and Homefurnishings Stores	9,667	12,241	2,574	26.63
8	44	Water Transportation	8,625	10,837	2,212	25.65
9	07	Agricultural Services	7,930	9,950	2,020	25.47
10	83	Social Services	15,180	18,851	3,671	24.18
11	79	Amusement and Recreation Services	11,932	14,733	2,801	23.47
12	61	Nondepository Institutions	4,598	5,623	1.025	22.29
13	45	Transportation by Air	29,950	36,603	6,653	22.21
14	81	Legal Services	14,743	17,856	3,113	21.12
15	82	Educational Services	16,670	20,184	3,514	21.08
16	41	Local and Interurban Transit	2,719	3,210	491	18.06
17	63	Insurance Carriers	10,179	11,965	1,786	17.55
18	80	Health Services	87,698	103,013	15,315	17.46
19	50	Wholesale Trade, Durable Goods	46,379	54,275	7,896	17.02
20	59	Miscellaneous Retail Stores	25,042	29,255	4,213	16.82

*This table includes industries with a minimum total change of 250 jobs.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

INDUSTRIES GAINING THE MOST NEW JOBS
AREA: FLORIDA - MIAMI-DADE COUNTY

			EMPLOYMENT			
	INDUSTRY		BASE YEAR	PROJECTED	CHANGE	
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT
1	73	Business SeNices	69,724	92,017	22,293	31.97
2	80	Health Servkes	07,698	103,013	15,315	17.48
3	93	Local Govemment	99,245	112,103	12,858	12.96
4	50	Wholesale Trade, Durable Goods	46,379	54,275	7,896	17.02
5	87	Engineering and Management Services	25,220	32,910	7,690	30.49
6	58	Eating and Drinking Places	54,501	61,256	6,755	12.39
7	45	Transportation by Air	29,950	36,603	6,653	22.21
8	47	Transportation Services	13,637	18,223	4,586	33.63
9	59	Miscellaneous Retail Stores	25,042	29,2S5	4,213	16.82
10	83	Social Services	15,180	18,851	3,671	24.18
11	82	Educatbnal Services	16,670	20,184	3,514	21.08
12	51	Vvholesale Trade, Nondurable Goods	35,567	38,769	3,202	9.00
13	81	Legal Services	14,743	17,856	3,113	21.12
14	54	Food Siores	29,750	32,559	2,809	9.44
15	79	ArnusementandRecreationServices	11,932	14,733	2,801	23.47
16	57	Fumiture and Homefumishings Stores	9,667	12,241	2,574	26.63
17	65	Real Estate	20,873	23,099	2,226	10.66
18	44	Water Transportation	8,625	10,837	2,212	25.65
19	07	Agricultural Services	7,930	9,950	2,020	25.47
20	92	State Govemment	17,967	19,767	1,800	10.02

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

FASTEST-GROWING OCCUPATIONS
AREA: FLORIDA - MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
1	34026	Camera Operator, Television and Movies	197	323	126	63.96	16	13	3	9.78
2	22127	Computer Engineer	712	1,158	446	62.64	49	45	4	25.28
3	25104	Computer Support Specialist	2,271	3,395	1,124	49.49	126	112	14	17.33
4	56008	Mail Machine Operator	676	1,009	333	49.26	53	33	20	8.71
5	25102	Systems Analyst	3,057	4,527	1,470	48.09	166	147	19	24.28
6	31317	Instructor, Nonvocational Education	1,133	1,674	541	47.75	66	54	12	14.73
7	56005	Duplicating Machine Operator	449	655	206	45.88	34	21	13	8.87
8	15032	Lawn Service Manager	409	595	186	45.48	22	19	3	12.34
9	34056	Producer, Director, Actor, Entertainer	955	1,384	429	44.92	64	43	21	18.13
10	32302	Respiratory Therapist	931	1,338	407	43.72	55	41	14	17.70
11	32925	Cardiology Technologist	269	382	113	42.01	18	11	7	17.57
12	97808	Parking Lot Attendant	1,151	1,628	477	41.44	68	48	20	6.50
13	49026	Telemarketer, Door-To-Door Sales, Street Vendor	8,419	11,828	3,409	40.49	558	341	217	12.29
14	66011	Home Health Aide	3,507	4,865	1,358	38.72	185	136	49	8.26
15	53802	Travel Clerk	364	499	135	37.09	22	14	8	16.30
16	79806	Veterinary Assistant	348	476	128	36.78	18	13	5	8.23
17	97517	Ordinary Seamen and Marine Oiler	304	412	108	35.53	23	11	12	11.89
18	27302	Social Worker, Medical and Psychiatric	1,953	2,616	663	33.95	91	66	25	16.54
19	53123	Adjustment Clerk	4,048	5,368	1,320	32.61	158	132	26	11.02
20	68021	Usher, Lobby Attendant, Ticket Taker	699	926	227	32.47	36	23	13	6.50
21	21111	Tax Preparer	1,128	1,494	366	32.45	62	37	25	14.87
22	66017	Physical, Corrective Therapy Assistant	697	921	224	32.14	39	22	17	13.79
23	34005	Technical Writer	547	718	171	31.26	31	17	14	19.44
24	32114	Veterinarian, Veterinary Inspector	405	530	125	30.86	21	13	8	29.44
25	55302	Stenographer	1,009	1,320	311	30.82	47	31	16	14.42
26	27307	Residential Counselor	538	703	165	30.67	29	17	12	9.13
27	34058	Athlete, Coach, Umpire and Related	610	796	186	30.49	41	19	22	19.03
28	25103	Database Administrator	544	709	165	30.33	26	17	9	23.
29	97514	Able Seaman	377	491	114	30.24	25	11	14	13.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

FASTEST-GROWING OCCUPATIONS*
AREA: FLORIDA - MIAMI-DADE COUNTY

OCCUPATION RANK	OCCUPATION CODE	TITLE	EMPLOYMENT BASE YEAR 1997	EMPLOYMENT PROJECTED 2007	CHANGE TOTAL	CHANGE PERCENT	AVERAGE ANNUAL OPENINGS TOTAL	AVERAGE ANNUAL OPENINGS DUE TO GROWTH	AVERAGE ANNUAL OPENINGS DUE TO SEPARATIONS	AVERAGE WAGE 1998 ($)
30	22126	Electrical and Electronic Engineer	1,643	2,135	492	29.95	84	49	35	24.11
31	31517	Instructional Coordinator	385	499	114	29.61	15	11	4	17.50
32	85705	Data Processing Equipment Repairer	472	611	139	29.45	21	14	7	15.47
33	68035	Personal Home Care Aide	924	1,193	269	29.11	51	27	24	8.70
34	43017	Sales Agent. Business Services	3,221	4,157	936	29.06	160	94	66	18.73
35	66005	Medical Assistant	2,964	3,808	844	28.48	157	84	73	10.87
36	53128	Brokerage Clerk	355	456	101	28.45	15	10	5	12.96
37	32928	Surgical Technician	616	787	171	27.76	32	17	15	12.05
38	34028	Broadcast Technician	660	841	181	27.42	53	18	35	14.10
39	27308	Human Services Worker	1,680	2,136	456	27.14	89	46	43	12.07
40	55332	Interviewing Clerk, Exc. Personnel	1,539	1,950	411	26.71	90	41	49	9.44
41	97502	Captain	471	594	123	26.11	30	12	18	15.98
42	49034	Demonstrator and Product Promoter	658	829	171	25.99	35	17	18	7.59
43	13017	Engineering, Science, Comp. Systems Manager	1,397	1,758	361	25.84	60	36	24	32.06
44	32911	Medical Records Technician	1,091	1,368	277	25.39	55	28	27	10.00
45	32514	Optician, Dispensing and Measuring	475	594	119	25.05	18	12	6	14.23
46	66002	Dental Assistant	1,743	2,172	429	24.61	70	43	27	11.19
47	31321	Instructor and Coach. Sports	1,515	1,876	361	23.83	52	36	16	12.59
48	79041	Laborer, Landscaper, Groundskeeper	8,124	10,051	1,927	23.72	435	193	242	7.82
49	34035	Artist and Commercial Artist	3,070	3,788	718	23.39	135	72	63	15.50
50	32511	Physician Assistant	759	936	177	23.32	31	18	13	21.84
51	15008	Medicine and Health Service Manager	1,704	2.098	394	23.12	69	39	30	25.47
52	63035	Detective and Investigator	525	645	120	22.86	25	12	13	12.79
53	32908	Dental Hygienist	1,094	1,343	249	22.76	50	25	25	22.43
54	68026	Flight Attendant	1,242	1,523	281	22.62	55	28	27	18.99
55	43014	Securities, Financial Service Sales	2,825	3,464	639	22.62	85	64	21	28.50
56	34008	Public Relations Specialist	1,249	1,531	282	22.58	75	28	47	16.78
57	31314	Teacher, Vocational Education	2,834	3,458	624	22.02	92	62	30	15.
58	53508	Bill and Account Collector	2,489	3,034	545	21.90	121	55	66	11.

*This table includes occupations with a minimum total change of 100 jobs.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics. Florida Industry and Occupational Employment Projections to 2007

FASTEST-GROWING OCCUPATIONS*
AREA: FLORIDA - MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
59	85323	Aircraft Mechanic	2,426	2,957	531	21.89	101	53	48	16.91
60	58011	Transportation Agent	486	591	105	21.60	14	11	3	13.40
61	32508	Emergency Medical Technician	1,245	1,511	266	21.37	58	27	31	11.48
62	53805	Reservation and Transportation Ticket Agent	6,306	7,640	1,334	21.15	266	133	133	12.19
63	13014	Administrative Service Manager	2,844	3,445	601	21.13	110	60	50	20.19
64	79017	Animal Caretaker, Except Farm	1,014	1,228	214	21.10	36	21	15	8.94
65	55305	Receptionist, Information Clerk	12,969	15,691	2,722	20.99	520	272	248	9.15
66	32308	Physical Therapist	1,085	1,312	227	20.92	39	23	16	27.71
67	34038	Designer, Exc. Interior Designer	2,516	3,040	524	20.83	89	52	37	14.92
68	43021	Travel Agent	2,363	2,855	492	20.82	99	49	50	10.29
69	55102	Legal Secretary	4,329	5,215	886	20.47	160	89	71	15.81
70	28305	Paralegal	1,990	2,396	406	20.40	58	41	17	19.34
71	34041	Interior Designer	672	809	137	20.39	24	14	10	29.11
72	55314	Human Resources Assistant, Except Payroll	1,566	1,880	314	20.05	61	31	30	11.75
73	27311	Recreation Worker	1,563	1,876	313	20.03	72	31	41	10.91
74	68014	Amusement and Recreation Attendant	2,240	2,688	448	20.00	86	45	41	6.63
75	13005	Human Resources Manager	1,533	1,839	306	19.96	67	31	36	19.71
76	43005	Broker, Real Estate	622	745	123	19.77	25	12	13	23.89
77	32305	Occupational Therapist	609	729	120	19.70	21	12	9	25.13
78	15011	Property and Real Estate Manager	3,244	3,876	632	19.48	107	63	44	17.93
79	34051	Musician, Instrumental	1,140	1,362	222	19.47	46	22	24	12.87
80	97947	Industrial Truck and Tractor Operator	2,197	2,623	426	19.39	69	43	26	10.43
81	21905	Management Analyst	2,270	2,701	431	18.99	61	43	18	23.91
82	63047	Guard	12,488	14,855	2,367	18.95	549	237	312	7.81
83	13011	Marketing, Adv., Public Relations Manager	3,878	4,597	719	18.54	126	72	54	26.62
84	57302	Mail Clerk, Exc. Mail Machine	935	1,108	173	18.50	39	17	22	8.26
85	43011	Real Estate Appraiser	689	816	127	18.43	27	13	14	15.01
86	98705	Refuse Collector	690	817	127	18.41	40	13	27	11.68
87	22511	Mechanical Engineering Technician	664	786	122	18.37	26	12	14	16.45

*This table includes occupations with a minimum total change of 100 jobs.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

FASTEST-GROWING OCCUPATIONS*
AREA: FLORIDA - MIAMI-DADE COUNTY

OCCUPATION			EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
88	27305	Social Worker, Exc. Medical and Psychiatric	2,435	2,881	446	18.32	77	45	32	14.23
89	34047	Music Director, Singer, and Related	762	901	139	18.24	30	14	16	9.89
90	31303	Teacher, Preschool and Kindergarten	3,851	4,543	692	17.97	151	69	82	7.27
91	66008	Nursing Aide and Orderly	7,782	9,174	1,392	17.89	247	139	108	8 26
92	22121	Civil Engineer, Including Traffic	1,315	1,550	235	17.87	49	24	25	25 77
93	21511	Personnel, Training, Labor Rel. Specialist	2,061	2,425	364	17.66	91	36	55	16.51
94	15023	Communication, Transport., Utility Manager	1,795	2,111	316	17.60	63	32	31	22.60
95	85702	Telephone and Cable TV Installer/Repairer	873	1,026	153	17.53	43	15	28	12.60
96	58005	Dispatcher: Exc. Police, Fire, Ambulance	1,504	1,765	261	17.35	50	26	24	11.68
97	68038	Child Care Worker	6,185	7,239	1,054	17.04	166	105	61	7.03
98	32919	Radiologic Technician	1,545	1,806	261	16.89	48	26	22	16.36
99	58026	Order Filler, Sales	2,238	2,615	377	16.85	92	38	54	8.07
100	97105	Truck Driver, Light	15,615	18,244	2,629	16.84	487	263	224	9.74

This table includes occupations with a minimum total change of 100 jobs.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

OCCUPATIONS GAINING THE MOST NEW JOBS
AREA: FLORIDA- MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
1	55347	General Office Clerk	27,358	31,785	4,427	16.18	1,201	443	758	9.95
2	19005	General Manager and Top Executive	29,384	33,388	4,004	13.63	915	400	515	28.32
3	49011	Salesperson, Retail	35,411	39,188	3,777	10.67	1,578	378	1,200	9.09
4	49026	Telemarketer,Door-To-DoorSales, Street Vendor	8,419	11,828	3,409	40.49	558	341	217	12.29
5	49023	Cashier	23,145	26,221	3,076	13.29	1,317	308	1,009	7.06
6	32502	Registered Nurse	18,807	21,781	2,974	15.81	607	297	310	22.12
7	55305	Receptionist Information Clerk	12,969	15,691	2,722	20.99	520	272	248	9.15
8	97105	Truck Driver Light	15,615	18,244	2,629	16.84	487	263	224	9.74
9	63047	Guard	12,488	14,855	2,367	18.95	549	237	312	7.81
10	79041	Laborer, Landscaper, Groundskeeper	8,124	10,051	1,927	23.72	435	193	242	7.82
11	65041	Food Preparation Server, Fast Food	13,164	14,971	1,807	13.73	906	181	725	6.52
12	49008	Sales Rep., Nonscientific, Exc. Retail	13,394	14,933	1,539	11.49	481	154	327	15.26
13	21114	Accountant and Auditor	9,295	10,830	1,535	16.51	298	154	144	21.66
14	25102	Systems Analyst	3,057	4,527	1,470	48.09	166	147	19	24.28
15	31305	Teacher, Elementary	9,685	11,115	1,430	14.77	367	143	224	16.40
16	55108	Secretary, Exc. Legal and Medical	20,863	22,266	1,403	6.72	480	140	340	11.62
17	66008	Nursing Aide and Orderly	7,782	9,174	1,392	17.89	247	139	108	8.26
18	66011	Home Health Aide	3,507	4,865	1,358	38.72	185	136	49	8.26
19	31308	Teacher, Secondary School	9,178	10,524	1,346	14.67	430	135	295	23.28
20	53805	Reservation and Transportation Ticket Agent	6,306	7,640	1,334	21.15	266	133	133	12.19
21	53123	Adjustment Clerk	4,048	5,368	1,320	32.61	158	132	26	11.02
22	85132	Maintenance Repairer, General Utility	9,582	10,723	1,141	11.91	329	114	215	10.28
23	65008	Waiter and Waitress	15,402	16,537	1,135	7.37	962	114	848	6.38
24	25104	Computer Support Specialist	2,271	3,395	1,124	49.49	126	112	14	17.33
25	65038	Food Preparation Worker	8,935	10,030	1,095	12.26	602	110	492	7.02
26	67005	Janitor and Cleaner	14,041	15,128	1,087	7.74	414	109	305	7.15
27	68038	Child Care Worker	6,185	7,239	1,054	17.04	166	105	61	7.03
28	28108	Lawyer	9,669	10,722	1,053	10.89	211	105	106	37.36
29	58023	Stock Clerk, Stockroom or Warehouse	7,389	8,411	1,022	13.83	214	102	112	8.62

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

OCCUPATIONS GAINING THE MOST NEW JOBS*
AREA: FLORIDA- MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
30	43017	Sales Agent, Business Services	3,221	4,157	936	29.06	160	94	66	18.73
31	55102	Legal Secretary	4,329	5,215	886	20.47	160	89	71	15.81
32	66005	Medical Assistant	2,964	3,808	844	28.48	157	84	73	10.87
33	58028	Traffic, Shipping, and Receiving Clerk	9,075	9,846	771	8.50	228	77	151	10.88
34	13002	Financial Manager	5,374	6,130	756	14.07	161	76	85	27.14
35	13011	Marketing, Adv., Public Relations Manager	3,878	4,597	719	18.54	126	72	54	26.62
36	34035	Artist and Commercial Artist	3,070	3,788	718	23.39	135	72	63	15.50
37	32505	Licensed Practical Nurse	5,369	6,073	704	13.11	186	70	116	18.18
38	31303	Teacher, Preschool and Kindergarten	3,851	4,543	692	17.97	151	69	82	7.27
39	27302	Social Worker, Medical and Psychiatric	1,953	2,616	663	33.95	91	66	25	16.54
40	53905	Teacher's Aide and Educational Assistant	4,706	5,368	662	14.07	120	66	54	6.36
41	43014	Securities, Financial Service Sales	2,825	3,464	639	22.62	85	64	21	28.50
42	98902	Hand Packer and Packager	6,529	7,162	633	9.70	224	63	161	6.87
43	15011	Property and Real Estate Manager	3,244	3,876	632	19.48	107	63	44	17.93
44	65026	Cook, Restaurant	6,300	6,925	625	9.92	228	63	165	9.01
45	31314	Teacher, Vocational Education	2,834	3,458	624	22.02	92	62	30	15.72
46	97102	Truck Driver, Heavy	8,910	9,518	608	6.82	190	61	129	11.78
47	13014	Administrative Service Manager	2,844	3,445	601	21.13	110	60	50	20.19
48	67002	Maid and Housekeeping Cleaner	9,258	9,856	598	6.46	233	60	173	6.82
49	32102	Physician	6,342	6,918	576	9.08	157	58	99	39.26
50	85302	Automotive Mechanic	5,971	6,546	575	9.63	206	58	148	14.92
51	55338	Bookkeeping, Accounting, and Auditing Clerk	17,996	18,559	563	3.13	392	56	336	11.62
52	87202	Electrician	4,205	4,753	548	13.03	141	55	86	14.05
53	53508	Bill and Account Collector	2,489	3,034	545	21.90	121	55	66	11.12
54	15005	Education Administrator	3,355	3,899	544	16.21	138	54	84	24.27
55	31317	Instructor, Nonvocational Education	1,133	1,674	541	47.75	66	54	12	14.73
56	85323	Aircraft Mechanic	2,426	2,957	531	21.89	101	53	48	16.91
57	34038	Designer, Exc. Interior Designer	2,516	3,040	524	20.83	89	52	37	14.92
58	22126	Electrical and Electronic Engineer	1,643	2,135	492	29.95	84	49	35	24.11

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

OCCUPATIONS GAINING THE MOST NEW JOBS
AREA: FLORIDA- MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE WAGE
RANK	CODE	TITLE	BASE YEAR 1997	PROJECTED 2007	TOTAL	PERCENT	TOTAL	DUE TO GROWTH	DUE TO SEPARATIONS	1998 ($)
59	43021	Travel Agent	2,363	2,855	492	20.82	99	49	50	10.29
60	97808	Parking Lot Attendant	1,151	1,628	477	41.44	68	48	20	6.50
61	15026	Food Service and Lodging Manager	5,723	6,188	465	8.13	147	47	100	14.96
62	49005	SalesRep.,ScientificProd.,Exc.Retail	3,397	3,857	460	13.54	129	46	83	21.58
63	27308	Human Services Worker	1,680	2,136	456	27.14	89	46	43	12.07
64	68014	Amusement and Recreation Attendant	2,240	2,688	448	20.00	86	45	41	6.63
65	22127	Computer Engineer	712	1,158	446	62.64	49	45	4	25.28
66	27305	Social Worker, Exc. Medical and Psychiatric	2,435	2,881	446	18.32	77	45	32	14.23
67	21905	Management Analyst	2,270	2,701	431	18.99	61	43	18	23.91
68	66002	Dental Assistant	1,743	2,172	429	24.61	70	43	27	11.19
69	34056	Producer, Director, Actor, Entertainer	955	1,384	429	44.92	64	43	21	18.13
70	49017	Counter and Rental Clerk	3,264	3,690	426	13.05	184	43	141	9.92
71	97947	Industrial Truck and Tractor Operator	2,197	2,623	426	19.39	69	43	26	10.43
72	31311	Teacher, Special Education	2,858	3,280	422	14.77	66	42	24	24.10
73	97111	Bus Driver, School	2,820	3,240	420	14.89	92	42	50	8.23
74	55332	Interviewing Clerk, Exc. Personnel	1,539	1,950	411	26.71	90	41	49	9.44
75	32302	Respiratory Therapist	931	1,338	407	43.72	55	41	14	17.70
76	28305	Paralegal	1,990	2,396	406	20.40	58	41	17	19.34
77	63017	Correction Officer and Jailer	3,011	3,414	403	13.38	122	40	82	13.33
78	55344	Billing, Cost and Rate Clerk	2,639	3,041	402	15.23	92	40	52	10.96
79	15008	Medicine and Health Service Manager	1,704	2,098	394	23.12	69	39	30	25.47
80	83005	Production Inspector, Grader	2,523	2,904	381	15.10	107	38	69	10.43
81	43008	Sales Agent, Real Estate	4,713	5,092	379	8.04	133	38	95	16.24
82	58026	Order Filler, Sales	2,238	2,615	377	16.85	92	38	54	8.07
83	81002	First Line Superv., Mechanic and Repairer	3,520	3,892	372	10.57	137	37	100	19.05
84	21111	Tax Preparer	1,128	1,494	366	32.45	62	37	25	14.87
85	21511	Personnel, Training, Labor Rel. Specialist	2,061	2,425	364	17.66	91	36	55	16.51
86	98905	Vehicle, Equipment Cleaner	2,477	2,840	363	14.65	114	36	78	7.36
87	13017	Engineering, Science, Comp. Systems Manager	1,397	1,758	361	25.84	60	36	24	32.06

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007.

DECLINING OR SLOW GROWTH OCCUPATIONS
AREA: FLORIDA- MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
1	92717	Sewing Machine Operator, Garment	4,954	3,133	-1,821	-36.76	68	-182	68	6.76
2	79801	Farm Worker	4,235	3,753	-482	-11.38	130	-48	130	N.A.*
3	49021	Stock Clerk' Sales Floor	11,135	10,844	-291	-2.61	168	-29	168	7.53
4	56011	Computer Operator, Exc. Peripheral Equip.	1,938	1,715	-223	-11.51	27	-22	27	12.60
5	57102	Switchboard Operator	2,729	2,528	-201	-7.37	59	-20	59	8.11
6	53102	Bank Teller	4,071	3,914	-157	-3.86	175	-16	175	9.24
7	98313	Helper, Electrician	1,123	968	-155	-13.80	52	-16	52	8.76
8	71002	Farmer	1,443	1,297	-146	-10.12	22	-15	22	N.A.*
9	71005	Farm Manager	1,220	1,084	-136	-11.15	21	-14	21	N.A.*
10	32105	Dentist	1,196	1,078	-118	-9.87	24	-12	24	47.79
11	81008	First Line Superv.,Production	3,231	3,114	-117	-3.62	84	-12	84	16.72
12	57105	Directory Assistance Operator	239	124	-115	-48.12	5	-12	5	10.11
13	65023	Butcher and Meat Cutter	1,273	1,162	-111	-8.72	30	-11	30	10.35
14	57108	Central Office Operator	342	231	-111	-32.46	7	-11	7	9.62
15	93938	Meat, Poultry, Fish Cutter	425	320	-105	-24.71	10	-11	10	7.17
16	89502	Patternmaker, Layout Worker, Fabric	367	262	-105	-28.61	7	-11	7	7.74
17	91905	Plastic Molding, Casting Operator	365	272	-93	-25.48	9	-9	9	7.41
18	92705	Textile Machine Operator	1,113	1,021	-92	-8.27	19	-9	19	7.79
19	92728	Pressing Machine Operator, Textiles	624	540	-84	-13.46	14	-8	14	7.40
20	87108	Drywall Installer	488	405	-83	-17.01	7	-8	7	13.62
21	89311	Cabinetmaker and Bench Carpenter	1,296	1,215	-81	-6.25	15	-8	15	8.76
22	92908	Photographic Processing Machine Operator	413	332	-81	-19.61	16	-8	16	7.91
23	92702	Textile Machine Setter/Operator	160	79	-81	-50.63	3	-8	3	10.77
24	85726	Station installer and Repairer, Telephone	186	110	-76	40.86	6	-8	6	19.52
25	15014	Industrial Production Manager	973	902	-71	-7.30	17	-7	17	22.44
26	89123	Jeweler and Silversmith	359	288	-71	-19.78	9	-7	9	12.77
27	85723	Electrical Powerline Installer/Repairer	689	623	-66	-9.58	16	-7	16	16.74
28	92512	Offset Lithographic Press Setter/Operator	416	354	-62	-14.90	8	-6	8	15.36
29	56021	Data Entry Keyer, Composing	143	84	-59	-41.26	1	-6	1	10.03

*Wage information is unavailable for this occupational category.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007

DECLINING OR SLOW GROWTH OCCUPATIONS**
AREA: FLORIDA- MIAMI-DADE COUNTY

	OCCUPATION		EMPLOYMENT		CHANGE		AVERAGE ANNUAL OPENINGS			AVERAGE
			BASE YEAR	PROJECTED				DUE TO	DUE TO	WAGE
RANK	CODE	TITLE	1997	2007	TOTAL	PERCENT	TOTAL	GROWTH	SEPARATIONS	1998 ($)
30	89508	Upholsterer	387	329	-58	-14.99	7	-6	7	10.65
31	83002	Inspector, Tester, Grader, Precision	481	426	-55	-11.43	10	-6	10	13.94
32	68002	Barber	368	316	-52	-14.13	11	-5	11	8.11
33	63028	Criminal Investigator, Federal	687	642	45	-6.55	18	-5	18	25.20
34	98311	Helper, Brick and Mason	311	269	-42	-13.50	14	-4	14	8.86
35	89706	Paste-Up Worker	93	53	-40	-43.01	2	-4	2	10.08
36	93926	Cutter and Trimmer, Hand	307	269	-38	-12.38	7	-4	7	7.27
37	89511	Shoe and Leather Worker	250	212	-38	-15.20	5	-4	5	9.07
38	91705	Welding Machine Operator	236	198	-38	-16.10	6	-4	6	8.80
39	92308	Sawing Machine Operator/Tender	148	111	-37	-25.00	4	-4	4	7.41
40	32926	EKG Technician	172	140	-32	-18.60	4	-3	4	12.01
41	92914	Paper Goods Machine Setter/Operator	347	315	-32	-9.22	7	-3	7	10.20
42	87308	Hard Tile Setter	224	193	-31	-13.84	6	-3	6	10.51
43	89517	Presser, Delicate Fabrics	342	311	-31	-9.06	8	-3	8	7.13
44	92546	Bindery Machine Operator	413	383	-30	-7.26	7	-3	7	9.73
45	92714	Textile Dyeing Machine Operator	86	56	-30	-34.88	1	-3	1	8.72
46	92932	Dairy Processing Equipment Operator	67	38	-29	-43.28	2	-3	2	12.29
47	89126	Hand Worker, Jewelry, Precision	83	54	-29	-34.94	2	-3	2	11.40
48	28311	Title Examiner and Abstractor	160	131	-29	-18.13	1	-3	1	13.93
49	87802	Insulation Worker	215	187	-28	-13.02	7	-3	7	11.81
50	91117	Machine Tool Cutting Operator, Metal/Plastic	120	92	-28	-23.33	3	-3	3	10.10

**This table includes occupations with a minimum base year employment of 20 jobs.

Source: Florida Department of Labor and Employment Security, Office of Labor Market Statistics.
Florida Industry and Occupational Employment Projections to 2007.

SCIENCE SURVEY TEAM

FINAL REPORT

BISCAYNE BAY
PARTNERSHIP INITIATIVE

BISCAYNE BAY PARTNERSHIP INITIATIVE

CONTENTS

EXECUTIVE SUMMARY

Authors:

Joan A. Browder and Harold R. Wanless

INTRODUCTION

Biscayne Bay stretches from a densely populated urban center to near-wilderness. With its naturally clear waters, unique underwater vistas, and high biodiversity, the Bay is a natural resource treasure of Miami-Dade County, the state of Florida, and the nation. Biscayne Bay has experienced considerable modification of bottom, shoreline, and freshwater inflow with the advent and expansion of modern human populations. In addition, inputs of human-associated nutrients, pathogens, and organic material have affected the Bay's water quality. The cumulative effects of all of these stressors has seriously compromised the functioning of the Biscayne Bay ecosystem and diminished its natural resource value. Elimination of inputs of municipal sewage beginning in the 1950s, as well as extensive efforts to stabilize shorelines and restore fringing wetland habitat in recent years have resulted in major improvements in Bay water quality. Nevertheless, further improvement is needed and major new problems threaten the Bay's ecosystem health and its support value for fish and wildlife, including many species of special interest and concern.

As part of the Biscayne Bay Partnership Initiative, a group of scientists knowledgeable about the Bay, as many as 80 scientists in all, met several times over the past year to the consider major environmental issues concerning the Bay, existing scientific knowledge applicable to these issues, and major gaps in scientific knowledge needed to resolve the issues. The following major threats to the future of the Bay were identified:

- Recently proposed or projected changes in the quantity, quality, timing, and distribution of freshwater inflow;
- Human-induced inputs of pollutants, nitrogen, phosphorus, and toxic chemicals;
- Potential development of coastal wetlands and inappropriate development of adjacent uplands;
- Physical alteration or damage to the bay bottom and other factors that destroy communities of bottom-dwelling organisms, destabilize bottom sediments, and increase turbidity;
- Lack of oversight on fishing pressure or knowledge of its effects.
- Sea-level rise and other aspects of climate change
- Expanding human population.

Experts were organized into six groups, and detailed science recommendations were generated by each group. Each group covered one of the following topics:

- Fish communities, environment, and human interaction;
- habitat and species of concern;
- water and sediment quality;
- watershed hydrology;
- hydrodynamics and mass transport; and
- geology, sedimentology, climate, and sea level.

The groups all recognized that the most immediate need is for scientific information (i.e., biological indicators, performance measures, and targets) to restore and protect the Bay in ongoing water management planning activities (i.e., the Comprehensive Everglades Restoration Plan and the Lower East Coast Regional Water Supply Plan). Sea level rise and population expansion were recognized as major problems increasing with time that require the application of scientific information to planning and management decisions.

These scientists, representing many disciplines and organizations, have recommended a series of investigations and predictive tools to address the challenges of restoring Biscayne Bay and protecting the Bay from immediate and long-term problems. Funds are requested from the Florida Legislature to develop a science program for Biscayne Bay built on these recommendations. Funds to support the development and operation of a permanent Science Advisory Committee and Science Oversight Panel for Biscayne Bay are also requested.

OVERARCHING SCIENCE RECOMMENDATIONS

Following are 14 overarching science recommendations that include and summarize major recommendations of the special topic groups. The full list of recommendations from each of the special-topic groups is included at the end of the Science Co-chairs' Report. Background information and a fuller discussion of the recommendations is given in the individual report of each special-topic science report.

1. **Using ecological criteria, determine the quantity, timing, and distribution of freshwater flow needed to protect and restore Biscayne Bay and to reestablish a viable estuarine ecosystem in the nearshore and coastal wetland zone of western Biscayne Bay.**

   (This information is urgently needed in major water management planning processes that will affect freshwater flow to Biscayne Bay. Definition of biological targets enable definition of target salinity envelopes that enable definition of target freshwater inflows. Targets are critically needed to guide the planning and implementation of CERP and other regional plans in the Bay's watershed. Defining appropriate targets to restore and protect Biscayne Bay will require integrated hydrologic, hydrodynamic, and biological efforts, including improvements in the capability to model freshwater inflows to the Bay under alternative management scenarios and the capability to model salinity patterns in the Bay as a function of freshwater inflows.)

   a) Select appropriate biological indicators—then articulate performance measures and desirable future states ["targets"] with respect to the selected biological indicators.

   b) Determine the desirable salinity range, or "salinity envelope", to support the biological indicators and the required location of this envelope to ensure that appropriate bottom or shoreline habitat will be available within the salinity envelope.

   c) Determine the freshwater inflow regime that will establish and maintain the desired salinity envelope in the appropriate habitat.

2. **Determine the condition of recreationally and commercially important fishery stocks and keystone species of the ecosystem. Develop a better understanding of their demographics and population dynamics. Determine fishing rates and the impact of fishing on population size and community structure, including effects on non-target species caught and released.**

   (An assessment of fishery resources has not occurred in Biscayne Bay since 1984, during which time fishing pressure may have increased. Particular attention needs to be paid to populations that utilize the bay's shallow (< 1 m depth), intertidal and mangrove-lined shoreline habitats since these will be the areas most affected by planned water management changes.)

3. **Assuming a 0.6 m (2 ft) rise in sea level, carefully evaluate the resulting changes that will occur to Biscayne Bay, its margins, circulation, freshwater inflow, and habitats in response to global warming over the next 50 to 100 years. Incorporate consideration of resulting models of the future Biscayne in all management, policy, economic, and remediation decisions.**

4. **Develop and implement a system for quantifying and monitoring the sources, fluxes, and fates of nutrients and contaminants entering Biscayne Bay and evaluating their biological effects.**

   (Monitoring data provide a basis for describing geographic and temporal patterns in water and sediment concentrations but must be coupled with hydrologic data to develop dynamic estimates of pollutant loading and nutrient mass balance. In addition, there is little information on atmospheric deposition of nutrients or contaminants. Information on fluxes related to sediments is nonexistent. There is little information on body burdens in fish and shellfish and little information on acute or chronic effects of contaminants known to be present in the Bay or canals that discharge into the Bay. Such data are needed to evaluate potential human health implications and ecological risks.)

   a) Acquire and integrate data on freshwater inputs and nutrient/toxicant concentrations.

   b) Acquire hydrodynamic transport and mixing data.

   c) Acquire data on sediment deposition and flux rates of contaminants.

   d) Develop calibrated, verified hydrodynamic model or other appropriate tool to predict transport, deposition, and flux that would be suitable for use as a basis for a predictive tool for water quality issues.

   e) Develop water quality, sediment flux model or other appropriate tool to predict the transport and fate of ecologically important nutrients and toxicants.

   f) Determine the effect of exposure to contaminants in surface water and sediments on local plant and animal populations.

   g) Develop ecological models or other appropriate tools to predict ecological consequences of nutrient and toxicant loads.

5. **Develop a quantitative understanding of sources of turbidity, interactions of turbidity and the benthic community, and effects of physical disturbance on the benthic communities maintaining sediment stability.**

6. **Develop a spatially detailed understanding of the permeability of the Biscayne aquifer as related to groundwater seepage to the Bay.**

7. **Develop an integrated understanding of freshwater inflows, salinity, circulation, and mass transport as they relate to all of the above recommendations.**

   a) Further develop, calibrate, and verify appropriate hydrodynamic models.

   b) Obtain the additional data needed to adequately develop, calibrate, and verify the hydrodynamic models.

   c) Form linkages to freshwater inflow, water quality, sediment flux, and ecological models.

   d) Apply the models to freshwater inflow, circulation, and water and sediment quality issues.

   e) Conduct a peer review of hydrodynamic models available for Biscayne Bay to develop an understanding of the relative strengths, weaknesses, and applicability of the various models. Use appropriate modeling to develop an understanding of salinity, circulation, and mass transport as it relates to major issues.

8. **Continue to support major ongoing wetland restoration projects in Biscayne Bay, while at the same time developing a process for periodic scientific review of the Bay's restoration needs and restoration approaches and the development and implementation of an integrated restoration program to meet the needs.**

9. **Provide funding for a multi-year science program in Biscayne Bay.**

10. **It is critical that scientists become an integral part of the design, promotion and evaluation of research and**

monitoring efforts for the betterment of Biscayne Bay. For this purpose, we recommend forming a permanent Biscayne Bay Science Committee for Biscayne Bay. Responsibilities of the Committee will be:

a) To be associated with the Science Coordination Team (SCT) of the South Florida Ecosystem Restoration Task Force and to interact with the Biscayne Bay Issue Team to be formed as recommended by the Biscayne Bay Partnership Initiative.

b) To focus primarily on Biscayne Bay science issues related to the Comprehensive Everglades Restoration Plan.

c) To provide input to and rigorous peer review of a strategic science plan for Biscayne Bay and assure its appropriate evolution over the coming years once such a plan has been put forward;

d) To help facilitate annual conferences and topical workshops to assure the widest possible dissemination of the relevant scientific information;

e) To facilitate education and outreach activities relating to Biscayne Bay and its ecosystem;

f) To interact with the state of Florida and relevant federal agencies to develop funding mechanisms sufficient to address the long term technical and scientific needs and to promote in-place funding for research and monitoring needs for catastrophic events, both natural and anthropogenic;

g) To appoint, with concurrence of the Biscayne Bay Issue Team, an Independent Science Oversight Panel to analyze the scientific pertinence and validity of publicly-funded research, monitoring and restoration methods, data, conclusions, and recommendations.

h) To interact with research scientists and program managers to assure maintenance of the highest quality research, monitoring and restoration activities.

State funds will be required to staff the Biscayne Bay Science Advisory Committee and the Science Oversight Panel, provide travel compensation for members, etc. The chair of this committee would be a member of the SFER Biscayne Bay Issue Team should one be established.

11. **Create a vigorous Biscayne Bay environmental education program on the value of Biscayne Bay's important plant and animal communities, how to enhance the quality of Biscayne Bay's environments, and how to prevent damage to the most critical elements and species of concern.**

(Education of the public youth and adults will lead to more responsible and respectful use of Biscayne Bay and its resources.)

12. **Facilitate the development of a Biscayne Bay web site devoted to disseminating research findings relevant to Biscayne Bay restoration, and land-use planning.**

13. **Promote the annual publication or posting of syntheses, evaluation, and interpretation of all publicly funded monitoring results, scientific reports, and data from monitoring under permits.**

14. **Ensure that publicly funded research, monitoring, and restoration data and information are maintained in an openly available web-based GIS database form easily and quickly available to other scientists and the public. Data should be layered to contain all historical and future publicly funded scientific research, modeling, and monitoring data and results, including all data generated for government agencies by the public for permitting and enforcement actions (biological and water quality monitoring reports).**

(Though open to all, it should to be specifically designed for scientific and management needs.)

CONCLUSION

Biscayne Bay faces many challenges and threats to its present and future well being. The public and its representatives must be well-informed to protect the Bay from the increasing pressures of diversion of freshwater inflow, development of coastal wetlands, recreational activity, port and marina expansion, harvesting of fishery resources, and damage to bottom communities resulting from fishing, boating, and pollution. Scientific knowledge is critical to the Bay's future. Building an understanding of the Bay's dynamics and evolution, its characteristic species and natural communities and their support functions and interactions will ensure that efforts made to protect and restore the Bay will be successful. Scientific participation in building an understanding of the Bay ecosystem and its dynamics is crucial.

SCIENCE TEAM CO-CHAIRS' REPORT

Co-chairs:

Harold R. Wanless and Joan Browder

Authors:

Joan A. Browder and Harold R. Wanless

INTRODUCTION

Biscayne Bay is a national treasure and a gift of nature not only to the nation but also to the people fortunate enough to live and work in Miami-Dade County. Many residents have selected this area as their home because of the amenities afforded by close proximity to Biscayne Bay, including opportunities to enjoy the tropical wildlife, fishing, underwater vistas, and other scenic pleasures associated with the Bay. As more and more people are attracted to these amenities, the pressure of increasing populations is exerted on the very aspects of the Bay that are most valued.

Biscayne Bay, as well as the South Florida coastal ocean ecosystem (i.e., Florida Keys, Florida Bay, and the Reef Tract), has undergone major environmental changes due to a century of intensive regional population growth that has accelerated coastal and watershed development, habitat degradation and loss, and pollution. Fortunately, despite this expansion of human activity, favorable trends in water quality have been recorded throughout at least the past 40 years, and the value of healthy benthic habitat and a viable coastal wetland has become recognized.

Following elimination of municipal sources of sewage and the establishment of laws and enforcement that reduced inputs of sewage and other contaminants, the Bay has recovered markedly from previous years of serious pollution. Restoration of shoreline communities and the establishment of natural limestone boulders along public shorelines has reduced erosion and wave-induced bottom disturbance that generates turbidity in North Biscayne Bay, allowing the Bay to recover somewhat from dredging and filling, although many bottom areas are still depauperate. Nevertheless, the Bay still receives substantial contaminants, sewage, and disturbance due to its proximity to intense urban and agricultural activity and the steadily growing human population of several million along its coastline. Sediments in parts of Biscayne Bay, the Miami River, and the Military Canal are toxic and contain significant quantities of contaminants. Several factors contributing to turbidity are increasing, including vessel traffic, prop scars and scouring from recreational boats, and pulsed freshwater inputs from canal point sources.

Estuarine environments are among the most productive parts of the ocean and contribute substantially to the abundance and diversity of marine life. Many fish and shellfish species harvested from offshore marine waters must spend a part of their lives in estuaries. Estuarine habitat has been lost in North Biscayne Bay because of the digging of Haulover Cut, causeway construction, canal construction, wetland habitat destruction, development, and dredging and filling. Estuarine function associated with coastal wetlands and shoreline has been lost in the western nearshore Bay due to changes in the quantity, quality, timing, and distribution of freshwater inflow.

Salinity, like temperature, is a major factor affecting physiological processes of plants and animals such as growth, survival, and reproduction. The availability of an appropriate salinity range, or “salinity envelope”, and its placement in relation to favorable bottom and shoreline habitat are critical to the distribution, abundance, and health of both plants and animals in estuaries. Abrupt decreases in salinity are stressful to plants and animals. Hypersaline (high salinity) conditions also are stressful and limit biomass and diversity. A natural salinity gradient extending from coastal wetlands to the Bay through tidal creeks provides critical nursery habitat for species such as redfish, and loss of this essential habitat is thought to be a major reason why efforts to reintroduce this species, which once was sufficiently abundant in the Bay to support a fishery, have not been very successful.

Two major water-management planning activities are in progress in South Florida that could have substantial effects on freshwater flow to Biscayne Bay. These are the Comprehensive Everglades Restoration Plan (CERP), which has restoration of wetland and estuarine and coastal ecosystems as a stated major objective, and the Lower East Coast Regional Water Supply Plan (LECRWSP). Both processes will use State water law to establish Minimum Flows and Levels [Section 373.042 F.S.] and will reserve water to deliver for preservation and/or restoration [Section 373.223(4) F. S]. CERP will substantially restructure the regional water management system. LECRWSP will affect the issuance of long-term municipal well field permits. Recent LECRWSP evaluations predict that future urban and agricultural development and water withdrawals for urban drinking water will reduce the amount of water flowing to Biscayne Bay. Both CERP and LECRWSP have created processes to use science-based biological criteria when designing plan components and to monitor changes resulting from their implementation. Both plans have a built-in provision for changing the design of system components, even after implementation, based on observations of ecosystem responses determined by monitoring. The success of these safeguards in protecting Biscayne Bay is dependent upon the availability of scientifically well-founded biological and physical criteria and predictive tools. A substantial body of scientific knowledge about Biscayne Bay must be developed and assembled to restore the Bay's estuarine resources and improve the timing and distribution of freshwater flows to the Bay in these planning processes.

Loss of coastal wetlands at the margin of the Bay is a long-term threat to the Bay's ecological function and its natural resources. Restoring a more natural quantity, quality, timing, and distribution of freshwater flow to Biscayne Bay and reestablishing a productive estuarine zone along the western margin of South Biscayne Bay are dependent upon receiving a sufficient quantity of water from the regional water management system and redistributing it along the shoreline through the coastal wetlands. The availability of coastal marshes to receive sheet flow, provide natural nutrient adsorption, and hold flood waters temporarily is also critical to restoring the Bay's productivity.

Substantial tracts of coastal wetland, including coastal freshwater wetland, exist on the margin of South Biscayne Bay from Matheson Hammock southward. Most of these wetlands remain relatively undeveloped but have been structurally altered and functionally degraded as wetland habitat by loss of freshwater inflow. Much of this area has been identified for purchase in Florida's Save Our Rivers and Miami-Dade County's Environmentally Endangered Lands programs. CERP proposes to restore wetland function and re-establish a more natural sheet flow of water to the Bay in wetlands from the Deering Estate southward to Turkey Point. The Florida Power and Light Mitigation Bank occupies some wetland area between Turkey Point and Jewfish Creek and can help link upland water sources to coastal wetlands and tidal creeks. An opportunity to develop an integrated restoration plan for these wetlands exists. Any future land development in coastal fresh and saltwater wetlands from the Deering Estate to Jewfish Creek could interfere with restoration of freshwater inflows to Biscayne Bay by preventing redistribution of flow from canals to wetlands. Inappropriate land development in adjacent uplands could undermine restoration efforts by reducing flexibility in making water management changes and by degrading water quality.

MAJOR ISSUES

As a clear-water subtropical system, the Bay supports a rich variety of fish, wildlife, and tropical bottom communities. Specific habitat is provided in the Bay for each species that lives in the Bay, including species that migrate in and out of the Bay daily, seasonally, or through their life cycle. If their habitat becomes unsuitable or disappears, the animals lose their home and humans lose the benefits of the Bay's biodiversity. Coastal wetland habitat and bay bottom (benthic) habitat, including seagrasses, have the greatest importance to aquatic life. Beach habitat and adjacent upland habitat, including coastal scrub and coastal tropical hardwood hammock, are other valued habitats that support a variety of wildlife, including endangered species. The principal immediate threats to existing Biscayne Bay habitat and the fish and wildlife they support are: (1) changes in the quantity, quality, timing, and distribution of freshwater inflows; (2) physical alteration or damage to the bay bottom and other factors that destroy communities of bottom-dwelling organisms, destabilize bottom sediments, and increase turbidity; (3) human-induced inputs of pollutants, including excess nitrogen and phosphorus, which add to turbidity by stimulating algal blooms; and toxicants, many of which accumulate in sediments and threaten animals directly; (4) potential development of coastal wetlands and inappropriate development of adjacent uplands; and (5) increasingly heavy, inadequately monitored, recreational and commercial fishing.

ROLE OF SCIENCE

It is critical that scientists become an integral part of the design, promotion and evaluation of research and monitoring efforts for the betterment of Biscayne Bay. For this purpose, we recommend forming a permanent Biscayne Bay Science Committee for Biscayne Bay. Responsibilities of the Committee will be:

1. To be associated with the Science Coordination Team (SCT) of the South Florida Ecosystem Restoration Task Force and to interact with the Biscayne Bay Issue Team to be formed as recommended by the Biscayne Bay Partnership Initiative.
2. To focus on Biscayne Bay science issues, including those related to the Comprehensive Everglades Restoration Plan.
3. To provide input to and rigorous peer review of a strategic science plan for Biscayne Bay and assure its appropriate evolution over the coming years once such a plan has been put forward;
4. To help facilitate annual conferences and topical workshops to assure the widest possible dissemination of the relevant scientific information;
5. To facilitate education and outreach activities relating to Biscayne Bay and its ecosystem;
6. To interact with the state of Florida and relevant federal agencies to develop funding mechanisms sufficient to address the long term technical and scientific needs and to promote in-place funding for research and monitoring needs for catastrophic events, both natural and anthropogenic;
7. To appoint, with concurrence of the Biscayne Bay Issue Team, an Independent Science Oversight Panel to analyze the scientific pertinence and validity of publicly-funded research, monitoring and restoration methods, data, conclusions, and recommendations. Interact with research scientists and program managers to assure maintenance of the highest quality research, monitoring and restoration activities;

State funds will be required to staff the Biscayne Bay Science Advisory Committee and the Science Oversight Panel, provide travel compensation for members, etc. The chair of this committee would be a member of the SFER Biscayne Bay Issue Team should one be established.

Biscayne Bay faces many challenges and threats to its present and future well being. The public and its representatives must be well-informed to protect the Bay from the increasing pressures of diversion of freshwater inflow, development of coastal wetlands, recreational activity, port and marina expansion, harvesting of fishery resources, and damage to bottom communities resulting from fishing, boating, and pollution. Scientific knowledge is critical to the Bay's future. Building an understanding of the Bay's dynamics and evolution, its characteristic species and natural communities and their support functions and interactions will ensure that efforts made to protect and restore the Bay will be successful. Scientific participation in building an understanding of the Bay dynamics and ecosystem is crucial. One role of science is to reliably predict the long-term consequences of proposed actions on the Bay function and ecosystem. Another is to recommend alternative ways to achieve objectives that are more ecologically desirable. Yet another role is to determine positive actions to improve the Bay's natural beauty and ecological functioning. Finally, scientists must communicate this information to the public, young and old, and should explain the benefits of protecting and enhancing Biscayne Bay. A series of scientific studies or projects to obtain critically needed information about Biscayne Bay are recommended in this report.

Some scientific conclusions about the Bay are presently sufficiently understood that there is consensus among scientists for recommending modifications to existing management and regulatory activities. These are presented separately as '*Specific Science-generated Management and Action Recommendations*' in the recommendation section.

DESCRIPTION OF BISCAYNE BAY

Biscayne Bay is described in terms of physical setting and history of change, biological structure, consisting of seagrass and other benthic communities within the Bay and the vegetation communities along its margins, and its residents, the fish, shellfish, bird, and other species of interest and concern.

THE SETTING AND HISTORY OF CHANGE

Natural Biscayne Bay was a shallow subtropical estuary characterized by clear water and dominated by diverse and productive benthic communities of sea grasses and hard bottom soft corals and sponges. A fringe of mangrove wetlands bisected with tidal creeks rimmed much of the Bay margin. The clear waters were maintained by benthic communities, fringing mangroves, and adjacent freshwater wetlands that filtered water and trapped sediments. The bottom communities, in turn, flourished because of the clear waters. Landward, freshwater sheet flow from the Everglades and local uplands fed tidal creeks that distributed freshwater flow along much of the shoreline. Freshwater seeped through the permeable aquifer into the Bay as ground water. The seaward margin of the Bay was a series of sandy barrier islands to the north, channel-dissected shallow marine sand and mud banks along the central portion, and islands of an emergent coral limestone ridge to the south.

Biscayne Bay is not like most of the better known eastern seaboard estuaries, which are deep, partially drowned river valleys receiving a large influx of river-borne clays. Natural Biscayne Bay is a shallow basin that received primarily clear, wetland-filtered fresh water via flow through many small creeks and groundwater from the Everglades and coastal ridge. All the sediment within Biscayne Bay is produced as skeletal and organic remains from the tropical organisms living in or adjacent to the Bay, plus some quartz-carbonate beach sands brought in from along the seaward coast.

Five thousand years ago, when sea level was about 20 feet lower than today, there was no Biscayne Bay. The Bay formed as sea level inundated a depression in the limestone between 5,000 and 2,400 years ago. During and since that time, the sandy barrier islands, the banks of carbonate sand and mud, and the coastal wetland swamp and marsh deposits have grown and evolved to give the Bay its present form. Especially critical was the relatively slow rise in sea level that occurred during the past 2,400 years (less than 2 inches of rise per century). Over this time, shallow sand and mud banks formed along the eastern margin of central Biscayne Bay and extended well across northern (north of present Julia Tuttle Causeway), south Central (Featherbed Banks), and southern Biscayne Bay, partitioning the Bay into natural divisions.

Biscayne Bay has been significantly modified in the past century. Freshwater levels were lowered by as much as 6 ft on, and west of, the mainland coastal ridge as drainage canals were cut and water drained from the Everglades. Two new inlets through south and north Miami Beach altered circulation in northern Biscayne Bay. The mangrove margins north of Coconut Grove and Key Biscayne were largely covered by fill and the shorelines bulkheaded to make developable bay-margin land. Dredging of the Bay margin for this fill left dredged areas of varying depth (up to 20 ft) in scattered locations of northern Biscayne Bay. New dredged islands, port facilities, and six cross-bay causeways further segmented northern Biscayne Bay. Dredge-deepening of the adjacent bay bottom was associated with each project. Most of these modifications had occurred by 1926. As a result, northern Biscayne Bay is now segmented into six compartments connected by narrow gaps in the causeways. A significant portion of the dredged Bay bottom is too deep for the communities of benthic organisms that characterized the natural Bay. The productive estuarine ecosystem, which once supported an oyster fishery, has been mostly lost along much of the shoreline. In addition, raw sewage emptied unchecked into the northern Bay until diverted to sewage treatment plants in 1952. These modifications resulted in high levels of turbidity in much of north and north central Biscayne Bay, further restricting the distribution of the important benthic habitats. Despite this, some parts of the northern Bay remain highly productive, and in recent years water quality has been improved through elimination of municipal sewage inputs, regulatory action to reduce other pollutant inputs, and the placement of natural limestone boulders along bulkheaded shorelines to reduce erosion and prevent wave reflection.

Harbor dredging projects to support an enormous growth of the cargo and cruise ship fleets serving the Caribbean, Central and South America, and the rest of the world have been associated with degraded water quality and destruction of essential habitats. Substantial beach re-nourishment projects from Miami Beach to Key Biscayne are regularly conducted, but the resultant turbidity, siltation, and destruction of habitats from these beach re-nourishment activities degrade the adjacent ecosystem.

South Biscayne Bay remains a clear-water, benthic-community dominated Bay, but alteration in freshwater input has diminished its estuarine character, and heavy boat traffic and commercial fishing have increased overall turbidity levels and are causing increasing damage to the benthic communities. Much of the southern Bay, despite substantial coastal development, has retained its relatively pristine habitats, has good water quality and supports significant production of economically-important fish and shellfish.

BIOLOGICAL STRUCTURE

The dominant benthic communities in Biscayne Bay are seagrass and hardbottom. Seagrass occupies over 64% of the Bay bottom, and hardbottom communities cover approximately 17% of the total bay (Milano, 1983). Remaining benthic communities are functionally very important and include algal communities, coral-algal shoal fringe community, mud bottom, and sand bottom filtering communities. Transitional zones between these communities support high species diversity.

Seagrasses are found in all parts of the Bay where water depth and clarity allow sufficient light penetration and past disturbances have not eliminated them. At least seven seagrass species commonly occur in Biscayne Bay: *Thalassia testudinum* (turtle grass), *Halodule wrightii* (shoal grass), *Syringodium filiforme* (manatee grass), three species of *Halophila*, including *H. johnsonii*, which is federally listed as endangered, and *Ruppia maritima* (widgeon grass). Species presence depends on local conditions, including light, substrate, salinity, and time of recovery from natural or human setbacks. Seagrasses commonly occur in mixed-species beds. The hard-bottom community assemblage is characterized by sea fans, sponges, and small coral patches and is found especially in Biscayne National Park. These areas are particularly sensitive to water quality, light transmission, and disturbance. The coral-algal shoal fringe assemblage occurs along the edge of the extensive mud banks in the central and southern Bay and at the Bay's entrance at the Safety Valve. Mud bottom communities are associated with the large areas of carbonate mud banks and mud bottom that occur throughout the Bay and also deep channels.

All benthic communities of the Bay provide important functions with respect to water clarity, sediment stabilization, and food and shelter for fish, shrimp, lobsters and crabs—especially postlarval and juvenile stages—and other aquatic life. Seagrasses and benthic algae are important primary producers, converting the sun's energy into food and structure useful to fish and wildlife. Seagrasses provide structure and habitat necessary to many animals. Manatees and adult green sea turtles feed directly on seagrass. Studies in South Florida estuaries indicate that the abundance of pink shrimp is greater in seagrass sites than on bare bottom. Seagrasses help stabilize banks and mud and silt bottoms on a large scale. The coral-algal shoal fringe assemblage grows on the most exposed flanks of mud banks and helps maintain their stability when subjected to high wave action.

Biscayne Bay was bordered historically by a mix of mangroves, salt marsh, herbaceous freshwater marsh, and penetrating tidal creeks. These supported the Bay ecosystem by spreading freshwater inflow, absorbing excess nutrients, and providing habitat—including critical nursery habitat—for fish and shellfish, as well as feeding habitat for wading birds. Local rainfall, groundwater seepage, overland sheet flow and small coastal rivers fed water to the Bay all along its margins rather than at just a few canal discharge sites. Maintained by freshwater inflow, the natural herbaceous wetlands, fresh-to-brackish tidal creeks, and low salinity mangrove shoreline and delta provided a broad band of habitat for estuarine organisms having a variety of salinity needs.

Freshwater wetlands in the Biscayne Bay watershed historically occupied the marl prairies immediately east of the Miami Rock Ridge. They were, and still are, most extensive in the southern reaches of the county, where the Ridge curves westward away from the coast. Prior to development, these marshes were dominated by sawgrass (*Cladium jamaicense*), spike rush (*Eleocharis cellulosa*) and other freshwater graminoids, including grasses, and herbs. Water reached them via direct precipitation, surface flow from the Everglades through breaks in the Ridge ("transverse glades"), or rising groundwater when the regional water table was high. Today their hydrologic regime is controlled largely by regional water management practices, and surface water inputs are largely precipitation-driven.

In the past, freshwater and brackish marsh habitats bordered the Bay's western shoreline and barrier islands, but over the last century, western shorelines of the Bay and eastern barrier islands have undergone extensive loss of marsh and mangroves. The western Bay was heavily impacted by the construction of 19 water management canals that drained wetlands and now release water in pulses to prevent intermittent coastal flooding and facilitate agriculture. The result is a highly modified delivery of fresh waters to the Bay that results in rapidly fluctuating salinity regimes adjacent to canals and loss of estuarine conditions elsewhere. Wetland loss on the bay margin of the sandy barrier islands was mainly due to smothering by dredged fill in the early 1900s.

FISH COMMUNITIES

Biscayne Bay is a unique subtropical coastal marine ecosystem renown for its diverse and abundant natural resources and scenic beauty. The Bay contributes to the multibillion-dollar tourism and fishing industry in South Florida by providing critical nursery habitats and food web links for many important commercial and recreational fishery resources. These include ecologically- and economically-important estuarine species like snook, tarpon, permit, spotted seatrout, oysters, clams, blue crabs, and pink shrimp; several baitfishes; and numerous reef species, including snappers, groupers, grunts and lobsters. The production dynamics of many natural resources in the Bay and nearby coastal waters and the reef tract are inextricably linked to the quality of Bay waters and habitats. For example, many reef fish species use the Bay as a nursery ground.

Previous change in freshwater flow to Biscayne Bay has led to change in fish and invertebrate communities. Many estuarine species, typified by the larger drum species and oysters, have declined in abundance due to the elimination of extensive freshwater and brackish habitats that was caused by diverting freshwater inflow away from coastal wetlands and tidal creeks into canals. Salinity fluctuations caused by the opening and closing of structures controlling freshwater inflow to the Bay stress plant and animal communities, reducing growth of aquatic plants and lowering animal abundance and diversity.

SPECIES OF CONCERN

One hundred seventy-three species occurring in Biscayne Bay, its coastal wetlands, or its coastal uplands, including barrier islands, can be found on some list of protected species (i.e., federal or state endangered or threatened species, state species of special concern, Federal protected marine mammals, and Federally mandated (designated by South Atlantic Fishery Management Council) Essential Fish Habitat. In addition, the Bay and adjacent wetlands support perhaps as many as 300 fish species and possibly even more invertebrates, including particularly the diverse species forming the Bay's exceptional hardbottom communities. Species of concern include the West Indian manatee, bottlenose dolphin, five sea turtle species, the crocodile, and many birds, including the Roseate Spoonbill, the White Ibis, the Brown Pelican, and the Black-necked Stilt. The manatee is the most seriously endangered animal in Biscayne Bay. Recreational boaters and gated water management control structures are the most serious threats to this species.

EVALUATION OF AVAILABLE INFORMATION RELATIVE TO NEEDS

THE SMALL WORKING GROUPS AND THEIR REPORTS

As the team began its work in January 2000, it formed six working groups defined by discipline to more effectively address the issues and formulate recommendations. Each working group has contributed a section or "chapter" to be included in the science portion of the Biscayne Bay Partnership Initiative's final report. Over 80 experienced scientists with first-hand knowledge of Biscayne Bay and concern for its long-term welfare have been involved in this process. The working group topics are:

- Geology, Sedimentology, Climate, and Sea Level
- Hydrodynamics and Mass Transport
- Watershed Hydrology
- Coupling Biscayne Bay's Fisheries and Other Natural Resources to Environmental Quality and Freshwater Inflow Management
- Habitats and Species of Special Concern
- Water and Sediment Quality

INVOLVEMENT IN SCIENTIFIC RESEARCH

A number of entities are involved in scientific research and monitoring activities in and around Biscayne Bay. These include governmental agencies such as the:

- National Marine Fisheries Service/ National Oceanic and Atmospheric Administration
- National Ocean Service/ National Oceanic and Atmospheric Administration
- Biscayne National Park/National Park Service
- U.S. Army Corps of Engineers
- U.S. Geological Survey
- U.S. Environmental Protection Agency
- U.S. Fish and Wildlife Service
- South Florida Water Management District
- Florida Department of Environmental Protection
- Florida Fish and Wildlife Conservation Commission
- Miami-Dade County Department of Environmental Resource Management

As well as university, nonprofit, and private entities, including:

- University of Miami
- Florida International University
- University of Florida
- Florida Institute of Technology
- National Audubon Society
- Miami Museum of Science
- Greater Caribbean Energy and Environment Foundation
- Carney Environmental Consulting
- M.A. Roessler Associates, Inc.
- EAS Engineering

DISCUSSION OF THE ISSUES

A long-term issue in Biscayne Bay is sea-level rise associated with climate change and its potential impacts on the Bay. Sea-level rise will increasingly influence and affect the outcomes of all planning activities about the Bay, its coastal wetlands and uplands, and the urban and agricultural areas of Miami-Dade County. The most urgent issue in Biscayne Bay today is addressing the Bay's needs with respect to freshwater inflow. Major water management planning activities are already underway that will change freshwater flow to the Bay. Scientific information about the Bay is urgently needed to protect and restore the Bay in these planning processes. Other important issues concern water and sediment quality, especially turbidity and contamination, which affect to the quality of life of the plants and animals that live in the Bay. The rapid growth of human population in the Biscayne Bay area exacerbates all of these problems.

Population Growth and Global Climate Change

Population and global climate change are dynamic influences that will control the future of Biscayne Bay. Planning, restoration and management efforts to maintain an ecologically healthy and productive Biscayne Bay will be for naught unless the role of these increasing stressors is properly addressed and incorporated. There is sufficient information to address the key components of these influences. Population is forecast to rise substantially by 2050 and will likely continue to increase through 2100. Sea level, the most fundamental concern of global warming for south Florida, is presently rising at a rate of one foot per century (since 1930) and is forecast to rise at least an additional 2-4 feet by 2100. We can and must assess the effects that these changes will have on Biscayne Bay, its coastal wetlands, and adjacent uplands.

Future development, restoration and management in the Biscayne Bay area should be for the long-term welfare of the environments in and adjacent to Biscayne Bay. Biscayne Bay must have a dynamic research, policy, regulation and management structure that is responsive to dynamic long-term stressors and improved scientific knowledge. It must be possible to frequently modify policy, management, and regulation as information and needs change.

Freshwater Inflow

The quantity, quality, distribution, and timing of water delivered to Biscayne Bay have been severely altered. The most important changes in freshwater inflow have been addition of runoff from drainage of the Everglades and the area west of the coastal ridge; a lowering of groundwater levels and reduction in associated groundwater seepage to the Bay; and a significant shift from sheet flow through coastal wetlands and tidal creeks to point-source discharge from canals directly into the Bay.

Biscayne Bay's future depends upon having reliable scientific information and modeling tools to adequately protect its resources in the further development and implementation of regional restoration and water supply programs. The new water management plans, CERP and LECWRSP, as presently formulated, have major uncertainties concerning effects on Biscayne Bay and could affect the amount of water the Bay receives. Fortunately efforts are being made to reduce the uncertainties and make Plan improvements, but major gaps exist in the information and modeling tools that are needed. Filling these needs is urgent because of the rapid pace of planning and implementation.

Water and Sediment Quality

North Biscayne Bay's water quality has improved substantially in the past 30 years, and water quality generally meets or exceeds federal, state, and local standards for recreational uses and propagation of fish and wildlife. In recognition of its exceptional values, the State of Florida has designated the entire Bay and its natural tributaries as Outstanding Florida Waters, and as such they receive the highest level of protection from degradation. However, some parts of the Bay have been significantly affected by past development and water management practices. Loss of wetland and seagrass communities has contributed to changes in physical and ecological water quality characteristics. Also, the Bay still receives dissolved nutrients, trace metals, organic chemicals, and particulates via storm-water runoff, canal discharge, and discharges from industrial facilities or vessels. Canal water typically has lower dissolved oxygen and clarity and higher concentrations of contaminants than receiving waters of the Bay, and so represents a source of degradation. The water quality problems of the Bay are discussed below as four topics, turbidity, sewage effluent, nutrients, and contaminants.

Turbidity. Maintaining water clarity is of critical importance because seagrass and benthic algae, which dominate Biscayne Bay productivity, depend on light reaching the bay bottom, as do corals. Biscayne Bay is characterized by low turbidity levels, although wind-driven resuspension of bottom sediments can occur following storm events. In most areas of Biscayne Bay, water clarity is adequate to support benthic vegetation. Turbidity is a concern in North Biscayne Bay because of loss of seagrass cover and continuing resuspension and erosion. The increased water depths in areas that have been dredged make it impossible for benthic vegetation to recover. Concrete bulkheads, which replaced some natural shorelines in north Biscayne Bay and reflect wave energy, also contribute to resuspension of bottom sediments as does the persistent erosion from unbulkheaded fill shorelines. Damage to bottom seagrass habitat by prop wash and scouring in the shallow portions of Central and South Biscayne Bay is a further cause of turbidity.

Nutrients. Since natural concentrations of nutrients in Biscayne Bay are low, the bay is vulnerable to nutrient loading from canals, direct upland runoff, and groundwater seepage. Excess nutrients, especially phosphorus (because Biscayne Bay is phosphorus limited), can stimulate the growth of phytoplankton and epiphyte populations which diminishes light penetration to sustain the vital benthic communities. Increases in ammonia and nutrient concentrations account for most negative water quality trends. Ammonia can be highly toxic to fish and invertebrates. Sources of ammonia and nutrients can include stormwater runoff, sewage contamination, leachate from landfills, fertilizers, and natural decay of plant material. These sources of contaminants can reach the Bay via surface water discharges from canals, direct upland runoff, or through groundwater pathways

Sewage. The sanitary quality of the waters of Biscayne Bay improved dramatically after regional sewage treatment plants were constructed in the 1950's and direct discharge of sewage effluent to Biscayne Bay was largely eliminated. But indirect sewage contamination from improper or illegal discharges to storm sewers or groundwater still occurs in some tributaries. The Miami River, urban tributaries, and poorly flushed nearshore areas show evidence of sewage contamination. Open water areas of the Bay rarely have exceeded standards for recreational contact for more than 20 years. In contrast, the Miami River and its tributaries chronically exceed standards, and occasionally exhibit coliform bacteria concentrations that exceed standards by several orders of magnitude. Coliform bacteria concentrations in the Miami River, except for Wagner Creek, have declined over the last 5 years, although they generally still exceed standards. Other highly urban canals, including the upper Oleta River, Arch Creek, and Little River, also exhibit frequent incidence of sewage contamination. During tropical storms, flooding, or damage to sewer infrastructure, contaminated canal water periodically affects adjoining parts of the Bay.

There is recent evidence that deep well injection efforts at the south Miami-Dade site are not isolating injected sewage effluent below planned permeability barriers and the effluent is seeping back to the near-surface waters in and adjacent to southern Biscayne Bay. The hundreds of millions of gallons of effluent injected since beginning deep-well injection in 1983, may result in a serious long term degradation of the waters in and adjacent to southern Biscayne Bay. The reality of this problem is only just surfacing, and it will take focused research to document the extent and intensity of resulting contamination.

Contaminants. The lower Miami River and several peripheral canals and tributaries of Biscayne Bay have severely contaminated and toxic sediments. The Miami River and Wagner Creek exhibit higher levels of trace metals and organic contaminants, such as some pesticides and PCB's, than any other area in the State of Florida. In the open basins of the bay, chemical concentrations and toxicity are generally higher in areas north of the Rickenbacker Causeway than south of it. Sediments from the main basins of the bay generally are less toxic than those from the adjoining tributaries and canals. Miami River sediments are contaminated with mixtures of toxicants, are highly toxic, and support relatively few benthic species relative to the Bay. Results from four different toxicity tests, overall, indicated highest toxicity in samples from the lower Miami River, Black Creek Canal, other canals adjoining the south bay, and canals and tributaries adjoining the bay near Miami and Miami Beach. The least toxic samples were collected from the far north and far south ends of the study area. The causes of toxicity could not be determined in this study. However, the weight of evidence strongly suggests that for the lower Miami River, toxicity as measured in the amphipod survival tests could have been caused, at least in part, by mixtures of some metals and synthetic organic chemicals. In the canals of the south bay, both toxicity and contamination were less severe and the identities of chemicals that most probably contributed to toxicity were less clear. Concentrations of PAHs, PCBs, and several trace metals, however, may have been sufficient to contribute to toxicity in the more sensitive sublethal tests.

The effects of toxicants on Biscayne Bay resources have been marginally studied. The prevalence of fish with external abnormalities has fueled concerns of local fishermen and environmentalists concerning toxic materials entering the bay and their ecological consequences. The major types of deformities observed from roller-frame trawl and hook-and-line captures were stunted or missing fin rays, depressions in the dorsal profile, jaw deformities and scale disorientation. These deformities were particularly evident in sea bream, bluestriped grunt, pinfish, and gray snapper. Significant correlations were found between abnormality prevalence (all fish combined) and aliphatic hydrocarbon concentrations in the sediments, and between the prevalence of abnormalities in bluestriped grunt and sediment concentrations of copper. The highest prevalence of abnormal fish was near marinas and canal discharge sites. This is consistent with studies elsewhere that have found the highest prevalence of abnormal fish at the most contaminated sites. However, the possible contribution of fishing-related mechanical damage to fishes, in the form of net entanglement for fin ray deformities and hook-and-line capture for jaw deformities, has not been investigated.

Fishing Pressure

The Bay's resources have been exploited seasonally since the late 1700s, when Biscayne Bay was visited by the migrant fishing fleet of Gloucester, Massachusetts, and even earlier by the Tequesta Indians. Over the past 40 years, recreational fleet expansion has followed human population growth, which went from a couple of hundred thousand to several million people. There is a perception that commercial and recreational fishing have contributed substantially to resource change in Biscayne Bay. There is a perception by both scientists and fishermen that the fish stocks of the Bay have declined, but, because there have been no assessments of fish stocks or fishing rates, this is difficult to ascertain. Certainly, the past 10 years have seen a growing recreational fleet of "fly-netters" during winter months as well as shoreline netters, in addition to the current 20-30 vessel commercial live-bait rollerframe trawlers. The live bait shrimp fleet damages hardbottom communities and also has a considerable fish bycatch. According to an estimate from the 1980s, more than 20% of Biscayne Bay's bottom is swept at least four times annually by this fleet.

Urgent problems and concerns necessitated by the current or upcoming activities in and marginal to Biscayne Bay.

Our science priorities and recommendations are, of necessity, somewhat reordered by the several ongoing or proposed changes or stresses that are or will dramatically influence the Biscayne Bay Ecosystem. These are:

- Redesign and replumbing of the Everglades (Comprehensive Everglades Restoration Plan and Lower East Coast Water Supply Plan)
- Development of former Homestead Air Force Base
- Miami River and Military Canal contamination and cleanup
- Malfunctioning deep-well injection in south and possibly north Miami-Dade
- Port of Miami dredging, expansion, vessel resuspension and opportunities to improve circulation
- Marina development
- Virginia Key development
- Landfills in south Miami-Dade, Virginia Key and Munisport.
- New rock pit permits

OVERARCHING SCIENCE RECOMMENDATIONS

1. **Using ecological criteria, determine the quantity, quality, timing, and distribution of freshwater flow needed to protect and restore Biscayne Bay and to reestablish a viable estuarine ecosystem in the nearshore and coastal wetland zone of western Biscayne Bay.**

   (This information is urgently needed in major water management planning processes already well underway that will affect freshwater flow to Biscayne Bay. Thus definition of biological targets leads to definition of target salinity envelopes that lead to definition of target freshwater inflows. This is critically needed to support the development of targets to guide the planning and implementation for CERP and other regional plans that could affect the watershed of the Bay. Accomplishing this task will require integrated hydrologic, hydrodynamic, and biological efforts, including improvements in the capability to model freshwater inflows to the Bay under alternative management scenarios and the capability to model salinity patterns in the Bay as a function of freshwater inflows.)

a) Select appropriate biological indicators—then articulate performance measures and desirable future states ["targets"] with respect to the selected biological indicators.

b) Determine the desirable salinity range, or "salinity envelope", to support the biological indicators and the required location of this envelope to ensure that appropriate bottom or shoreline habitat will be available within the salinity envelope.

c) Determine the freshwater inflow regime that will establish and maintain the desired salinity envelope in the right place.

2. **Determine the condition of the Bay's fishery stocks and key components of the fish communities to compare with past condition and to provide a baseline for following future trends.**

(Examine demographics and population dynamics of recreationally or commercially important species and other key species. Determine fishing rates and the impact of fishing on population size and community structure, including effects on nontarget species caught and released. An assessment of fishery resources has not occurred in Biscayne Bay since 1984, during which time fishing pressure may have increased. Particular attention needs to be paid to populations that utilize the bay's shallow (< 1 m depth), intertidal and mangrove-lined shoreline habitats since these will be the areas most affected by planned water management changes.)

3. **Use available information to determine a reasonable anticipated rise in sea level during the next century (a 0.6-1.2 m [2-4 ft] rise is generally recognized), and use geologic knowledge to carefully evaluate the resulting changes that will occur to Biscayne Bay, its margins, circulation, freshwater inflow, and habitats in response to this effect of global warming over the next 50 to 100 years. Incorporate resulting models of the future Biscayne Bay in consideration in all management, policy, economic, and remediation decisions.**

(The above research/modeling exercise will provide a visual model of future changes in the configuration of the substrate and the Bay margins, circulation, salinity, distribution of habitats, and foci of human stress over the next century. This will provide the foundation for all long-term management, legislative and policy strategies.)

4. **Develop and implement a system for quantifying and monitoring the sources, fluxes, and fates of nutrients and contaminants entering Biscayne Bay and evaluating their biological effects**.

(Monitoring data provides a basis for describing geographic and temporal patterns in water and sediment concentrations but must be coupled with hydrologic data to develop dynamic estimates of pollutant loading and nutrient mass balance. In addition, there is little information on atmospheric deposition of nutrients or contaminants. Information on fluxes related to sediments is nonexistent. There is little information on body burdens in fish and shellfish and little information on acute or chronic effects of contaminants known to be present in the Bay or canals that discharge into the Bay. Such data are needed to evaluate potential human health implications and ecological risks.)

a) Acquire and integrate data on freshwater inputs and nutrient/toxicant concentrations.

b) Acquire hydrodynamic transport and mixing data.

c) Acquire data on sediment deposition and flux rates of contaminants.

d) Develop calibrated, verified hydrodynamic model to predict transport, deposition, and flux.

e) Develop water quality, sediment flux model.

f) Determine the effect of exposure to contaminants in surface water and sediments on local plant and animal populations.

g) Develop ecological models to predict ecological consequences of nutrient and toxicant loads.

5. **Develop a quantitative understanding of sources of turbidity, interactions of turbidity and the benthic community, and effects of physical disturbance on the benthic communities maintaining sediment stability.**

6. **Develop a spatially detailed understanding of the permeability of the Biscayne aquifer as related to groundwater seepage to the Bay.**

7. **Develop an integrated understanding of freshwater inflows, salinity, circulation, and mass transport as they relate to all of the above recommendations.**

   a) Further develop, calibrate, and verify appropriate hydrodynamic models.

   b) Obtain the additional data needed to adequately develop, calibrate, and verify the hydrodynamic models.

   c) Form linkages to freshwater inflow, water quality, sediment flux, and ecological models.

   d) Apply the models to freshwater inflow, circulation, and water and sediment quality issues.

   e) Conduct a peer review of hydrodynamic models available for Biscayne Bay to develop an understanding of the relative strengths, weaknesses, and applicability of the various models. Use appropriate modeling to develop an understanding of salinity, circulation, and mass transport as it relates to major issues.

8. **Continue to support major ongoing wetland restoration projects in Biscayne Bay, while at the same time developing a process for periodic scientific review of the Bay's restoration needs and restoration approaches and the development and implementation of an integrated restoration program to meet the needs.**

9. **Provide funding for a multi-year science program in Biscayne Bay.**

   It is critical that scientists become an integral part of the design, promotion and evaluation of research and monitoring efforts for the betterment of Biscayne Bay. For this purpose, we recommend forming a permanent Biscayne Bay Science Committee for Biscayne Bay. Responsibilities of the Committee will be:

   a) To be associated with the Science Coordination Team (SCT) of the South Florida Ecosystem Restoration Task Force and to interact with the Biscayne Bay Issue Team to be formed as recommended by the Biscayne Bay Partnership Initiative.

   b) To focus primarily on Biscayne Bay science issues, including those related to the Comprehensive Everglades Restoration Plan.

   c) To provide input to and rigorous peer review of a strategic science plan for Biscayne Bay and assure its appropriate evolution over the coming years once such a plan has been put forward;

   d) To help facilitate annual conferences and topical workshops to assure the widest possible dissemination of the relevant scientific information;

   e) To facilitate education and outreach activities relating to Biscayne Bay and its ecosystem;

   f) To interact with the state of Florida and relevant federal agencies to develop funding mechanisms sufficient to address the long term technical and scientific needs and to promote in-place funding for research and monitoring needs for catastrophic events, both natural and anthropogenic;

   g) To appoint, with concurrence of the Biscayne Bay Issue Team, an Independent Science Oversight Panel to analyze the scientific pertinence and validity of publicly-funded research, monitoring and restoration methods, data, conclusions, and recommendations.

   h) To interact with research scientists and program managers to assure maintenance of the highest quality research, monitoring and restoration activities.

State funds will be required to staff the Biscayne Bay Science Advisory Committee and the Science Oversight Panel, provide travel compensation for members, etc. The chair of this committee would be a member of the SFER Biscayne Bay Issue Team should one be established.

10. **Create a vigorous Biscayne Bay environmental education program on the value of Biscayne Bay's important plant and animal communities, how to enhance the quality of Biscayne Bay's environments, and how to prevent damage to the most critical elements and species of concern.**

    (Education of the public youth and adults will lead to more responsible and respectful use of Biscayne Bay and its resources.)

11. **Facilitate the development of a Biscayne Bay web site devoted to disseminating research findings relevant to Biscayne Bay restoration, and land-use planning.**

12. **Promote the annual publication or posting of syntheses, evaluation, and interpretation of all publicly funded monitoring results, scientific reports, and data from monitoring under permits.**

13. **Ensure that publicly funded research, monitoring, and restoration data and information are maintained in an openly available web-based GIS database form easily and quickly available to other scientists and the public. Data should be layered to contain all historical and future publicly funded scientific research, modeling, and monitoring data and results, including all data generated for government agencies by the public for permiting and enforcement actions (biological and water quality monitoring reports). (Though open to all, it should to be specifically designed for scientific and management needs.)**

RECOMMENDATIONS BY BREAKOUT GROUPS

GEOLOGY, SEDIMENTOLOGY, CLIMATE, AND SEA LEVEL

Group Recommendations

1. **Better Document The 3-Dimensional Limestone Control On Groundwater/ Surface Water Flow And On Resulting Benthic Community Distribution And Bay Circulation.**

   (Justification: Although the surficial limestone is highly porous and permeable, the actual lateral and vertical flow may be strongly confined and directed by inhomogenieties. These inhomogenieties strongly define the resulting lateral and vertical movement of groundwater and the interaction of surface water and groundwater interaction. This is, however poorly documented.)

Specific Science Recommendations

a) Document the 3-dimensional permeability patterns and groundwater flow of the surficial aquifer beneath the mainland marginal to Biscayne Bay. Determine the source of waters entering the Bay from artesian springs, the exchange between surficial water and shallow groundwater, and the influence of canal cuts in 3-dimensional flow patterns.

   (*Justification: The upper portion of the limestone is commonly considered unconfined and homogeneous. As exp* *lained in the text, this is incorrect, and the inhomogenieties greatly affect the 3-dimensional movement of groundwater.*)

b) Document the amount of inflow and outflow of freshwater and salt water and freshwater into and out of the substrate in areas of exposed limestone in Biscayne Bay. Determine the relative importance of general rock porosity versus solution pipe porosity providing this flow. (*Justification: The role of artesian freshwater springs in delivering water to Biscayne Bay is significant but undocumented. Not only is it important to know how much is entering the Bay through various sources, but also, in the case of springs, where is the water coming from and are any of the sources contaminated.)*

c) Define the nutrient/pollutant loads being provided by canals, surficial sheet flow and groundwater flow into Biscayne Bay. (*Justification: This must be resolved to provide a background to reducing contaminant and toxicant inputs.)*

d) Assess the effect of the historical 0.7' rise in sea level on surface water/groundwater flow and saline intrusion. Assess the effect of a further 2.0' and 4.0' rise in sea level on the surface water/groundwater hydrology of western Biscayne Bay and the adjacent mainland. (*Justification: With sea level rise the freshwater head has lessened and the balance of surface and groundwater contribution changed. In a system as low in elevation as southeast Florida, the role of changing sea level must be incorporated into present and future hydrologic models.)*

2. Increase Water Clarity, Thus Improving Benthic Community Distribution

The following measures should increase water clarity in the area north of Rickenbacker Causeway so that sea grass and hard bottom communities can increase their depth range and begin to move into the remaining artificially deepened dredged bottoms.

Specific Science-generated Management and Action Recommendations

2.1. Recovering Northern Biscayne Bay. A report on sources and circulation of turbidity in Biscayne Bay in 1983 (Wanless, et al) recommended a series of steps to ameliorate the urbanization-generated deterioration of water clarity, increase in turbidity, and loss of important benthic communities. These recommendations (updated) are as follows:

a) Re-establish viable mangrove communities along the margin of as much of the natural and artificial shorelines of northern Biscayne Bay as possible, **both** public and private frontages. These should be of sufficient width to permit areas for trapping and binding of introduced sediment.
(Justification: The coastal mangrove community is important in removing turbidity from tidal waters, baffling wave energy, stabilizing the substrate, and providing habitat for juvenile fish species and species of critical concern.)

b) Eliminate all unbulkheaded shorelines of raw loose sediment fill. These shorelines should be converted to mangrove, clean beach sand or riprap.
(Justification: Unbulkheaded fill shorelines are prime sources of long-term persistent fine particulate sediment release and significantly contribute to the elevated turbidity levels of central and northern Biscayne Bay.)

c) All vertical concrete sea wall shorelines should be fronted by either riprap or a mangrove community band.
(Justification: Shorelines of natural limestone boulders (rip rap) or mangrove will (i) adsorb rather than reflect incoming wave energy and (ii) host a water-clarifying benthic or intertidal community. Vertical seawalls increase day-to-day wave energy in northern Biscayne Bay by reflecting boat wakes. As a result, the shallow benthic communities are stressed and resuspension if fine sediment is increased.)

d) All artificially deepened dredged areas that are not necessary for boat traffic should be modified to promote a water-clarifying benthic community by shallowing the bottom with fill to a depth of less than six feet and planting seagrasses or using clean construction debris to create artificial hardbottom community reefs. *(Justification: Shallowing deep dredged bottoms will permit re-establishment of substrate-stabilizing communities, increase Bay productivity and reduce soft bare bottom areas that are responsible for much of the resuspended turbidity in northern Biscayne Bay.)*

e) To prevent the migration of flocculent bottom material (ooze) to sites of resuspension, all artificially deepened dredged areas should be bounded by berms six feet or less in depth. Berms should be planted with seagrasses for stabilization.
(Justification: The flocculent surface of the deeper bare bottom areas in northern Biscayne Bay commonly deepen and constrict at gaps between causeway islands. As a result, the tidal currents focused at these necks constantly resuspend bottom flocculent matter that migrates towards the deeper necks. Shallow underwater berms would isolate off deeper dredged areas away from the channel necks.)

f) The introduction of turbidity and nutrients through natural and artificial canals and channels should be monitored, and, if significant, flow modified or berms created to limit these sources.
(Justification: Canals commonly receive both fine sediment deposition from Biscayne Bay. Pollutants and toxicants from freshwater runoff also enter the canals and commonly adhere to the fine particles. Re-release of this fine sediment back to the Bay [during flood discharge events] both increases the amount of fine sediment and turbidity in the Bay and introduces adsorbed contaminants.)

2.2. Improving and Protecting All of Biscayne Bay. Most important in improving and protecting the water clarity throughout Biscayne Bay is honestly addressing physical stresses of boat activity. *(We must treat boat traffic across the shallow benthic communities of Biscayne Bay in the same way that we treat vehicular traffic on land, controlling speeds, prohibiting digging up of the roadbed, restricting vehicles from driving on the vegetative communities in our parks and gardens, and limiting the travel of trucks.)*

Specific Science Recommendations

a) Quantify the impact and short- and long-term stresses to water clarity and benthic communities caused by boating activity, and monitor the changes in water clarity and benthic community health as modifications to permitted boating activity are made. *(Justification: With increased use of medium to large boats in Biscayne Bay, bottom resuspension, bottom scour and damage to benthic communities can be expected. Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.)*

Specific Science-generated Management and Action Recommendations

b) Eliminate use of large thrust commercial boats, tugs, and barges from southern Biscayne Bay. The Tug/barge delivering diesel fuel to Turkey Point is a blatant example. *(Justification: Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.)*

c) Limit all boats with large thrust and wake to idle speed if in other than the main east-west shipping channels to and from the Bay. *(Justification: This will encourage the larger and more powerful boats to travel offshore, the place for which they were designed.)*

d) Better mark channels through the Safety Valve, Featherbed Bank and other shallow areas. (*Justification: This will reduce the damage to sea grasses caused by prop scour and excavation.)*

e) Have map boards at marinas with directions, notification of penalties for bay bottom damage and education on value of benthic communities. *(Justification: Education and guidance is fundamental to improved boating practices.)*

f) Have brochures provided with boat tag renewals, with marine officer citations, at all put ins, and at marine stores that provide directions, notification of penalties for bay bottom damage and education on value of benthic communities. (*Justification: Education and guidance is fundamental to improved boating practices.)*

3. Predict Future Evolution of Biscayne Bay In Response To Hurricanes, And Sea Level Rise And Incorporate This In To Management, Legislation And Policy Decisions.

(It is imperative that the high probability for significant future sea level rise be addressed head on. A recent discussion in Science demonstrates the cost, waste and increased risk that occurs if the reality of future sea level rise is not incorporated in to planning and design for the future of low-lying coastal cities (Ammerman and McClennen, 2000). The following are considered high priority recommendation as they provide the foundation for modeling and design of the Biscayne Bay of the future.)

Specific Science Recommendations

a) Assess the quantitative effect of the past 70 years of increased rate of relative sea level rise on the environments and waters in and marginal to Biscayne Bay. (*Justification: The 0.7-foot rise in sea level over the past 70 years is about 7 times faster than the rate over the past 2,000 years. As a result there have already bee nfundamental changes in the stability of the coastlines, wetlands, mudbanks, circulation, and hydrology of Biscayne Bay.)*

b) Using knowledge of the response of coastal and shallow marine environments to differing rates of relative sea level rise (from geologic studies of south Florida), assess how the coastal and shallow marine environments in various settings of Biscayne Bay will respond over the next 100 years to a further sea level rise of 2 and 4 feet.

- Create a map and dynamic model of how the marine, coastal and upland environments in and marginal to Biscayne Bay will look in 50 and 100 years with a 2- and a 4-foot rise in relative sea level.
- Assess areas, rates, amounts and types of erosion that will occur in destabilized sediment bodies in and marginal to Biscayne Bay for the four models.
- From these four maps and dynamic models, define the changes in the interaction of Biscayne Bay waters with the surface and ground waters of the coastal ridge and Everglades Basin.
- From this, define the resulting patterns of circulation, salinity and residence time for waters in Biscayne Bay.
- And from this, project the distribution of benthic communities in Biscayne Bay.
- Identify areas in which human intervention can ameliorate the negative environmental effects of increased rates of rising sea level, and those areas in which current or anticipated human activities will negatively accentuate the consequences of rising sea level.

(Justification: The above research/modeling exercise will provide a visual model of future changes in the configuration of the substrate and the Bay margins, circulation, salinity, distribution of habitats, and foci of human stress over the next century. This will provide the foundation for all long-term management, legislative and policy strategies.)

Specific Science-generated Management and Action Recommendations

c) Incorporate the reality of the historical rapid rise in sea level and the high probability of further future increases in the rate of sea level rise into every aspect of planning for the future of Biscayne Bay and Miami-Dade County. (*Justification: Without using the produced knowledge of the future of Biscayne Bay, management and policy decisions will be meaningless and likely environmentally and economically harmful to the Bay and the people of south Florida.)*

HYDRODYNAMICS AND MASS TRANSPORT

Group Recommendations

There is a close relationship between water management, salinities, and water quality in Biscayne Bay. The temporal and spatial variation of salinity is a major controlling factor on the type and growth of fish populations and benthic communities. To properly estimate salinities and effects of point and non-point sources on Biscayne Bay water quality, better information on freshwater inflows and atmospheric forcing are needed in conjunction with predictive hydrodynamic and mass transport models. To fulfill these needs will require the following developments:

1) **Determine the quality, quantity and timing of fresh water discharges to the bay from all sources, present and predrainage.**

2) **Develop a peer-reviewed, calibrated, verified hydrodynamic model of the Bay circulation, salinity distribution (including the western fringe), and exchanges with the coastal ocean, and which is or can be coupled to atmospheric forcing, water quality, and biological models.**

3) **Use the hydrodynamic model and other analytical tools to help evaluate ramifications of all scenarios of altered physical conditions, such as changes in freshwater inflow, dredging and filling, sea level rise, hurricanes and storms, etc.**

4) **Hindcast predrainage circulation and salinity patterns.**

5) **Water quality including suspended solids resulting from point and non-point sources of pollution is a critical concern. "End effects" ecological models coupled with the hydrodynamic models are needed. Traditional nutrient/primary production type models are likely useful only as research tools for a long time to come. To prepare for these models, hydrodynamic transport and mixing data are needed.**

6) **Develop a better understanding of the water wave climate and the effect of waves on bottom re-suspension and surf zone mixing processes that need to be included in predictive models.**

7) **Develop a suite of Biscayne Bay endpoints (important characteristics, e.g. salinity patterns, distribution of juvenile shrimp) and model output parameters for water quality and biological communities that can be monitored to assess the state of the Bay. Ensure that the endpoints are considered in numerical model selection, grid design, data collection, and model development.**

8) **Develop a long-term monitoring strategy of important physical/biological parameters based on identified Biscayne Bay endpoints and model output parameters. Where feasible transmit data in real-time for use in predictive models to detect changes in the state-of-the-bay.**

9) **Develop the capability to evaluate and predict the effect of shoreline/Bay development on Bay water quality using hydrodynamic models and associated water quality and biological ecological models.**

10) **Assemble a group of individuals knowledgeable in oceanographic and hydrologic data collection, data analysis, hydrodynamic, water quality and biological modeling, model application, and familiar with local conditions to participate in the above efforts.**

WATERSHED HYDROLOGY

Group Recommendations

The following section contains a number of general recommendations. Each general recommendation is followed by an explanation, as well as a number of recommended specific projects and specific recommended management actions that are needed with regard to the recommendation. While the specific projects, research, or actions listed under each recommendation are important, the lists are not intended to be exclusive or exhaustive-and other approaches that would achieve the same objectives are acceptable.

1. **Review and refine estimates of predevelopment, historic, and present fresh water inflow to the Bay.**

(Gaps and uncertainties in our knowledge of present and past freshwater inflows need to be resolved to more reliably determine the Bay's freshwater inflow needs. Post-drainage historic flow is incomplete because groundwater and overland flow information are lacking. A better understanding of natural, or "pre-drainage", freshwater flow to the Bay would provide perspective on Biscayne Bay's present freshwater needs and help develop restoration targets for Biscayne National Park. Paleoecological approaches to identifying the salinity requirements of species that once lived in the Bay provide an objective means of determining the Bay's past salinity patterns; and past freshwater inflows can be inferred from salinity.)

Related Specific Scientific Recommendations:

a) Conduct sediment and coral studies to determine past salinity patterns.

b) Use information about salinity tolerances and preferences of salinity dependent species, including estuarine dependent species, known to have once occurred in Biscayne Bay, to infer past salinity conditions in the Bay. Conduct biological studies to acquire additional information, where needed.

c) Complete finer-scale (than the 2 miles x 2 miles) and salinity interface modeling needed to evaluate water management effects on freshwater flows to Biscayne Bay.

d) Reexamine changes in flows to Biscayne Bay expected from CERP (excluding the Water Reuse option) using models with finer resolution and a salinity interface capability.

e) Develop and implement a practical routine protocol for estimating direct rainfall and evaporation on Biscayne Bay and its watershed, including the addition of rainfall measurement capability to existing fixed stations in the Bay. Extend the data spatially using NEXRAD and historically using existing nearby long-term meteorological stations.

2. **Characterize the chemical, biological, and physical environments in the near-shore areas of Biscayne Bay**.

(The western nearshore part of the Bay is the area most subject to change in freshwater inflow and associated water quality, but little information is available on this dynamic area, partly because it is difficult to reach. More detailed knowledge of this area is needed to design restoration elements of CERP. Needed studies include; 1) surface and ground water flow characterization; 2) benthic and biologic surveys, 3) detailed water quality surveys, 4) detailed topographic and bathymetric data, and 4) long-term, detailed hydrodynamic studies of salinity, water movement, and water depth along the shoreline, in coastal creeks, and within the mangrove fringe.)

Related Specific Science Recommendations:

a) Conduct detailed survey of substrates and benthic community types.

b) Acquire detailed long-term water level and salinity and current measurements along the coast and within the mangrove *creeks (establish long term monitoring stations in the western nearshore area)*.

c) Determine spatial and temporal distribution and abundance of fish and invertebrates

d) Determine benthic flux of fresh water and water quality parameters

e) Couple an appropriate hydrodynamic model, which predicts salinity and circulation, with a model or other suitable tool that can predict water quality and indicator species distributions

f) Continue and expand sediment studies to determine historic and pre-drainage salinity patterns, especially in western nearshore areas.

g) Develop a model or other appropriate tool suitable for studying the interaction of the intertidal and nearshore regions of Biscayne Bay to support design and planning of CERP's Biscayne Bay Coastal Wetlands component.

h) Acquire information about the western nearshore part of the Bay needed by existing hydrodynamic models in order to improve their resolution and accuracy in this ecologically important area, including (i) vertically- and horizontally-detailed topographic and bathymetric data for use in determining wetting and drying under various tidal stages and mean, (ii) refined freshwater inflow data, and (iii) spatially detailed information on water level, salinity. *(This is particularly important in South Biscayne Bay, where an extensive, largely continuous fringe of coastal wetlands borders the Bay south of Matheson Hammock Park.)*

i) Design and establish an expanded long term monitoring network in the Bay to collect detailed salinity and water quality information, with particular attention to the western nearshore regions and the mangrove creeks. *(Integrate and expand existing water quality/salinity monitoring network, establish long-term monitoring stations in the western nearshore area, and employ continuous recording devices to collect data wherever feasible.)*

3. **Identify indicator species for Biscayne Bay in terms of salinity and habitat needs to help develop targets for CERP and Minimum Flows and Levels.**

(The key to establishing the freshwater needs of Biscayne Bay is to define these needs in terms of the salinity requirements of characteristic species and communities and then to relate magnitude and timing of freshwater inflow to salinity patterns. Information about indicators and their requirements will provide a basis for establishing biological criteria, or performance measures, that will be used to evaluate how well CERP is meeting restoration objectives with respect to Biscayne Bay and how well LECWSP is avoiding significant harm to the Bay. A scientific rationale for each selection must be provided, along with documentation on optimal salinity (a salinity envelope), optimal physical habitat (bottom type, bottom cover, depth, and distance from shoreline), and tolerance to salinity fluctuation.)

Related Specific Science Recommendations:

a) Identification, justification, and documentation of a set of appropriate indicator species and communities characteristic of the Bay whose distributions are likely to be influenced by changes in salinity.

b) Biologic studies on salinity and habitat requirements of juveniles of ecologically or economically important estuarine species that would be expected to use the western nearshore Bay as a nursery ground.

4. **Set restoration salinity targets and locations** (i.e. wet and dry season salinity envelopes in appropriate bottom or shoreline habitat).

(Definition of the appropriate range and placement of salinity envelopes is a critical link in determining Biscayne Bay's freshwater inflow needs. "Salinity envelope" is a simple term referring to the combination of appropriate salinity range, fluctuation, and habitat that should exist in an estuary. Salinity envelopes have been developed by the South Florida Water Management District for other South Florida estuaries as a prerequisite to the necessary determination of freshwater inflow restoration targets and minimum flows and levels.)

Related Specific Science Recommendations:

a) Use the information provided by the recommended biological studies to determine the salinity ranges and salinity fluctuations, specific to season and location, that would be appropriate to maintain key indicator species. Document this information and use it as the basis for biologic and hydrologic performance measures and targets that can be used to evaluate regional water management alternatives and to monitor the success of alternatives as they are implemented.

b) Determine the locations of appropriate bottom and/or shoreline habitat for the species and the appropriate placement of the salinity envelope to ensure that desirable salinity coincides with appropriate habitat.

5. **Develop flow regimes (quantity, timing, and distribution) that produce the desired salinity envelopes.**

(Appropriate predictive tools to relate water management to salinity patterns are critical to protect and restore the Bay in the detailed design stage of CERP and in setting Minimum Flows and Levels for implementation of LECRWSP. Water management for drainage and flood control has altered freshwater inflows to the Bay. CERP and LECRWSP, when implemented, will further change freshwater inflow to the Bay. These plans have an adaptive assessment process to restore, or at least protect, the Bay ecosystem. Their adaptive processes depend on predictive models to link the salinity requirements of key indicator species and communities to the freshwater inflows required to maintain these salinities in the specific locations where other suitable habitat conditions are found.)

Related Specific Science Recommendations:

a) Develop a regression or time series model to estimate salinity patterns in the western nearshore Bay as a function of the recent history of freshwater inflow. Development of a regression or time series model will require the acquisition of a time series salinity data synoptic with freshwater inflow data. The record must be sufficiently long and varied to cover a wide range of possible freshwater inflow and salinity conditions. *(The regression model will fulfill a vital function until hydrodynamic models to predict salinity patterns in the western nearshore Bay are operational.)*

b) Couple surface water and groundwater models to a hydrodynamic model to simulate and predict salinity distributions in response to water deliveries. The desired salinity envelopes can then be matched by adjusting freshwater inputs into the hydrodynamic model. Seasonal and year-to-year variations of freshwater inputs should be simulated in the coupled model.

c) Review and improve appropriate hydrodynamic models of the Bay and integrate them with ground and surface water models that can provide appropriate and accurate watershed boundary conditions. Seasonal and year-to-year variations of freshwater inputs should be simulated with the coupled model. Continue to improve the performance and resolution of the coupled surface water-groundwater-hydrodynamic model using data from the expanded monitoring network.

d) When operational, use the model to determine the quantity, timing, and distribution of flows (or refine estimates of flow provided by regression or time series models) required to maintain the salinity envelope (i.e., target salinity range) in areas of suitable bottom and/or shoreline habitat.

e) Apply performance measures to evaluate existing conditions in the Bay (baseline measurement), to test and compare proposed new managed inflow regimes, and to evaluate progress toward meeting biological and salinity targets. Define measurable success realistically (allowing for occasional departures from salinity envelopes).

f) Apply performance measures and targets to establish Minimum Flows and Levels for Biscayne Bay to ensure that significant harm from lack of freshwater inflow will not be experienced in any part of the Bay, including extreme southern areas (i.e., Card Sound, Little Card Sound, Barnes Sound, Manatee Bay) that are of particular concern because they are at the most downstream end of the water management system.

6. Identify and acquire additional coastal lands necessary for flow redistribution.

(Freshwater flow to Biscayne Bay will provide greater biological benefits if it enters through coastal wetlands and tidal creeks rather than as a point source because the fresh to brackish wetland zone provides essential nursery and feeding habitat for estuarine fish, invertebrates, and other wildlife. An almost continuous mangrove shoreline fringe exists from Matheson Hammock Park to US 1 at Jewfish Creek that provides an opportunity to redirect some canal flows through coastal wetlands. Land near the coast may be required to store water captured during the wet season for release to the Bay in the dry season, and/or provide groundwater recharge. Land used for these purposes must be in public ownership or flowage easements must be acquired.)

Related Specific Science-generated Management and Action Recommendations:

a) Assess land needs for flow redistribution and other restoration projects.

b) Assign the highest priority for public acquisition to needed parcels and move to acquire them immediately.

7. Develop the capability to predict water quality changes and resultant effects on the Bay's biological integrity that might occur with proposed water management changes.

(An ability to predict the loads, water quality, and biological effects of change in water management is needed to protect Biscayne Bay. Predictive models or other appropriate tools relating flows to water quality should be developed, and potential biological indicators of water quality should be selected. Selections should be on the basis of presence (or potential presence) in the Bay at locations most likely to experience change and sensitivity to the types of water quality changes that might occur, including changes in nutrient, toxicant, or other pollutant loading.)

Related Specific Science Recommendations:

a) Develop a model or other appropriate water quality tool to predict loading of nutrients, toxicants, and other pollutants to the Bay as a function of water management.

b) Develop, test, and verify a water quality model or other appropriate water quality tool that can be linked to the hydrodynamic model and receive input from the loading model to predict the effects of water management changes on water and sediment quality in the Bay.

c) Develop and document water quality indicators and performance measures that can be used to evaluate effects of water management changes on the biological integrity of the Bay. Emphasis should be on the use of biological indicators that are sensitive to change in water quality.

8. **Determine the importance of fresh water springs to the quantity and distribution of freshwater inflow to Biscayne Bay, past, present, and future**.

(Historically, springs emanated from the bottom of the Bay through natural leakage channels occurring in the rock formations. An unknown portion of the groundwater flow may be discharging via these springs and their existence may affect predictions of groundwater flow by existing models. A series of projects are suggested to provide an indication of the significance of spring discharge to groundwaterflow to Biscayne Bay and to evaluate whether existing groundwater models can be improved by the acquisition of further information on springs in the Bay and associated channels in the aquifer. The steps are to locate springs, locate channels that relate to springs, and quantify the amount of discharge from these in relation to the surrounding aquifer.)

Related Specific Science Recommendations:

a) Interview fishermen and other knowledgeable locals regarding the existence of springs in the bay.

b) To locate possible channels within the aquifer, measure tidal propagation inland by comparing fluctuation in the water table or pieziometric surface in a series of groundwater monitoring wells at the same distance from the coastline with tidal amplitude in adjacent coastal waters. Wells with substantially higher ratios of surface fluctuation to tidal amplitude will indicate sites of greater permeability and higher rates of groundwater flow to the coast.

c) Conduct studies such as airborne thermal infrared surveys or resistivity surveys to locate springs within the Bay. Special emphasis should be placed on opportunistic sampling after high rainfall events.

d) Once located, install seepage meters on the springs to measure the flow and sample the discharged water to determine its salinity and other water quality parameters of interest.

e) Locate the inland points of recharge to investigate the possibly of maintaining higher ground water levels in those areas to promote spring discharge and also identifying and controlling potential sources of pollution.

Priority Related Specific Science Recommendations:

a) Conduct studies to determine the magnitude and ecological ramifications of changes in and redistribution of freshwater inflows to Biscayne Bay.

b) Establish hydrologic, biological, and water quality indicators, benchmarks, and targets based on biological needs and historic and pre-drainage conditions to help establish minimum flows and levels for LECWSP and to provide design criteria and performance measures for CERP.

c) Determine the appropriate redistribution of water to restore fresh to brackish water wetlands and provide sustained freshwater flows along the western shoreline of South Biscayne Bay.

d) Review, refine, and integrate hydrologic and hydrodynamic models so that realistic predictions of freshwater flows to the Bay and resultant salinity patterns under different water management scenarios can be compared.

e) Provide a baseline of current conditions for comparison with post project monitoring.

Priority Specific Science-generated Management and Action Recommendations:

a) Provide flexibility to the water management system to allow storage of wet season water excess to provide needed dry season flows.

b) Support the rapid development of restoration targets based on pristine and historic conditions and biological indicators.

c) Determine how best to redistribute point source canal discharges to sheetflow and natural creek systems in the Biscayne Coastal Wetlands and C111 components of CERP. This includes identification and purchase of needed lands.

COUPLING FISH COMMUNITIES, ENVIRONMENT, AND HUMAN INTERACTIONS

Group Recommendations

The future of Biscayne Bay depends on management of the effects from human population growth and economic activities. The function and dynamics of the Bay's critical resources need to be understood to effectively address management and sustainability issues currently faced. The most serious immediate problem is alteration in freshwater inflows. What is urgently needed is the capability to reliably predict the effects of altered upstream water management. Sound predictions depend on development of an integrated view of the coupled human and natural processes regulating ecosystem dynamics in the Bay. Focused biological and physico-chemical research is essential to developing this view. A robust ecosystem-wide strategy to monitor the Bay's ecological condition is critical. An integrated program of monitoring, process studies, and interdisciplinary modeling that contains the following elements is recommended.

1) **Investigate historical salinity conditions**

(Justification: while it is generally believed that Biscayne Bay was more estuarine in the past, the actual salinity distribution in the Bay prior to water management and human development impacts is not well known. A view of the Bay's past freshwater inflows is needed as a reference point and perspective for ecological restoration.)

Specific Science Recommendations

a) Conduct a background synthesis on the range and dynamics of 'pre-European settlement' salinity conditions that existed prior to 1700 using a strategic combination of literature synthesis, numerical modeling, and paleo -ecological studies on foraminifera abundance and oyster bar distributions.

2) **Monitor pink shrimp, blue crab and juvenile fishes**

(Justification: These species constitute something of a special case since they can be sampled (and have been sampled) as part of an integrated trawl-based monitoring effort. Given their trophic importance and demonstrated sensitivity to salinity distribution change these efforts need to be continued and expanded)

Specific Science Recommendations

a) Expand baywide and continue as restoration proceeds, a field monitoring effort directed at quantifying the abundance and distribution pink shrimp, blue crab and juvenile fishes.

b) A disease and abnormality component should be integrated within this effort with expertise and field personnel specific to this purpose.

3) **Monitor fish utilization of Bay's shallow and shoreline habitats**

(Justification: Shoreline habitats are the first and most significant areas to be affected by proposed changes in water management policies in Biscayne Bay).

Specific Science Recommendations

a) Particular attention needs to be paid to populations that utilize the bay's shallow (< 1 m depth), intertidal and mangrove-lined shoreline habitats wheres within the Bay salinity changes will be greatest.

4) **Conduct before-after ecological studies associated with Coastal Wetlands Component.**

(Justification: The Comprehensive Everglades Restoration Plan (CERP), Biscayne Bay Coastal Wetlands Component has the potential to effect major changes in the extent of available wetlands if implemented.

Specific Science Recommendations

a) Appropriate "before-after" ecological studies need to be done in conjunction with this restoration project since it directly affects one of the principal contiguous Sub ecosystems in the Bay.

b) These studies should be extended well beyond the immediate zone of influence of the project to ensure that a complete understanding of project effects is achieved and that effective and timely changes are made to improve project performance over the course of its' implementation

5) **Monitor exploited species populations and fisheries.**

(Justification: Changes in exploited species populations and fisheries have substantial social and economic consequences)

Specific Science Recommendations

a) Basic demographic and population-dynamic data on stock abundance, age, size structure, growth, and reproduction are needed.

b) Rates of fishing pressure/exploitation are also required for resource assessment, and fishery management purposes and to parse out restoration effects from over-fishing.

c) As part of this effort, further research is necessary to establish the extent to which mechanical damage from trawling and dredging activities directly and indirectly affect the bay's fish assemblages, including the quantification of habitat recovery rates of the resilience and stability of key resources.

6) **Determine habitat value of altered and restored habitats north of Rickenbacker Causeway.**

(Justification: This area is especially characterized by man-made structures, shorelines and altered benthic habitats and has unfortunately been inadequately sampled over the last decade in comparison with south Biscayne Bay)

Specific Science Recommendations

a) Determine the fish and invertebrate diversity, distribution, population size structure, abundance and dynamics of the bay north of Rickenbacker Causeway.

b) Fishery resource monitoring of areas enhanced or restored by Miami-Dade County should be specifically included in this effort since local differences are expected as a result of these local actions and might confound interpretation relative to overall restoration effects.

7) **Conduct laboratory studies on salinity effects.**

(*Justification: the primary effect of* CERP is expected to be alteration of the Bay salinity regime. Given the canal structures pulsed introductions are typical and we need better understanding of physiological responses to such realistic stresses not just overall "salinity tolerance" determination to predict population consequences).

Specific Science Recommendations

a) Laboratory experiments on salinity effects on key (and sensitive) species are essential.

b) Specifically needed are controlled laboratory studies on the physiological impacts of variable salinity regimes (and freshwater pulse frequency, duration, and magnitude) on growth and survivorship of key life stages of ecologically and economically important species.

8) **Study creek and canal flora and fauna .**

(Justification: Additional freshwater entering the Bay will be introduced through the present network of creeks and canals the fauna and fauna of which has already been substantially altered and to which numerous exotic species have been introduced. We need to better characterize these populations if we are to determine what changes follow restoration actions.)

Specific Science Recommendations

a) Quantitative characterization not just of the Bay itself but of the native and exotic flora and fauna in the lower reaches of the canals and natural creeks that flow into the Bay is essential

9) **Investigate contaminant and physical stress effects on marine organisms.**

(Justification: Limited information already available suggests pollutants and toxicants are reaching the Bay and that some of the canals are particularly contaminated. Animal abnormalities have been reported but no clear cause and effect relationships have been established).

Specific Science Recommendations

a) The source and distribution of pollutants and toxicants entering the Bay as well as spatio-temporal distribution of abnormalities requires further attention.

b) Initial focus is recommended on laboratory research that examines the extent to which mechanical and toxicant stresses, both singly and in combination, are responsible for the two major abnormalities encountered in fish in the Bay, scale disorientation and fin ray deformity.

10) **Develop coupled biophysical models**.

(*Justification: Quantitatively linking* biological change to the physical changes resulting from upstream water management changes requires dynamic predictive modeling of physical – biological interactions given the highly nonlinear responses typical of such complex systems).

Specific Science Recommendations

a) Coupled biophysical models that predict the spatial dynamics and distribution of key upper trophic-level resources need to be refined considerably to be useful in fishery management and coastal zone development to evaluate the ecological risks of certain development and restoration scenarios.

11) Develop spatially-explicit ecological databases.

(Justification: Testing scientific hypotheses and evaluating management alternative scenarios requires access by both the scientific and management communities to the same information base)

Specific Scientific Recommendations

a) Very high priority should be given to development of an integrated database containing all biological and physical 'habitat' layers, hydrodynamic circulation, salinity and water quality variables, and commercial and recreational fisheries and ecological data.

b) High resolution habitat maps (in GIS or other visualization formats) are needed to clarify types and extent of static and dynamic habitats throughout Biscayne Bay.

c) The GIS tool should be embedded in a sophisticated database management,statistical, visualization, and modeling system to facilitate the assessments and risk analyses required by managers

HABITAT AND SPECIES OF CONCERN

Breakout Group Recommendations

1) Delineate the distribution and quality of benthic marine, coastal wetland, coastal upland species, and species of special concern.

(*Justification: The distribution of benthic environments must be carefully documented prior to freshwater inflow modifications to the Bay margin and for comparison to changes that may occur in response to hurricanes, unanticipated pollution events and sea level rise.*)

Specific Science Recommendations

a) Evaluate existing maps and quantitative spatial data for accuracy, resolution, and expected needs and develop a protocol for the following: Map and quantify coverage of benthic communities, including infauna, by species composition and density, in areas of soft-sediment seagrass cover, hard bottom, barren bottom, coastal wetlands, and coastal uplands. Especially focus on the western portions and edge of Biscayne Bay.

b) Delineate the distribution and density of endangered species and species of special concern in and marginal to Biscayne Bay and their relation the bottom habitat.

c) Compare a) and b) with previous mappings and estimates to determine change. Determine functions and processes causing benthic habitat shifts in the Bay.

Specific Science-generated Management and Action Recommendations

d) Integrate current and future publicaly funded monitoring activities into a coordinated monitoring and mapping program from Dumfoundling Bay through Biscayne Bay to Manatee Bay, with intensive, detailed observations in the western nearshore Bay.

2) **Define the salinity and freshwater inflow parameters (timing, quantity, quality and distribution) that will permit the re-establishment of a viable estuarine ecosystem in the nearshore and coastal wetland zone of western and northern Biscayne Bay.**

(*Justification: The loss of an inshore estuarine habitat in Biscayne Bay has degraded the overall quality, diversity and functionality of the Biscayne Bay ecosystem. This degradation occurred as the result of historical lowering of water levels and converting to point source (canal) pulses of freshwater discharge. The Comprehensive Everglades Restoration Plan (CERP), which includes a Biscayne Bay Wetlands Restoration component, provides a unique opportunity to coordinate the requirements for re-establishing estuarine conditions in Biscayne Bay with the redesign and replumbing of water flow to the Everglades. It is of the highest priority to take advantage of this opportunity.)*

Specific Science Recommendations

a) Define a more natural quantity, quality, timing and distribution of freshwater flow to the wetlands marginal to western Biscayne Bay.

b) Expedite planning to determine the freshwater budget and land area needed to meet the goals of the Biscayne Bay Coastal Wetlands component of the Comprehensive Everglades Restoration Plan (CERP).

c) In designing the parameters for this restoration, attention should be given to increasing habitat for endangered species and species of concern and salinity requirements of habitat species on which they are dependent. *[Most if not all of these species are discussed in the U.S. Fish and Wildlife Service South Florida Multi-species Recovery Plan.]*

d) Restore freshwater and saltwater wetlands in association with the Biscayne Bay Coastal Wetlands Project of the Comprehensive Everglades Restoration Plan.

e) Provide baseline surveys and continued monitoring of wading bird and migratory bird use of restored coastal wetland and estuarine habitat.

Specific Science-generated Management and Action Recommendations

f) Continue to remove exotic species from the intertidal and coastal wetland and upland habitats to create more area for native habitat species, especially as habitat for species of special concern, and maintain these areas to prevent reinfestation.

3) **In conjunction with restoration, scientific management programs for the Bay should be established for endangered species and species of special concern including turtles, manatees, dolphins, crocodiles, seagrasses, and selected birds such as the roseate spoonbill, brown pelican, turkey vulture, and various shorebirds.**
[Note: DERM already has a manatee protection plan.] [Coordinate with U.S. Fish and Wildlife Service Multi-species Recovery Plan.]

4) **Restore coastal freshwater to saltwater wetlands form Turkey Point to US1 in cooperation with the Florida Power and Light Mitigation Bank. Complete acquisition of land available east of US 1 from Palm Drive south and restore freshwater flows through these wetlands and into extreme southern Biscayne Bay, Card Sound, Barnes Sound and Manatee Bay.**

5) Evaluate the potential effect of a change in freshwater flow to North Biscayne Bay.

6) Improve design of floodgates to reduce manatee mortalities.

7) Pursue aggressive efforts that will continue the reduction in turbidity within the waters of central and northern Biscayne Bay and will reduce physical damage to benthic communities and substrate.

(*Justification: Biscayne Bay is dominated by benthic communities that need clear water and a substrate that is not physically disturbed. Historical changes to the bay, its margins and nature of freshwater inflow have degraded the water clarity and reduced the quality and distribution of Benthic community coverage. Ongoing prop washing and scouring by boats are damaging the communities.*)

Specific Science Recommendations

a) Evaluate the impacts of turbidity on primary productivity and habitats in Biscayne Bay.

b) See section on turbidity in Geology portion.

Specific Science-generated Management and Action Recommendations

c) Finish largely completed stabilization of public vertical seawalls with natural limestone boulders and/or planters for intertidal vegetation. Develop an incentive program to encourage private property owners to install natural limestone boulders in place of, or in front, of bulkheads.

d) Identify and implement ways to reduce or eliminate turbidity and bottom scour of benthic communities that is due to large vessel traffic.

8) Define channels for use by larger boats to enter and egress Biscayne Bay.

9) Mark channels more effectively and improve enforcement next to important species of concern feeding or resting areas and next to important shallow habitat areas such as seagrasses, hard bottom and coral-algal fringe communities so that turbidity and direct impact are minimized.

10) Limit turbidity laden effluents into the Bay.

11) Conduct ecotoxicology studies to document and monitor stresses and damage to endangered species, species of special concern, and indicator species in benthic habitats. Use this information to guide reduction of point source pollution and cleanup of historical contaminant sources.

(*Justification: although partly urbanized it is a fundamental goal to restore and maintain Biscayne Bay as a healthy bay for all organisms who depend on it.*)

Specific Science Recommendations

a) Continue toxicity monitoring of blood tissue samples of the resident dolphin population of Biscayne Bay as a health indicator of Biscayne Bay.

b) See recommendations in Water and Sediment Quality section.

Specific Science-generated Management and Action Recommendations

c) During and after proposed dredging operations in the Miami River and other channels and canals, use up-to-date technology to minimize or eliminate movements of contaminated sediment into the Bay.

d) Reduce further toxic substance input form upland sources, especially during catastrophic events such as floods and hurricanes.

e) Review and update hazardous substance, petroleum, and sewage spill plans to make sure these provide adequate protection of habitat and for species of concern.

f) Critically review the risks of leachates to Biscayne Bay from present and past landfills, sewage discharge sites (land, sea and groundwater), and canals. Reconsider the siting of landfills and other waste disposal sites in proximity to the wetlands and waters of Biscayne Bay.

12) **Document and compare the functionality and resilience of important benthic habitats throughout Biscayne Bay by conducting comparative turbidity, food web, and fisheries studies in habitats of varying density and species composition** (within the various seagrass communities, hard bottom community, coral-algal fringe community and soft bottom barren and algal mat community)**.**

(*Justification: The influence of density and species structure of different benthic habitats in supporting fish populations needs to be documented in order to guide and optimize restoration and protection plans. The role of various types of seagrasses in stabilizing sediment also needs to be evaluated. These studies will also serve as a baseline from which the quality of benthic community habitat can be monitored with changes management or following natural and human disasters in the Bay.)*

Specific Science Recommendations

a) Document and compare the functionality and resiliency of the important benthic habitats throughout Biscayne Bay by conducting comparative turbidity, food web and fisheries studies in habitats of varying density and species composition (within the various seagrass communities, hard bottom community, coral-algal fringe community and soft bottom barren and algal mat community)**.**

13) **Review, develop, and apply scientifically and economically sound methods for restoration and maintenance of freshwater wetland, coastal wetland, coastal upland, and benthic seagrass communities.**

(*Justification: Methods and approaches to ecological restoration and exotic control must be agreed upon so as to be able to effectively repair areas of damage and optimize Bay restoration efforts.)*

Specific Science Recommendations

a) Hold workshops and, as necessary, conduct demonstration projects and evaluation of previous projects to assess approaches for coastal wetlands, coastal uplands, and seagrass restoration and for control of exotics in coastal and freshwater wetlands and coastal uplands.

b) Document rates and manner of natural re-establishment over disturbed bottom in different settings in different bay sectors so as to establish criteria to define when and how replanting is appropriate and necessary for maintaining healthy benthic and wetland communities in Biscayne Bay.

c) Review, develop, and apply scientifically sound, cost-effective, and reliable methods to restore seagrass cover on banks damaged by prop scars and scours and sites affected by high turbidity and persistent wave action (mostly by boats in portions of Biscayne Bay).

Specific Science-generated Management and Action Recommendations

a) Continue ongoing restoration projects at Virginia Key, Chapman Field, Snapper Creek, Bill Baggs State Recreation Area, and the Oleta River Corridor and support rehydration of Cutler Drain if feasible.

b) Ensure that restoration projects have a funded component that provides for scientific followup and monitoring of restoration sites. Sufficient support should be provided for consistent monitoring using scientifically sound, systematic, and quantitative procedures.

c) Ensure adequate funding for continued maintenance and exotics control on coastal wetland and coastal upland restoration projects.

14) Expand education on value of habitats, species of special concern, threats to the Bay and how individuals can maintain and improve the quality of the habitats and species in Biscayne Bay.

(*Justification: Understanding leads to support for efforts to improve the bay and leads to more respectful users of the Bay.)*

a) Continue public education about the ecosystems losses that result from dumping in and polluting in the Bay, damaging benthic habitats by boating activities, and not being respectful of species of concern. Provide information and warnings through dive shop and marina postings, posters, brochures and maps to inform users about habitats, species of special concern, areas to avoid or be watchful, damage caused by different types of boats, and regulations.

b) Enhance Manatee education and awareness, including posting signs in manatee feeding and congregation zones.

c) Create environmental education centers at specific bayside parks for primary, middle and secondary school children. Provide labs, full displays about habitats and species of special concern, material for teachers and exhibits, which can circulate into schools. Establish "Science Outposts" with programs and facilities for student science research, with pilots at Oleta River and Bill Baggs State Recreational Area. *[See full description in recommendations from Education Team.]*

d) Create curriculum for elementary schools that discuss habitats and species of concern.

e) Develop or support existing community service programs for cleaning up the Bay and its margins.

f) Publicize and enforce laws and rules that prevent damage to the Bay's resources.

g) Mark and enforce manatee-zone speed limits.

WATER AND SEDIMENT QUALITY

Breakout Group Recommendations

1) Quantify pollutant loading to Biscayne Bay.

(*Justification: Extensive monitoring data provides a basis for description of geographic and temporal patterns, but this information must be coupled with hydrologic data to develop more dynamic estimates of pollutant loading and nutrient mass balance. Hydrologic models now under development are expected to provide the foundation for water quality models that should be useful in projecting changes in geographic patterns, trends, and loading of nutrients and contaminants. However, there are little or no data presently available on atmospheric deposition or flux rates, and little information available on sediment-water column exchange of nutrients or contaminants.*

Specific Science Recommendations

a) Conduct water quality and hydrologic studies necessary to quantify pollutant loading to Biscayne Bay. This should include studies to quantify groundwater inputs to the bay and address the role groundwater plays in pollutant loading.

b) Conduct additional studies to identify fate and transport mechanisms for contaminants in the bay system. This should include studies to address atmospheric deposition or flux rates, and provide information on sediment-water column exchange of nutrients or contaminants.

c) Conduct studies to evaluate impact of elevated nutrient levels in south Dade watershed on the receiving waters of Biscayne National Park.

2) **Refine water quality standards used to indicate the presence of sewage in surface water.**

(*Justification: Various techniques exist for identifying the presence of sewage in surface waters. However, each method has inherent limitations and method performance may vary with climate. Epidemiological data on the incidence of swimming-related illness is needed to refine standards for sewage indicator organisms used in South Florida.*)

Specific Science Recommendations

a) Conduct surveys to determine the incidence of swimmer related illness for public beaches in South Florida. Correlate results from the survey with beach water quality monitoring data results to identify the most effective indicator of sewage contamination, and use this information to develop an appropriate numerical standard.

b) Continue and expand water quality monitoring at public beaches to provide data necessary to evaluate survey results and provide to inform the general public.

3) **Determine the effect of exposure to contaminants in surface water and sediments on local plant and animal populations.**

(*Justification: With the exception of health-risk assessments conducted in the Military Canal area, there are little data available on levels of mercury or other toxic contaminants in fish and shellfish tissues for the Bay. There are also little or no information on the acute or chronic effects of these contaminants on resident plant and animal populations. Such data are necessary for directing resource management efforts, and are needed to evaluate potential human-health implications of subsistence fishing in urban surface waters with potential water and sediment quality degradation.*)

Specific Science Recommendations

a) Conduct studies of local plant and animals to determine body burdens for toxic contaminants detected in surface water and sediments. These studies should include evaluations of species of special concern such as the bottlenose dolphin.

b) Conduct studies of local plant and animal populations to determine effects of exposure to surface water and sediment contaminants. These studies should address issues such as the effects of herbicides on seagrasses.

4) **Determine the causes for toxicity observed in sediments from south Biscayne Bay.**

(*Justification: Recent studies conducted by N.O.A.A. have identified the presence of toxicity in sediments from south Biscayne Bay. However, evaluation of paired sediment chemistry data does not show contaminant concentrations at levels that can explain the observed toxicity. Further study is needed to identify the causes of toxicity in sediments from this region. In addition, while the use of standardized testing can be a valuable tool for identifying relative toxicity, it is suggested that further studies are needed to quantify the impact of sediment contaminants on resident biota.*)

Specific Science Recommendations

a) Conduct investigations to determine the cause for observed toxicity in sediments from southern region of the bay. These studies should include paired chemistry and toxicity analysis.

b) Conduct studies to quantify the impact of sediment toxicity on resident biota.

Management Related Recommendations

5) **Develop a routine schedule of review and publishing scientific data for Biscayne Bay.**

(*Justification: While there are many unanswered science questions for Biscayne Bay, various entities with ongoing monitoring programs are generating useful data. It is suggested that efforts be made to develop a program of regular evaluation, summarization, and publishing of results from these programs. In addition, it is recommended that standard analysis methods with lowest available detection limits be used to more accurately characterize contaminant levels in the bay.*)

6) **Continue and expand efforts to reduce contaminant loading to the Bay.**

(*Justification: Studies have identified the presence of contaminants in canal and bay sediments. Monitoring programs have identified exceedances of surface water and groundwater quality standards in the Bay and its watershed. Efforts to reduce sources of contaminants and minimize inputs to the bay should continue. These efforts should also be expanded to address continued pressures from future growth and development. This includes continuing efforts to reduce contaminant loading from surface water runoff, reducing contamination of groundwater from landfill leachate, and reducing nutrient loading to the bay.*)

GEOLOGY, SEDIMENTOLOGY, CLIMATE, AND SEA LEVEL

Chair:

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RECOMMENDATIONS

1. Better Document The 3-Dimensional Limestone Control On Groundwater/ Surface Water Flow And On Resulting Benthic Community Distribution And Bay Circulation.

Justification: Although the surficial limestone is highly porous and permeable, the actual lateral and vertical flow may be strongly confined and directed by inhomogenieties. These inhomogenieties strongly define the resulting lateral and vertical movement of groundwater and the interaction of surface water and groundwater interaction. This is, however poorly documented.

Specific Science Recommendations

a. Document the 3-dimensional permeability patterns and groundwater flow of the surficial aquifer beneath the mainland marginal to Biscayne Bay. Determine the source of waters entering the Bay from artesian springs, the exchange between surficial water and shallow groundwater, and the influence of canal cuts in 3-dimensional flow patterns.

   Justification: The upper portion of the limestone is commonly considered unconfined and homogeneous. As explained in the text, this is incorrect, and the inhomogenieties greatly affect the 3-dimensional movement of groundwater.

b. Document the amount of inflow and outflow of freshwater and salt water and freshwater into and out of the substrate in areas of exposed limestone in Biscayne Bay. Determine the relative importance of general rock porosity versus solution pipe porosity providing this flow.

   Justification: The role of artesian freshwater springs in delivering water to Biscayne Bay is significant but undocumented. Not only is it important to know how much is entering the Bay through various sources, but also, in the case of springs, where is the water coming from and are any of the sources contaminated.

c. Define the nutrient/pollutant loads being provided by canals, surficial sheet flow and groundwater flow into Biscayne Bay.

   Justification: This must be resolved to provide a background to reducing contaminant and toxicant inputs.

d. Assess the effect of the historical 0.7' rise in sea level on surface water/groundwater flow and saline intrusion. Assess the effect of a further 1.0' and 2.0' rise in sea level on the surface water/groundwater hydrology of western Biscayne Bay and the adjacent mainland.

   Justification: With sea level rise the freshwater head has lessens and the balance of surface and groundwater contribution changes. In a system as low in elevation as southeast Florida, the role of changing sea level must be incorporated into present and future hydrologic models.

2. Increase Water Clarity, Thus Improving Benthic Community Distribution

The following measures should increase water clarity in the area north of Rickenbacker Causeway so that sea grass and hard bottom communities can increase their depth range and begin to move into the remaining artificially deepened dredged bottoms.

Specific Science-generated Management and Action Recommendations

a. Recovering Northern Biscayne Bay.

A report on sources and circulation of turbidity in Biscayne Bay (Wanless, et al, 1983) recommended a series of steps to ameliorate the urbanization-generated deterioration of water clarity, increase in turbidity, and loss of important benthic communities. These recommendations (updated) are as follows:

- Re-establish viable mangrove communities along the margin as much of the natural and artificial shorelines of northern Biscayne Bay as possible, **both** public and private frontages. These should be of sufficient width to permit areas for trapping and binding of introduced sediment.

  Justification: The coastal mangrove community is important in removing turbidity from tidal waters, baffling wave energy, stabilizing the substrate, and providing habitat for juvenile fish species and species of critical concern.

- Eliminate all unbulkheaded shorelines of raw loose sediment fill. These shorelines should be converted to mangrove, clean beach sand or riprap.

  Justification: Unbulkheaded fill shorelines are prime sources of long-term persistent fine particulate sediment release and significantly contribute to the elevated turbidity levels of central and northern Biscayne Bay..

- All vertical concrete sea wall shorelines should be fronted by either riprap or a mangrove community band.

  Justification: Shorelines of natural limestone boulders (rip rap) or mangrove will (a) adsorb rather than reflect incoming wave energy and (b) host a water-clarifying benthic or intertidal community. Vertical seawalls increase day-to-day wave energy in northern Biscayne Bay by reflecting boat wakes. As a result, the shallow benthic communities are stressed and resuspension if fine sediment is increased.

- All artificially deepened dredged areas that are not necessary for boat traffic should be modified to promote a water-clarifying benthic community by, shallowing the bottom with fill to a depth of less than six feet and planting seagrasses, or using clean construction debris to create artificial hardbottom community reefs.

  Justification: Shallowing deep dredged bottoms will permit re-establishment of substrate-stabilizing communities, increase Bay productivity and reduce soft bare bottom areas that are responsible for much of the resuspended turbidity in northern Biscayne Bay.

- . To prevent the migration of flocculent bottom material (ooze) to sites of resuspension, all artificially deepened dredged areas should be bounded by berms six feet or less in depth. Berms should be planted with seagrasses for stabilization.

  Justification: The flocculent surface of the deeper bare bottom areas in northern Biscayne Bay commonly deepen and constrict at gaps between causeway islands. As a result, the tidal currents focused at these necks constantly resuspend bottom flocculent matter that migrates towards the deeper necks. Shallow underwater berms would isolate off deeper dredged areas away from the channel necks.

- The introduction of turbidity and nutrients through natural and artificial canals and channels should be monitored, and, if significant, flow modified or berms created to limit these sources.

  Justification: Canals commonly receive both fine sediment deposition from Biscayne Bay. Pollutants and toxicants from freshwater runoff also enter the canals and commonly adhere to the fine particles. Re-

release of this fine sediment back to the Bay (during flood discharge events) both increases the amount of fine sediment and turbidity in the Bay and introduces adsorbed contaminants.

b. **Improving and Protecting All of Biscayne Bay.** Most important in improving and protecting the water clarity throughout Biscayne Bay is honestly addressing physical stresses of boat activity. We must treat boat traffic across the shallow benthic communities of Biscayne Bay in the same way that we treat vehicular traffic on land, controlling speeds, prohibiting digging up of the roadbed, restricting vehicles from driving on the vegetative communities in our parks and gardens, and limiting the travel of trucks.

Specific Science recommendations

- Quantify the impact and short- and long-term stresses to water clarity and benthic communities caused by boating activity, and monitor the changes in water clarity and benthic community health as modifications to permitted boating activity are made.

  Justification: With increased use of medium to large boats in Biscayne Bay, bottom resuspension, bottom scour and damage to benthic communities can be expected. Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.

Specific Science-generated Management and Action Recommendations

- Eliminate use of large thrust commercial boats, tugs, and barges from southern Biscayne Bay. The Tug/barge delivering diesel fuel to Turkey Point is a blatant example.

  Justification: Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.

- Limit all boats with large thrust and wake to idle speed if in other than the main east-west shipping channels to and from the Bay.

  Justification: This will encourage the larger and more powerful boats to travel offshore, the place for which they were designed.

- Better mark channels through the Safety Valve, Featherbed Bank and other shallow areas.

  Justification: This will reduce the damage to sea grasses caused by prop scour and excavation.

- Have map boards at marinas with directions, notification of penalties for bay bottom damage and education on value of benthic communities.

  Justification: Education and guidance is fundamental to improved boating practices.

- Have brochures provided with boat tag renewals, with marine officer citations, at all put ins, and at marine stores that provide directions, notification of penalties for bay bottom damage and education on value of benthic communities.

  Justification: Education and guidance is fundamental to improved boating practices.

3. Predict Future Evolution Of Biscayne Bay In Response To Hurricanes, And Sea Level Rise And Incorporate This In To Management, Legislation And Policy Decisions

It is imperative that the high probability for significant future sea level rise be addressed head on. A recent discussion in *Science* demonstrates the cost, waste and increased risk that occurs if the reality of future sea level rise is not incorporated in to planning and design for the future of low-lying coastal cities (Ammerman and McClennen, 2000). The following are considered high priority recommendation as they provide the foundation for modeling and design of the Biscayne Bay of the future.

Specific Science Recommendations

a. Assess the quantitative effect of the past 70 years of increased rate of relative sea level rise on the environments and waters in and marginal to Biscayne Bay.

   Justification: The 0.7-foot rise in sea level over the past 70 years is about 7 times faster than the rate over the past 2,000 years. As a result there have already bee nfundamental changes in the stability of the coastlines, wetlands, mudbanks, circulation, and hydrology of Biscayne Bay.

b. Using knowledge of the response of coastal and shallow marine environments to differing rates of relative sea level rise (form geologic studies of south Florida), assess how the coastal and shallow marine environments in various settings of Biscayne Bay will respond over the next 100 years to a further sea level rise of 1 and 2 feet.

   - Create a map and dynamic model of how the marine, coastal and upland environments in and marginal to Biscayne Bay will look in 50 and 100 years with a 1 and a 2 foot rise in relative sea level.
   - Assess areas, rates, amounts and types of erosion that will occur in destabilized sediment bodies in and marginal to Biscayne Bay for the four models.
   - From these four maps and dynamic models, define the changes in the interaction of Biscayne Bay waters with the surface and ground waters of the coastal ridge and Everglades Basin.
   - From this, define the resulting patterns of circulation, salinity and residence time for waters in Biscayne Bay.
   - And from this, project the distribution of benthic communities in Biscayne Bay.
   - Identify areas in which human intervention can ameliorate the negative environmental effects of increased rates of rising sea level, and those areas in which current or anticipated human activities will negatively accentuate the consequences of rising sea level.

   Justification: The above research/modeling exercise will provide a visual model of future changes in the configuration of the substrate and the Bay margins, circulation, salinity, distribution of habitats, and foci of human stress over the next century. This will provide the foundation for all long-term management, legislative and policy strategies.

Specific Science-generated Management and Action Recommendations

c. Incorporate the reality of the historical rapid rise in sea level and the high probability of further future increases in the rate of sea level rise into every aspect of planning for the future of Biscayne Bay and Miami-Dade County.

   Justification: Without using the produced knowledge of the future of Biscayne Bay, management and policy decisions will be meaningless and likely environmentally and economically harmful to the Bay and the people of south Florida.

SCIENTIFIC BACKGROUND INFORMATION, STATUS OF KNOWLEDGE AND RECOMMENDATIONS

SCOPE OF TOPICS

A. Limestone substrate influence as it relates to biscayne bay and the adjacent upland.

B. Sediment bodies and sedimentary environments in and marginal to biscayne bay: Their origin, dynamic evolution, influence on benthic communities, influence on water quality, effects of human modifications, and stability in a time of rising sea level.

C. Sources and circulation of turbidity in biscayne bay, including evaluation of success of improvements made in the past 20 years.

D. Historical and projected future sea level rise as it influences the stability and evolution of the configuration of biscayne bay and its sediment bodies, circulation, environments, communities, dispersal of nutrients, turbidity and contaminants, salinity patterns, and freshwater inflow. And;

Role of hurricanes and other catastrophic events in the dynamics of the biscayne bay system and in initiating evolution of sedimentary environments in and marginal to biscayne bay.

E. Documentation of historical modifications and improvements.

Throughout we use the HISTORICAL SEDIMENT RECORD as a proxy for historical record of benthic communities, water quality, and toxin/pollutant dispersal and the HISTORICAL AERIAL PHOTOGRAPH RECORD as a means of delineating historical changes in benthic communities, patterns of human modification and stress to the Biscayne Bay system, and patterns of turbidity.

A. LIMESTONE CONTROL ON GROUNDWATER FLOW, BENTHIC COMMUNITY DISTRIBUTION AND CIRCULATION

South Florida is not the Netherlands or New Orleans. Our Pleistocene limestone substrate is highly porous and permeable. Changing upland water levels in one area will quickly affect adjacent areas. Withdrawal of water from one area will quickly affect adjacent areas. Although the limestone beneath and adjacent to Biscayne Bay is highly porous and permeable, there are within it significant and complicated barriers to flow. These barriers are of three types: exposure calcretes, dense muddy limestone units, and karst solution cavities and pipes.

Calcretes or limestone soil crusts are sub-horizontal thin zones of low permeability limestone formed during times of emergence in the Pleistocene. Rainwater induced dissolution and reprecipitation of calcium carbonate and soil processes creates this zone at the top of more permeable marine limestone sequences. There are 4-5 distinct calcretes in the upper 40-80 feet of Pleistocene limestone in southeast Florida. These calcretes form distinct surfaces that inhibit vertical groundwater flow and segment the horizontal flow into discrete zones. The calcrete surfaces are not perfect aquicludes (permeability boundaries) as they are eroded in places and cut by vertical solution cavities.

A second type of horizontal barrier to groundwater flow is a layer of low permeability limestone. Marine and freshwater carbonate muds, on cementation become low permeability surfaces. If not disrupted by coarser burrow fills or unfilled root or burrow traces, these become restrictions to vertical flow. Unlike calcrete surfaces, these carbonate mud layers are laterally discontinuous ad they represent an ancient environment with lateral boundaries.

The third type of barrier or constriction to groundwater flow is the interconnected maze of solution cavities in the limestone. During glacial periods of lowered sea level, rainwater dissolved a network of solution pipes, cavities and caves into the limestone. Some of the cavities from one low stand may be connected to those of previous ones. Dissolution and reprecipitation on the margins of these cavities commonly makes them high permeability networks with very low permeability margins.

Thus, though the limestone is highly porous and permeable, the actual lateral and vertical flow may be strongly confined and directed. This is best illustrated by the artesian freshwater springs that historically flowed up through limestone cavities out in Biscayne Bay (Kohout). These springs occurred because the above described permeability barriers restricted and directed the flow of freshwater groundwater from the mainland out under Biscayne Bay where it emerged at specific points defined by solution pipe/cavity networks cut through the surficial calcrete aquicludes.

These springs were sufficiently dependable that they had platform structures around them and were used by passing ships to resupply fresh water. The last of these perennial artesian springs in Biscayne Bay was located just offshore the Deering Estate and had weak flow into the mid-1960s. Springs further offshore are reactivated in times of high rainfall. Springs well off the mainland shore were active in 1993 and 1994 in response to elevated freshwater levels form heavy rainfall (Wanless and Tedesco personal observation). Springs were easily visible form a distance on calm days by distinct water patches. At and adjacent to the spring the mixing of fresh and saline water produced the characteristic blurry water, or schleren. The benthic community at the spring site was invariably different than that of the surrounding bottom. One of these springs sampled on 11/23/94 was located southeast of 168th Street Canal about 250 meters offshore (N25º 35.632' and W80º18.275'). At the Spring water was nearly fresh form top to bottom. The bottom directly adjacent to the spring had no seagrass cover, but the bottom was covered with a bloom of benthic foraminifera. Water inshore and to the north was distinctly saltier. Two water samples were collected from the spring and supplied to Biscayne National Park (L.P. Tedesco).

Kohout (1966 and 1967) and Kohout and Kolipinski (1967) documented that discharge from offshore freshwater springs strongly influenced the salinity patterns of western Biscayne Bay.

Three things have happened in the past 100 years that have changed the nature of freshwater discharge into Biscayne Bay. First, the natural freshwater levels on the adjacent mainland have dramatically lowered reducing the freshwater head. Second, canals were cut from the Bay into the mainland. This further lowered freshwater levels and caused extensive saltwater intrusion into the near coast surface and groundwater. Many of these have since been blocked to prevent saltwater intrusion. How the canal cuts have broken through permeability barriers, however, is not documented. Third, there has been a relative rise in sea level or 0.7 feet since 1930. This had the effect of forcing the sea onto and into the land, further reducing the freshwater head.

As evidenced by the conclusions of the recent Draft SEIS for the proposed development of the former Homestead Air Force Base, a few unsupported assumptions on the nature of the limestone (homogeneous and low permeability) and the role of canals (will handle most of the rainwater removal) can easily be used to produce very misguided conclusions as to groundwater flow into Biscayne Bay. That report stated that groundwater introduced at the Homestead base would take 50-100 years to reach Biscayne Bay. On the other hand, the specific influence of macroporosity, 3-dimensional inhomogeneities in permeability, and the role of solution conduits are insufficiently defined so as to be able to use to provide quantifiable models of specific flow. Similarly, it is presently speculative how proposed re-establishment of surficial sheet flow across coastal wetlands into portions of Biscayne Bay will affect subjacent groundwater flow. Bryne (1999) has addressed the role of nutrient loading in Biscayne Bay as the result of groundwater introduction.

Meeder et al (1999b and 2000) have documented that the flow in natural tidal/discharge channels into the mainland wetlands have dramatically changed historically as the channels have become clogged with peat and roots of the invading mangrove communities. How this change in surficial drainage landscape has affected both surface and groundwater hydrology is the focus of their ongoing research. Meeder et al. (1999a) have addressed the flux from tidal creeks into southern Biscayne Bay, and and Ross et al (1999) have evaluated the possibilities of rediversion of canal flow to sheet flow into southern Biscayne Bay

Recommendations for Groundwater Movement

- Document the 3-dimensional permeability patterns and groundwater flow of the surficial aquifer beneath the mainland marginal to Biscayne Bay. Determine the source of waters entering the Bay from artesian springs, the exchange between surficial water and shallow groundwater, and the influence of canal cuts in 3-dimensional flow patterns.

  Justification: The upper portion of the limestone is commonly considered unconfined and homogeneous. As explained in the text, this is incorrect, and the inhomogenieties greatly affect the 3-dimensional movement of groundwater.

- Document the amount of inflow and outflow of freshwater and salt water and freshwater into and out of the substrate in areas of exposed limestone in Biscayne Bay. Determine the relative importance of general rock porosity versus solution pipe porosity providing this flow.

  Justification: The role of artesian freshwater springs in delivering water to Biscayne Bay is significant but undocumented. Not only is it important to know how much is entering the Bay through various sources, but also, in the case of springs, where is the water coming from and are any of the sources contaminated.

- Define the nutrient/pollutant loads being provided by canals, surficial sheet flow and groundwater flow into Biscayne Bay.

  Justification: This must be resolved to provide a background to reducing contaminant and toxicant inputs.

- Assess the effect of the historical 0.7' rise in sea level on surface water/groundwater flow and saline intrusion. Assess the effect of a further 1.0' and 2.0' rise in sea level on the surface water/groundwater hydrology of western Biscayne Bay and the adjacent mainland.

  Justification: With sea level rise the freshwater head has lessens and the balance of surface and groundwater contribution changes. In a system as low in elevation as southeast Florida, the role of changing sea level must be incorporated into present and future hydrologic models.

B. ORIGIN, DYNAMICS, AND EVOLUTION OF THE SEDIMENT BODIES AND BOTTOM ENVIRONMENTS IN AND MARGINAL TO BISCAYNE BAY

The sediment bodies in and marginal to Biscayne Bay are dynamics features that actively respond both gradually and catastrophically to changing conditions. The origin and dynamics of the various sediment bodies have been described previously (Aigner, 1985; Harlem, 1979; Tedesco and Wanless, 1995; Wanless, 1969, 1976a, 1976b; Wanless et al., 1989, 1995; Warzeski, 1975). The following is a brief summary focusing on how these environments have evolved and changed historically in response toe natural and human modifications. This is necessary background for understanding all aspects of Biscayne Bay's dynamics and in order to assess how the Bay will respond to future human modification and the projected further increase in the rate of relative sea level rise.

Coral Limestone Ridge

A linear north-south trending ridge of Pleistocene coral limestone defines the seaward, eastern, margin of Biscayne Bay. To the south, this ridge is largely emergent forming the limestone islands of Sands Key, Elliott Key, Old Rhoades Key and Key Largo. To the north, it gradually submerges forming the Ragged Keys and Soldier Key but remains as a submerged ridge to the north beneath the Safety Valve mud bar belt, just seaward of Key Biscayne, Virginia Key and Fisher Island, and beneath Miami Beach. This now submerged portion of this ridge defined the position of the Safety Valve mud bar belt and the sandy barrier islands to the north as they formed over the past 5,000 years of rising sea level.

Beginning about 3,000 years ago, tidal and storm currents passing through newly inundated gaps in the ridge north of Elliott Key created the Featherbed Banks, carbonate sand and mud banks that extend well out across Biscayne Bay and divide central and southern Biscayne Bay.

About 3,500 years ago, rising sea level inundated the channeled low area of the ridge at Caesar's Creek and storms progressively opened a gap in the bay-side mangrove forest creating effective tidal exchange through the Ceasar's Creek. This opening dramatically altered the circulation of central and southern Biscayne Bay. Caesar's Creek became a focus of discharge from Biscayne Bay of sediment resuspended by winter storms and hurricanes. Caesar's Creek Bank is the result of this transport of sediment (Warzeski, 1975). Although capped by vibrant seagrass and coral-algal fringe communities, the bank was largely built of storm sediment swept form Biscayne Bay.

Elliott Key contains several topographically low gaps that are choked with mangroves. With a continued rise in sea level over the next century, storms will open these gaps further altering the circulation of southern Biscayne Bay.

Sandy Barrier Islands

The sandy barrier islands bordering northern and central Biscayne Bay are the end of a nearly continuous line of barrier islands along the Atlantic coastline of the United States. Key Biscayne is the most southerly. Beyond a subtidal ridge of sand extends southeasterly and fades out east of Soldier Key. These barrier islands are Miami Beach, Virginia Key and Key Biscayne are composed of about 25% quartz sand, derived from transport from the north, and 75% carbonate skeletal sand, more locally derived (Wanless, 1969, 1976).

Natural inlets are/were Baca Ratones, Norris Cut and Bear Cut. Bear Cut, separating Virginia Key form Key Biscayne, is present on the earliest 16th century maps. Boca Ratones formed in 1720 near the site of the Indian Creek Country Club on Miami Beach. This inlet was open until 1820. Southerly longshore drift offset the seaward mouth over that time, and when it closed the mouth was near 20th Street (Chardon, 1976 and 1978). Between 1820 and 1835 Bear Cut became the only inlet through the barrier islands, and northern Biscayne Bay had essentially no exchange with offshore waters. A hurricane in 1835 opened Norris Cut separating Virginia Key from Miami Beach. Norris cut remained a narrow shallow inlet until human modification of the area to the north in 1905.

Two artificial inlets and major dredging of two natural inlets have dramatically modified the nature of the dynamics of the barrier island beaches and of the exchange of Biscayne Bay with offshore waters. In 1905, Government Cut (the Miami Shipping Channel) was cut across the narrow southern portion of Miami Beach. Fill from this dredging was placed behind the separated beach segment to the south creating Fisher Island. As longshore drift of beach sand repeatedly shallowed the inlet and blocked shipping access, rock jetties were extended seaward from the north and south margins of Government Cut channel. For over 85 years, they have effectively blocked the net southward transport of beach sand to the islands to the south. As a result the natural beach of Fisher Island quickly eroded exposing the coral limestone rock of the dredging at the shoreline, Norris Cut has widened and deepened. The ocean shoreline of Virginia Key has persistently rapidly eroded in spite of renourishment projects in 1969 and 1974, and sand has been completely stripped from the once sandy littoral platform seaward of Fisher Island and Virginia Key. This block to southward transport is now affecting Key Biscayne's shoreline. A resurvey of the area seaward of Virginia Key and Fisher Island by Oleck in 1998 documents sand loss of averaging 80,000 cubic years per year has occurred in that area since construction of Government Cut. Government Cut has been progressively deepened to meet shipping needs and is now over 50 feet in depth.

Baker's Haulover Inlet was constructed in 1925, in part as an effort to increase circulation to relieve 'the stench of raw sewage in the Bay'. This inlet is shallower than Government Cut and has groins that do not completely block the littoral transport of sand. Nevertheless, large volumes of beach sand are swept into the northern end of Biscayne Bay or are pushed seaward by ebbing tides and storm currents. The result has been serious erosion of the coastline to the south and repeated renourishment efforts.

In conjunction with deriving fill for development of Virginia Key and Key Biscayne, two existing inlet channels were dredged in the early 1950s, significantly modifying the dynamics of littoral transport. Dredged material from the northwest side of Bear Cut was used in preparation for development of southern Virginia Key. This dredging deepened the bayward portion of the cut, cut away a portion of the sandy flood tidal delta, and widened the channel connection inot Biscayne Bay. At the south end of Key Biscayne, dredging material to fill the southern third of the island (now Cape Florida Park) was derived from safety Valve area to the southwest. Prior to dredging, the southern ocean beach of Key Biscayne wrapped around to the bay side. Adjacent to the bay side beach was a beach narrow shallow channel and the shallow intertidal sand and mud flats of the Safety Valve beyond. The dredging created a deep wide channel trough from the south tip of Key Biscayne along the entire southwestern margin of Key Biscayne and a vertical sea wall at the shoreline. In both cases, areas that had been a part of the dynamic give and take of sand in the littoral systems became sediment sinks. Beach sand moving along the shore system to these dredged holes became lost into them. These dredging projects created new sites of sand loss and shore erosion in an already stressed shore system.

Hurricanes of the past century have caused dramatic steps of erosion on the barrier island coastline. The barrier islands bordering Biscayne Bay are low, with out the high dune ridges found elsewhere, and onshore storm surges sweep sand onto and across the islands creating a permanent loss of sand from the ocean-side littoral system. The Hurricane of 1926, for example, caused 200 feet of erosion in a portion of central Key Biscayne. Subsequent storms have resulted 25-60 feet erosion steps. Nearly all the beaches in Miami-Dade County have been renourished in an effort to offset erosion or overzealous coastal construction (Miami Beach). A variety of sand sources have been used. Key Biscayne has used sand from the littoral sand platform seaward (1969) and to the south (1985) of the island. Virginia Key has used sand form Key Biscayne (1969) and quartz sand form a fossil beach encountered in deepening Government Cut (1974). Fisher Island has used carbonate oolitic and from the Bahamas (~1991). Miami Beach and north has used carbonate sand found in troughs in the limestone shelf several miles seaward of the shore (1980) and subsequent. The sand mantling the present beaches is very different from that found naturally. A problem with beach renourishment in general and with several Miami-Dade County projects in particular is the increase in nearshore turbidity following renourishment. Marine sand used in renourishment, invariably have significant amounts of fine sediment and commonly have skeletal grains that are easily abraded. The renourished beach thus becomes a source of persistent long term release of fine suspended particulates, degrading the nearshore water quality. The massive Miami Beach renourishment of the 1980s has had the most degrading effect of the projects in the County.

Marginal Carbonate Mud and Sand Banks

The Safety Valve mud bar belt, formed on and behind the submerged limestone ridge, defines the eastern margin of central Biscayne Bay. The banks and channel complex is built in response to tidal and storm waters flowing across the banks. The carbonate sand and mud sediment comprising the bank is derived both from storm transport onto the banks and intense local production (itself reworked and redistributed by storms; Aigner, 1985; Tedesco and Wanless, 1995; Wanless et al., 1995). In the Ragged Keys area of partly emergent limestone, the banks are irregular in form separated by irregular channel patterns. As the limestone ridge submerges to the north, the bank complex has evolved to a series of broad shallow banks separated by well-defined channels trending perpendicularly across from the Bay to ocean. Relics of earlier phases of banks growth are visible imbedded in the northern Safety Valve (Wanless, 1969, 1976; Harlem, 1979). As the mud bank form has evolved, channels have changed through abandonment, filling and recutting — not migration (ibid.). The well-defined channels are mostly cut to the limestone rock across their axis. Within the banks are relict abandoned channels in various states of infill.

The banks and channel flanks are presently well covered by seagrass and *Halimeda* algal mounds. The seaward flanks have a living coral-algal fringe community except in the northern portion where it has largely died off in the past 40 years. Rock floored channels and a hardbottom community of sponges, soft corals and corals. Sediment floored channels have seagrass cover unless subjected to full tidal scour.

Historical hurricanes in the 1920s and 1960s severely set back the benthic community cover to the safety Valve mud banks. As pointed out by Harlem (1979), smaller hurricane events can be as devastating or more devastating to seagrass cover than large events. The internal stratigraphy of the banks documents the dominating role of storm events in building the Safety Valve banks and in expanding them bayward and seaward (Aigner, 1985; Tedesco and Wanless, 1995; Wanless et al., 1995; Warzeski, 1976).

Increasing boat traffic has caused moderate to severe damage to the seagrass cover on the bank tops through prop scour of boats venturing into too shallow water and prop-wash excavation of stuck boats. In addition boat wake traffic through established channels has destabilized channel flanks and increased turbidity through persistent erosion of the margins.

Intrabay Carbonate Mud and Sand Banks

Featherbed Banks. The Featherbed Banks are two east-west trending banks of carbonate sand and mud that effectively divide central from southern Biscayne Bay. North and south Featherbed Bank each originated in response to pairs of defined natural tidal channels through the emergent limestone ridge at the eastern boundary of the Bay (Wanless, —). Sediment laden waters sweeping into the Bay through these channels during winter storm and hurricane events built these banks. South Featherbed Bank began forming about 2,500 years ago as the seaward channels between Boca Chita Key and Sands Key opened up to tidal and storm exchange (Wanless, 1991; Wanless et al., 1995). North Featherbed Bank formed somewhat earlier in response to opening of channel passes at the north end of the present Ragged Keys. With rising sea level, the limestone ridge in the northern Ragged Keys area became increasingly submerged and water flow was no longer restricted to the channels. North Featherbed Bank is no longer actively forming, but rather is being remolded by storm currents within the Bay.

A coral-algal fringe community with abundant soft corals and molluscs caps the narrow eastern portion of south Featherbed Bank. To the west, seagrass dominates the broader banks flanks and top. Bare patches in the broad western bank interior are areas that have not yet recovered from historical hurricane setback. The internal stratigraphy records growth of these south Featherbed Bank by pulses of rapid deposition of mud on a barren bottom. This growth is similar to that documented for the mud banks in central Florida Bay (Wanless and Tagett, 1989; Wanless et al., 1995).

The Featherbed banks are severely damaged by prop ruts and scour excavations from boats. In some portions, this is having a significant destabilizing influence on the bank itself. A channel of the Intracoastal Waterway and several other marked channels cut the Featherbed Banks. Boat wakes are causing visible erosion and resuspension on the channel and bank flanks.

Black Ledge and Pelican Bank are isolated banks of carbonate mud and quartz sand that sit atop submerged NE-SW trending limestone bathymetric highs. They are remnants of a mangrove and beach shoreline that became isolated with rising sea level and overall retreat of the mainland coast. Seagrass communities cover the banks, but that on the quartz sand portion of Black Ledge can be severely set back by hurricanes.

Bank North of Julia Tuttle Causeway. An extremely shallow bank of sand and mud extended across northern Biscayne Bay between what is not Julia Tuttle Causeway and 79th Street Causeway. To permit even small boat traffic into northernmost Biscayne Bay, a channel was cut in the late 1890s (Harlem, 1979). This was followed by another channel to serve the Intracoastal Waterway, and dredging along the eastern and western margin of the Bay so as to fill the mangrove margins for development. Dredged troughs also now mark the north and south margins of this bank, created to obtain fill for the bounding causeways. Although surrounded by turbid waters of these deeper dredged troughs and channels, the lush seagrass cover of the surviving bank is a highly effective filter to waters moving onto the bank. In a turbidity study in the early 1980s, the interior of this bank had the clearest water in Biscayne Bay (Wanless et al., 1983).

Core borings show that there was sea grass cover on the southern portion of this bank through much of its formation, but not to the north. The improved circulation through northern Biscayne Bay as a result of opening baker's Haulover inlet in 1925, has greatly improved the opportunity of sea grass community cover across the entire bank.

Open Bay Interior

Much of central and southern Biscayne Bay is underlain by shallow Pleistocene limestone. This limestone surface slopes gently eastward to a deep axis about 3/4 of the way across the Bay and then rises more sharply to the coral limestone ridge at the eastern margin. The limestone bottom deepens to he north, and north of Coconut Grove, the limestone beneath the western portion of the Bay also deepens. In the landward portion of central Biscayne Bay, intense dissolution of deposited carbonate mud occurs in response to the organic-rich sediment and poorly buffered pore waters (Wanless, 1991).

The nature of the community structure is covered in Habitats of Critical Concern.

Hardbottom of Southern and West-Central Biscayne Bay. In general, sediment has not accumulated over this limestone substrate in areas where the limestone is less than 3 meters in depth. Thus, the shallow southern Bay and the western portion of central Bay is an exposed rocky bottom with only a veneer of sediment and a hardbottom benthic community. These hardbottom communities are sites of intense production of sediment by sponges and soft corals (spicules), calcareous algae (carbonate mud), foraminifera (calcareous tests), and bioerosion of the limestone and macroskeletal remains (fine sand and silt fragments). Moat of the resulting sediment is fine and easily resuspended and transported from the areas by winter storms and hurricanes.

Seagrass, tending to form persistent benthic communities only in areas with at least 15 centimeters of sediment cover, forms only spotty cover over much of southern and west-central Biscayne Bay.

Soft Bottom. In open Bay areas with greater than 15 cm of sediment cover, the bottom tends to be covered with a persistent seagrass community. This occurs in a narrow north-south strip on the deep axis of southern Biscayne Bay, across the middle and eastern portions of central Biscayne Bay and in areas that have not been deepened by dredging to the north.

The nature of the sediment comprising the soft bottom of the open bay varies considerably. In the northern Bay, the eastern half is quartz-carbonate sand similar to that making up the barrier islands to the East. To the west this yields to organic-rich carbonate muds. In central Biscayne Bay, the carbonate sand and mud dominate the eastern and middle portion. To the west (towards Vizcaya, Coconut Grove and Matheson Hammock) carbonate mud diminishes and organic-rich quartz sand dominates. To the south carbonate sediments predominate throughout.

Although winter storms and especially hurricanes redistribute fine sediment throughout the Bay, the mineralogy of the fine sediment deposit. This is best illustrated in an east-west trasnect across the Bay form the northern Safety Valve to Coconut Grove. In the less than 62 micron fraction, the magnesium calcite and aragonite dominate the carbonate sediment of the Safety Valve and central portion of the Bay, and low-magnesium calcite is a minor component. To the west, these abundance of carbonate mud diminishes, and the relative abundance of the carbonate components rapidly invert. Within a mile of the mainland shoreline only low-magnesium calcite is present in the sediment. This distribution is a product of intense dissolution of the less stable carbonate components in the less buffered pore water s of the quartz and organic-rich sediment towards the mainland.

Intense dissolution and remobilization of mineral components is important not only to the general sediment composition. Adsorbed metals and pollutants also become involved in remobilization and redistribution.

The deepest natural part of Biscayne bay is the middle of the Bay south of Rickenbacker Causeway. Here depths reach 5-6 meters. There is historical evidence that seagrasses once grew at these depths, but increased turbidity levels has converted these deeper areas to barren soft bottoms. Aerial photographs from the 1940s onward commonly also show linear north-south bare bottom areas to the south of this deepest area. It is likely that these are the result of bottom trawling activity. Waves and currents from winter storms easily resuspend this deeper bottom area and the high turbidity levels persist well after events.

Mangrove Wetland Shorelines

Mangrove swamp shorelines backed by freshwater marshes bordered Biscayne Bay during much of the 6,000 years of its formation. Through most of that time, the mangrove coastline has progressively migrated landward in response to rising sea level. This erosive landward migration continued in most of the area during the last 3,000 years of very gradually rising sea level, a time during which the wetland complex on the southwest Florida Coast was advancing seaward by leaps and bounds. Only on the east and south margins of Card Sound and Barnes Sound has the mangrove margin held or advanced over the past 3,000 years Wanless (1991) and Wanless et al (1994).

Much of the mainland shore of Biscayne Bay had a narrow margin of mangrove swamp behind which was a freshwater marsh. Mangroves have progressively spread landward over the past 70 years, as the freshwater head was reduced and direct flow from the Everglades cut off and in response to the dramatic rise in sea level (Meeder et al., 2000; Teas et al, 1976 and 1978; Wanless, 1976 and 1991). The islands of the Arsenicker Keys tend to be erosional on the north and east margins, in response to repetitive winter storm wave attack (George Berbarian, Mimeo; see also Wanless and Tagett, 1989 for similar process affecting islands in Florida Bay).

Major hurricanes have caused distinct erosional steps in the mangrove coastline, and there is concern that, in a time of rapidly rising sea level, the rapid subsidence of the decaying root peat following major hurricanes may put recovery of major portions of the mangrove coast in peril over the next century when recovery is further stressed by continued rapidly rising sea level.

As serious, intertidal mangrove wetlands need to be able to migrate up slope in response to rising sea level. In developed areas the red mangrove fringe is commonly preserved (by law) but the higher intertidal Black and white mangrove zone has been bulkheaded and filled. This leaves nowhere for migration to occur.

Recovery from major hurricane damage is strongly dependent on flushing of the waters of the red mangrove swamp. Decay products of the mangrove peat further kill mangroves and inhibit regrowth and recovery if not actively flushed by tidal waters.

C. SOURCES, CIRCULATION AND SINKS OF TURBIDITY IN BISCAYNE BAY

Biscayne Bay is remembered as a bay of crystal clear waters, a condition that still persists in portions of the southern and northern Bay. This clarity occurred because of the intense filtering, trapping and binding activity of the benthic communities living within the Bay, not because of the lack of fine particulate matter. (Unless otherwise noted, the following is taken from Wanless et al., 1983).

Unlike most estuarine bays, the fine particulate material in Biscayne is composed of calcium carbonate, opalline silica and organic material. Calcium carbonate particles are derived from skeletal material of organisms living within or adjacent to the Bay of from the bio-erosion of the limestone surface exposed in south Biscayne Bay. Opalline silica is as skeletal material from organisms, mainly spicules of sponges and tests of diatoms. Organic matter is living and decomposing plant (mangrove and seagrass), algal, and bacterial material.

Clays, formed through the weathering of continental rocks and dominating most estuarine systems are present only in trace amounts in Biscayne Bay. The Everglades systems sits on limestone, quartz sand and organic matter, and has not source of clay minerals to transport. The less than one per cant of clay mineral material found within Biscayne sediments is derived from the Mississippi River discharge and from Saharan dust.

Fine-grained carbonate-siliceous-organic sediment is produced throughout the Biscayne Bay, including in the rocky intertidal and subtidal environments where it is not accumulating. The hard-bottom communities of south Biscayne Bay are a major source of fine-grained sediment. This is dispersed by winter storms to other environments.

Fine-grained carbonate-siliceous-organic sediment has accumulated significant sediment bodies within and marginal to Biscayne Bay — the Safety Valve and Featherbed mud banks in central Biscayne Bay; Pelican Bank, Cutter Bank and Card Bank in southern Biscayne Bay; the deeper central Bay north of the Featherbed Banks, and the mangrove margins to all of Biscayne Bay. These large deposits of muddy sediment were stabilized by seagrass and mangrove communities and thus effectively isolated from being recycled in to the Bay waters.

Historical levels of high levels of water clarity in Biscayne Bay promoted luxuriant benthic communities that actively filtered, trapped and bound fine-grained sediment which maintained good water clarity, which … Each benthic environment within the Bay played a similar role. The sponges, soft corals and mollusks of the hard-bottom communities and Bay-margin mangrove fringe filtered particulates from the Bay waters. The epiphytic growth on the seagrasses and the baffle of the seagrass blades themselves actively trapped passing fine particulate matter, and the stable root-bound bottom bound the trapped material and retarded its resuspension even during winter storms. And the seagrass bottoms and mangrove margins became traps into which material transported during storms would settle and be quickly removed from the Bay waters.

This chicken and egg relationship is easily broken by damage to or loss of the benthic or bay-margin community. This occurred in the late 1800s and early 1900s in northern Biscayne Bay as the mangrove margin was smothered by fill for housing, and the Bay bottom was dramatically deepened as material was dredged for filling the mangrove margins, constructing islands within the bay and creating causeways connecting Miami Beach with the mainland. All of northern Biscayne bay was originally bordered by mangrove and freshwater wetlands, and all of the islands and causeways within northern Biscayne Bay are the artificial product of this dredge and fill activity. By the mid 1950s, dredge and fill activity had effectively obliterated the mangroves communities from Coconut Grove and Key Biscayne north. The extensive complex of dredged Bay bottom essentially formed a moat around the northern Biscayne Bay, with the area between Dodge Island and Julia Tuttle Causeway being nearly entirely deepened and the Bay to the north crisscrossed with deep channels. These dredged areas are 10-30 feet in depth with 12-15 feet being characteristic.

In addition, the dredge and fill activity left the shore margins as either vertical concrete seawalls which reflected the wave energy of the increasing boat traffic in northern Biscayne Bay or exposed raw will. These unbulkheaded raw fill shorelines and the associated steep raw sediment margins to the adjacent subtidal dredged pits became sources of persistent long-term release of fine particulates with agitation form winter storms and boat wakes. Harlem (1979) demonstrated the influence of boat wakes in Biscayne Bay by demonstrating that the dredged spoil islands adjacent to both the ease and west sides of the Intracoastal Waterway were migrating (eroding) away form the Intracoastal Waterway — on both sides of the Waterway even though they were set well back from the channel.

In addition, the increasing volumes and raw sewage and nutrients introduced into the Bay (until 1952 when this was essentially eliminated) introduced fine particulates and promoted planktonic blooms that further reduced water clarity.

This suite of modifications eliminated the water clarifying influences of the marginal mangrove community, added a vast array of new sites of turbidity (fine suspended particulates) release. The resulting increased turbidity (and decreased water clarity) left the newly dredged Bay bottom too deep (with insufficient light) for recolonization and stabilization by sea grass communities. In addition, settling fine particulates form a fluid ooze on the bottom of the interconnected deep dredged areas. This ooze flows to the deeper areas, which are commonly the narrow tidally turbulent gaps in causeways. At these points, the material is resuspended adding to the increased persistent turbidity levels of northern Biscayne Bay.

Thus, the chicken and egg problem: Seagrasses in clear water can grow in water depths of greater than 30 feet. In post-urbanization turbid northern Biscayne Bay, sea grasses grow to only 6 -7 feet in depth, but much of the northern Bay bottom in now greater than that. To permit seagrass growth in deeper water, water clarity must first increase.

Increased boating activity has increased turbidity (decreased water clarity) throughout Biscayne Bay. There are several causes for this. First, boats with large thrust and wakes directly resuspend material from the bottom, the flanks of channels and the shoreline. Commonly this thrust and wake turbulence also causes erosion to the substrate and benthic community. Second, boats venturing into too shallow water are increasingly cutting prop ruts and, if they become stuck, deep thrust excavations with thick smothering layers of sediment over the adjacent bottom. These ruts and scours are invariably cut into seagrass beds, persist for well over a decade, and commonly widen and deepen with subsequent wave and current activity scour. They become sites of long-term turbidity release and widening benthic community destabilization. Third, boat wakes cause a significant increase in the ambient wave climate, increasing the level and depth of day to day wave agitation. This a widespread affect but is most apparent in the narrow Bay sector north of 79th Street Causeway where boat waves, amplified by marginal vertical sea walls, commonly make this sector choppy even on calm days. Fourth, bottom trawling activity from boats is suspected to be stressing the bottom seagrass communities and in the deeper area of central Biscayne Bay south of Rickenbacker Causeway, having been the cause for loss of the seagrass sea grass community. Historical aerial photographs show linear stripes of barren bottom among the seagrass. All of these boating-related stresses are real and significant. The quantitative effect of a few of these has been attempted (Harlem, 1979). Biscayne National Park has documented that the heightened turbidity levels created by weekend boat activity persists to the following weekend (Curray, personal communication).

Recommendations for Increasing Water Clarity, Thus Improving Benthic Community Distribution

1. **Recovering Northern Biscayne Bay**

   A report on sources and circulation of turbidity in Biscayne Bay in 1983 (Wanless, et al) recommended a series of steps to ameliorate the urbanization-generated deterioration of water clarity, increase in turbidity, and loss of important benthic communities. These recommendations (updated) are as follows:

   a. Re-establish viable mangrove communities along the margin as much of the natural and artificial shorelines of northern Biscayne Bay as possible, <u>both</u> public and private frontages. These should be of sufficient width to permit areas for trapping and binding of introduced sediment.

      Justification: The coastal mangrove community is important in removing turbidity from tidal waters, baffling wave energy, stabilizing the substrate, and providing habitat for juvenile fish species and species of critical concern.

   b. Eliminate all unbulkheaded shorelines of raw loose sediment fill. These shorelines should be converted to mangrove, clean beach sand or riprap.

      Justification: Unbulkheaded fill shorelines are prime sources of long-term persistent fine particulate sediment release and significantly contribute to the elevated turbidity levels of central and northern Biscayne Bay..

   c. All vertical concrete sea wall shorelines should be fronted by either riprap or a mangrove community band.

      Justification: Shorelines of natural limestone boulders (rip rap) or mangrove will (a) adsorb rather than reflect incoming wave energy and (b) host a water-clarifying benthic or intertidal community. Vertical seawalls increase day-to-day wave energy in northern Biscayne Bay by reflecting boat wakes. As a result, the shallow benthic communities are stressed and resuspension if fine sediment is increased.

   d. All artificially deepened dredged areas that are not necessary for boat traffic should be modified to promote a water-clarifying benthic community by

- Shallowing the bottom with fill to a depth of less than six feet and planting seagrasses or
- Using clean construction debris to create artificial hardbottom community reefs.

  Justification: Shallowing deep dredged bottoms will permit re-establishment of substrate-stabilizing communities, increase Bay productivity and reduce soft bare bottom areas that are responsible for much of the resuspended turbidity in northern Biscayne Bay.

e. To prevent the migration of flocculent bottom material (ooze) to sites of resuspension, all artificially deepened dredged areas should be bounded by berms six feet or less in depth. Berms should be planted with seagrasses for stabilization.

   Justification: The flocculent surface of the deeper bare bottom areas in northern Biscayne Bay commonly deepen and constrict at gaps between causeway islands. As a result, the tidal currents focused at these necks constantly resuspend bottom flocculent matter that migrates towards the deeper necks. Shallow underwater berms would isolate off deeper dredged areas away from the channel necks.

f. The introduction of turbidity and nutrients through natural and artificial canals and channels should be monitored, and, if significant, flow modified or berms created to limit these sources.

   Justification: Canals commonly receive both fine sediment deposition from Biscayne Bay. Pollutants and toxicants from freshwater runoff also enter the canals and commonly adhere to the fine particles. Re-release of this fine sediment back to the Bay (during flood discharge events) both increases the amount of fine sediment and turbidity in the Bay and introduces adsorbed contaminants.

These measures should increase water clarity in the area north of Rickenbacker Causeway so that sea grass and hard bottom communities can increase their depth range and begin to move into the remaining artificially deepened dredged bottoms.

2. Improving and Protecting All of Biscayne Bay

Most important in improving and protecting the water clarity throughout Biscayne Bay is honestly addressing physical stresses of boat activity. We must treat boat traffic across the shallow benthic communities of Biscayne Bay in the same way that we treat vehicular traffic on land, controlling speeds, prohibiting digging up of the roadbed, restricting vehicles from driving on the vegetative communities in our parks and gardens, and limiting the travel of trucks.

a. Quantify the impact and short- and long-term stresses to water clarity and benthic communities caused by boating activity, and monitor the changes in water clarity and benthic community health as modifications to permitted boating activity are made.

   Justification: With increased use of medium to large boats in Biscayne Bay, bottom resuspension, bottom scour and damage to benthic communities can be expected. Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.

b. Eliminate use of large thrust commercial boats, tugs, and barges from southern Biscayne Bay. The Tug/ barge delivering diesel fuel to Turkey Point is a blatant example.

   Justification: Commercial and recreational use of the Bay's waters should not degrade the water or the benthic communities of the Bay.

c. Limit all boats with large thrust and wake to idle speed if in other than the main east-west shipping channels to and from the Bay.

Justification: This will encourage the larger and more powerful boats to travel offshore, the place for which they were designed.

d. Better mark channels through the Safety Valve, Featherbed Bank and other shallow areas.

Justification: This will reduce the damage to sea grasses caused by prop scour and excavation.

e. Have map boards at marinas with directions, notification of penalties for bay bottom damage and education on value of benthic communities.

Justification: Education and guidance is fundamental to improved boating practices.

f. Have brochures provided with boat tag renewals, with marine officer citations, at all put ins, and at marine stores that provide directions, notification of penalties for bay bottom damage and education on value of benthic communities.

Justification: Education and guidance is fundamental to improved boating practices.

D. FUTURE EVOLUTION OF BISCAYNE BAY IN RESPONSE TO HURRICANES, AND SEA LEVEL RISE

In planning for the future health of the Biscayne Bay system, it is imperative to incorporate those changing influences that will drive changes in the system from how we presently perceive it. Any evaluation for the management of Biscayne Bay must be made for long-term management of its health. If the goal is to design management and policy goals for the next 50 years, then the systems models must be verified for at least 100 years. Of the future changes that will most certainly drive changes to the Biscayne Bay system in the next century, there are two that stand out: future population growth and impacts of global warming. The following is adapted from Wanless (1991) Wanless et al (1994) and the variety of above mentioned articles on sedimentologic evolution of Biscyane Bay.

During the past 2,400 years, our south Florida coastal and interior Everglades environments have evolved to their present character under the influence of a very slow relative rise in sea level. This rate averaged 5 cm per century, rising from about -1.2m to its present (1930) level during that period. In response, our beaches, barrier islands, and marl-levee coastlines stabilized and grew, and the vast mangrove swamps of the southwest Florida coast expanded over shoaling nearshore environments to take on their present character. In Biscayne Bay, the mainland mangrove coastline was stable or slowly erosional, likely in response to exposure to NE winds of winter storms. Freshwater wetlands behind produced organic and carbonate deposits helping to raise the level of the Everglades system. The Safety Valve mud bank at the margin of Biscayne Bay grew to their present shallowness and breadth, and the interior Featherbed Banks, at least south Featherbed, was initiated and built during this period. This gradual sea level rise and its constructive growth phase to our coastal environments are over.

Beginning in 1930, a 23-cm (9-inch) rise of sea level has occurred in south Florida. This is equal to a rate of about 30 cm (12 inches) per century, about 6 times that of the past 2,400 years. This increased rate of rise has severely destabilized our sandy, mud, and mangrove coastlines and banks and initiated dramatic changes in them. This rise has destabilized the coastal mangrove communities and resulted in significant transgression: storm erosion of mangrove coastlines (to 100 m), storm-initiated loss within mangrove forests, and rapid landward expansion of the red, black and white mangrove ecotones.

A further 60-cm (24-inch) relative sea level rise is projected for the next century in response to global warming (our current rate plus the projected further 30 cm in response to global warming. This rise will set into motion a near catastrophic evolution of the coastal environments of south Florida similar to that which occurred between 2,500 and 2,400 year before present. The types of changes that will occur to Biscayne Bay include: catastrophic loss of the coastal mangrove fringe, increased erosion of barrier island beaches and increased frequency of flooding and overwash, and increased frequency of flooding of the artificial islands in and filled margins to the Bay. In addition there are several changes that will fundamentally change the nature of Biscayne Bay: breaching of low areas of Elliott Key, providing new connections to offshore waters, increasing the tidal prism as landward former wetlands are added to the daily tidal flooding, enlargement of tidal channels at the entrance to the Bay. There are yet other fundamental changes that will occur for which we cannot yet define the rate or magnitude, but which may most fundamentally affect the Biscayne Bay system. These include: erosion and reconfiguration of the Safety Valve mud bank and mud banks within the Bay; nutrient and turbidity levels in a systems with higher rates of erosive recycling of contained mud and peat environments; effect on timing and distribution of freshwater input from a more sluggish (less elevation above base level) Everglades; changes in salinity and circulation of various sectors of the bay; and changes in benthic community structure.

Future changes in south Florida's coastal and freshwater wetlands can be mapped using knowledge of coastal evolution during the past 4,000 years under known sea level conditions. Five principles are forming the foundation for the preliminary forecast mapping presently underway by Wanless: 1) hurricanes initiate devastating changes to both the coastal margin and the interior of mangrove forests; 2) mangrove forest recovery or evolution is closely related to types of sediment substrate and rate of sea level rise; 3) landward mangrove migration is controlled by tidal (channel bound) and hurricane surge (not-channel bound) seeding; 4) freshwater drainage (non-channeled Everglades) and saline intrusion (channeled and non-channeled tidal waters) are closely tied to subtleties in the low-lying limestone topography and will dramatically change during rapidly rising sea level; and 5) different substrates have differing resistance to physical erosion and recycling during transgression. Substrates, from physically most to least resistant, are: Pleistocene limestone, coastal marl levee deposits, marine carbonate mudbank, mangrove peat, muddy sands, and sand. In addition, transgressed peat substrates, if not covered by other sediment, are prone to rapid erosion by burrowing and oxidation.

Mapping of the future patterns of coastal erosion, wetland evolution and upland inundation are made by interfacing these principles with mapped distributions of surface environments, substrate types and thicknesses, limestone topography/bathymetry, present surface topography, and differing rates of sea level rise.

Recommendations

It is imperative that the high probability for significant future sea level rise be addressed head on. A recent discussion in *Science* demonstrates the cost, waste and increased risk that occurs if the reality of future sea level rise is not incorporated in to planning and design for the future of low-lying coastal cities (Ammerman and McClennen, 2000). The following are considered high priority recommendation as they provide the foundation for modeling and design of the Biscayne Bay of the future.

a. Assess the quantitative effect of the past 70 years of increased rate of relative sea level rise on the environments and waters in and marginal to Biscayne Bay.

   Justification: The 0.7-foot rise in sea level over the past 70 years is about 7 times faster than the rate over the past 2,000 years. As a result there have already been fundamental changes in the stability of the coastlines, wetlands, mudbanks, circulation, and hydrology of Biscayne Bay.

b. Using knowledge of the response of coastal and shallow marine environments to differing rates of relative sea level rise (form geologic studies of south Florida), assess how the coastal and shallow marine environments in various settings of Biscayne Bay will respond over the next 100 years to a further sea level rise of 1 and 2 feet.

   - Create a map and dynamic model of how the marine, coastal and upland environments in and marginal to Biscayne Bay will look in 50 and 100 years with a 1 and a 2 foot rise in relative sea level.

- Assess areas, rates, amounts and types of erosion that will occur in destabilized sediment bodies in and marginal to Biscayne Bay for the four models.
- From these four maps and dynamic models, define the changes in the interaction of Biscayne Bay waters with the surface and ground waters of the coastal ridge and Everglades Basin.
- From this, define the resulting patterns of circulation, salinity and residence time for waters in Biscayne Bay.
- And from this, project the distribution of benthic communities in Biscayne Bay.
- Identify areas in which human intervention can ameliorate the negative environmental effects of increased rates of rising sea level, and those areas in which current or anticipated human activities will negatively accentuate the consequences of rising sea level.

  Justification: The above research/modeling exercise will provide a visual model of future changes in the configuration of the substrate and the Bay margins, circulation, salinity, distribution of habitats, and foci of human stress over the next century. This will provide the foundation for all long-term management, legislative and policy strategies.

c. Incorporate the reality of the historical rapid rise in sea level and the high probability of further future increases in the rate of sea level rise into every aspect of planning for the future of Biscayne Bay and Miami-Dade County.

   Justification: Without using the produced knowledge of the future of Biscayne Bay, management and policy decisions will be meaningless and likely environmentally and economically harmful to the Bay and the people of south Florida.

E. WHAT IS KNOWN AND WHAT IS NOT ADEQUATELY KNOWN

A. Limestone Substrate

A.1. Limestone Porosity and Permeability Properties

Known:

General lithology, stratigraphy, porosity and permeability.

General aquifer/hydrologic characteristics.

Not Known:

Local characteristics of stratigraphic aquitards and aquicludes that affect flow of upland inputs and flow into the Bay.

The specific role of interconnected solution cavities in defining flow from uplands into the Bay.

How change in freshwater head in upland has changed inflow into Biscayne Bay

Amount of inflow and outflow of freshwater and salt water and freshwater into and out of the substrate in areas of exposed limestone in Biscayne Bay.

Dynamics of tidal pumping through limestone at margin of Biscayne Bay.

How historical rise in sea level and forecast future rise ins sea level has changed/ will change the dynamics of groundwater flow.

A.2. Differentiating Role of Historical Rainfall from Human Modifications in Surface/Groundwater Flow

Known:

The historical trends, fluctuations and extremes in rainfall and temperature.

Not Known:

How these have influenced the benthic environment and community dynamics in Biscayne Bay.

B. Biscayne Bay Environments

B.1. Marine Environmental

Known:

General origin of sediment bodies and sedimentary environments in and marginal to Biscayne Bay response to sea level history.

General dynamics of sediment bodies and sedimentary environments in and marginal to Biscayne Bay in response to prevailing conditions, storm events, sea level change, and human stresses of nutrients, turbidity, and physical damage.

Not Known:

Historical distribution of bay bottom and coastal wetland environments.

How, when and to what extent these have changed in response to:

1. Natural stresses and natural stresses within the Bay,
2. Human modifications within the Bay;
3. Human stresses within and to the Bay;
4. Changes in the type and amount of freshwater flow to the bay;
5. Historical rise in sea level.

Interacting influences of the sedimentary environments in and marginal to Biscayne Bay.

B.2. Coastal Wetlands

Known:

General historical evolution in response to setting and sea level rise.

Major hurricanes are initiators of dramatic steps of change.

Not Known:

Effect of historical sea level rise on erosion of mangrove margin and deterioration of mangrove forest interior..

Effect of historical hurricanes on coastal wetland evolution (before and after increase in rate of sea level rise).

Effect of future sea level forecasts of loss of coastal wetlands and landward area of migration.

C. *Turbidity*

C.1. Soft-sediment Bottoms in Biscayne Bay

Known:

General Origin and Dynamics of mud banks and muddy bottom sediment in central and south Biscayne Bay.

Barren bottoms of northern Biscayne Bay enhance turbidity.

Not Known:

Rate of erosion of vegetatively stabilized versus barren bottoms.

Role of boat traffic and scour, storms and bottom trawling in destabilizing muddy banks and bottoms.

Sediment bodies that have become unstable through physical modification to the Bay and through historical and forecast future sea level rise.

Type and rate of change that can be expected.

C.2. Causes for Turbidity

Known:

Unbulkheaded fill shorelines and banks and unstabilized barren bottoms are undesirable sources of turbidity release.

Vertical sea walls and other altered shorelines accentuate turbidity by not providing a habitat for filtering organisms and by reflecting wave energy.

Higher nutrient levels can accentuate turbidity through promoting plankton production.

Not Known:

Rate and timing of turbidity release from sediment bodies that have become unstable through physical modification to their bottom and through historical and forecast future sea level rise. Type and rate of change that can be expected.

Role of various filter feeders on turbidity removal.

D. *Catastrophic Events and Sea Level Change*

D.1. Historical Changes in Sea Level

Known:

There has been an 0.7 foot rise in sea level in south Florida since 1930.

This is a rate about 10x faster than for the past 2,000 years

Not Known:

How and to what extent this change in sea level has initiated changes in the stability of sediment bodies, sedimentary environments, and communities in and adjacent to Biscayne Bay.

To what extent the tidal prism has changed and how this change has affected circulation and environments in and adjacent to Biscayne Bay.

D.2. Forecast Future Changes in Sea Level

Known:

A further rise of sea level of 1-2.5 feet is forecast for the coming century.

Not Known:

How the tidal dynamics, circulation, sediment bodies, sedimentary environments, coastal wetlands, storm flooding frequency, levels and patterns, turbidity, nutrient and toxin dispersal, coastal stability, and salinity patterns will change with a further 1-, 2-, and 3-foot rise in sea level over the next 100 years.

How the barriers defining the eastern margin of Biscayne Bay (barrier islands, sand tidal deltas, carbonate mud and sand banks, and low limestone islands) will change with a further 1-, 2-, and 3-foot rise in sea level over the next 100 years.

Which sedimentary bodies and communities will be most affected, in what manner and to what extent with a further 1-, 2-, and 3-foot rise in sea level over the next 100 years.

How previous and anticipated future modifications will affect the nature and amount of change in the above listed characteristics of Biscayne Bay with a further 1-, 2-, and 3-foot rise in sea level over the next 100 years.

What will be the usefulness each future development and future restoration/improvement in light of with a further 1-, 2-, and 3-foot rise in sea level over the next 100 years?

How will salt-water intrusion respond to a further 1-, 2-, and 3-foot rise in sea level over the next 100 years?

How will freshwater and upland pollutant input be influenced by a further 1-, 2-, 3-foot rise in sea level over the next 100 years?

D.3. Stress of Hurricanes and other Catastrophic Events

Known:

That hurricanes and other catastrophic events cause damage - recovery cycles in Bay environments and communities.

That hurricanes and other catastrophic events can initiate evolution of Bay and coastal wetland environments and communities.

That hurricanes and other catastrophic events will initiate evolution in stressed environments and communities.

Not Known:

How, where, and to what extent historical catastrophic events have caused damage - recovery cycles and/or have initiated evolution of environments and communities.

How, where, and to what extent damage - recovery cycles and event- initiated evolution is associated with stresses caused by human modifications and/or with historical changes in freshwater discharge and sea level changes.

E. Historical Improvements

Known:

Specific improvements have been made to the bottom environment (e.g. sea grass replanting, artificial reef construction, shallowing bottom), the coastline (replacing sea walls and unbulkheaded shorelines with rip rap and mangroves), and to the nutrient loads entering Biscayne Bay (e.g. sewage and phosphate).

Not Known:

How and to what extent each change actually has modified (hopefully improved) the quality of the Biscayne Bay environment.

Has a 'critical mass' of improvements been made to result in a meaningful improvement in the quality of the Bay environments? What is the 'critical mass?'

What are the most cost effective, recreationally useful, and habitat beneficial improvements?

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HYDRODYNAMICS AND MASS TRANSPORT

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SCOPE

Physical processes and their interactions

BACKGROUND

The currents in Biscayne Bay move the water and with it any suspended or dissolved matter. These currents are responsible for moving water between the coastal wetlands and the bay and from there out into adjacent waters such as Hawk Channel and the Atlantic Ocean. The current response is driven by astronomical tides, wind, and freshwater input forcing. Thus the study of hydrodynamics and mass transport strives to not only understand the current patterns and regimes, but also transport pathways, water exchange, and residence times.

CONCERNS

The major concern is to have a sound scientific knowledge base and predictive tools adequate for assessing the health and sustainability of the existing system and for evaluating the impacts of planned modifications to the system. Specific concerns regarding hydrodynamics:

I. Availability of sufficient data to construct predictive models

II. Availability of useful models in a timely manner.

III. Hindcasts, for example of what were the conditions in the unaltered natural system

IV. Predictions that allow assessment of future plans, for example restoration scenarios

V. Availability of a skilled and knowledgeable modeling group

Two-dimensional (2D) hydrodynamic numerical models that relate salinity distributions to freshwater inflow exist for Biscayne Bay. However, none are fully responsive to all concerns. The most comprehensive model, which includes the entire Bay, is designed to link to the USGS Biscayne Bay groundwater flow model. This hydrodynamic model, however, is still in the development stage, requires long computer run times, and does not perform well in the critical near-shore and intertidal zone. Salinity patterns in this zone are of greatest interest with respect to defining targets for freshwater inflow based on restoring the Bay's nursery function for estuarine-dependent species. Detailed topographic data and salinity data to support improvements in near-shore representations of salinity patterns by this or alternative models are lacking. Even though Biscayne Bay is predominately shallow and well-mixed, there appears to be a need for 3-D modeling capability in certain key areas, such as near point-source freshwater inflows, deeper channels and holes, and at the deep-draft navigation project of Miami Harbor. Furthermore, there is concern about the accuracy of available freshwater input data. If these data needs could be met, a hydrodynamic model might be used not only to estimate salinity patterns under future proposed water management schemes, but also to provide a view of what salinity patterns, in relation to rainfall, might look like if freshwater flow came from a natural, unaltered watershed.

1. Issues that need to be better described and understood:

a. Fresh water input to Bay - canal runoff, ground water, sheet flow, Miami River, effective rainfall.

b. Flushing rates and residence times - transport and exchange within Bay, between different compartments of the Bay, and Bay/Ocean exchange - What are the exchange pathways within the Bay and with surrounding regions.

c. Circulation response to forcing mechanisms - The Bay's response to atmospheric forcing (winds, evaporation, precipitation); tidal forcing; other fresh water inputs; and oceanic forcing need to be better understood for semi-daily, daily, seasonal, annual and interannual time scales. Understanding the response to transient storms and sea breeze is important.

d. Spatial and temporal distribution of salinity, turbidity and nutrients in water column and sediment need to be better observed.

e. Future shoreline/bay development - canals, shoreline configuration, dredging, system loadings, nutrients, boat resuspension of sediments, deepening of Port of Miami, Miami River dredging, Homestead Airforce Base are all issues that can effect the water quality of the Bay.

2. What do we know about these issues:

a. Most issues require future observational and modeling studies to adequately understand their influence on the Bay.

b. Those issues that are understood are: tides, statistics of large scale atmospheric forcing and some point source information.

c. North Bay was fresh or estuarine in the distant past.

d. The quantities and timing of freshwater going to south Bay were different in the natural system.

3. Existing studies that address issues:

a. USGS is working on SEAWAT, a finite difference variable density numerical model for the purpose of simulating groundwater seepage to the Bay.

b. Place holder awaiting input: FAU, in cooperation with SFWMD is developing an adaptation of MODFLOW, a 3-D finite difference groundwater and wetland flow model in support of the Lower East Coast Water Supply Plan.

c. DERM has an ongoing monitoring/sampling program and has initiated a hydrodynamic modeling study with the COE. The modeling is being accomplished as a three phase effort. Phase I is application of the RMA-10 2-D hydrodynamic model plus salinity to Biscayne Bay. This effort is underway and observational data (currents, temperature and salinity) have been collected for verification purposes. Phase II is a planned water quality model. And Phase III is a planned coupled biological/physical model.

d. University of Miami, RSMAS, has developed and applied a 2-D hydrodynamic model that includes salinity to south Bay and adjacent coastal region. The model uses realistic forcing including all types of freshwater input. Simulations have been made for several 31 years periods (restoration scenarios 95 Base and D13R4).

e. University of Miami, RSMAS, has also developed a muliti-species population dynamics model for the Bay and coastal region that is coupled to the RSMAS hydrodynamic model.

f. DERM in cooperation with SFWMD is developing a storm water numerical model to simulate daily amount, timing, and distribution of 118 pollutants entering the Bay for wet, dry and average year events.

4. What extent will new research be needed: New research is needed on most of the issues listed above, but in particular there is a need for:

a. Better observations/model of fresh water inputs to Bay - canal, ground, sheet flow, precipitation.

b. Better observations/model of atmospheric forcing of Bay - resolution of winds, evaporation/precipitation compatible with hydrodynamic models. An atmospheric model should be developed to provide forcing to the Bay circulation model.

c. Accurate modeling of topographic (e.g. ICW, dredge holes) and coastal wetlands and surf zones in both north and south Bay.

d. Improved observations of Bay circulation, transport pathways, salinity patterns and exchange/flushing properties for comparison with models and to improve understanding of Bays residence times and future loadings. Understanding of transport and mixing relevant to transient point sources and for non-conservative substances is especially needed.

e. Biscayne Bay model should incorporate the flow exchange with adjacent coastal water and as needed include the effects of the Florida Current with realistic frontal eddies.

f. Need to couple the new USGS groundwater model to the Water Management Model because it provides substantially different groundwater inflows to Biscayne Bay than that estimated by the Water Management Model.

g. Need to know the manner in which water enters the Bay (i.e., as ground or surface water, as point source discharge or sheet flow/tidal creek flow, or as high frequency pulse flows or sustained flows) and does this affect the relationship between freshwater inflow and salinity patterns? Does point discharge from canals mix with, and influence, salinities in the nearshore western Bay? What do the salinity contours resulting from this mixing look like? Did a narrow (or not so narrow) zone of brackish water (5-25 ppt) exist at all times along the western edge of the Bay? This would take only a small amount of fresh water, but would require water storage capacity to supply inflow for dry seasons.

h. Need to know the salinity regime of South Biscayne Bay prior to drainage and distinguish the western nearshore area.

i. Need to know the effect of advanced-treatment reuse water would have on Biscayne Bay?

j. Need to be able to predict the effect of freshwater inflow on salinity and circulation patterns. Existing models need to have improved resolution in the western Bay to be useful in evaluating effects of freshwater inflow on salinity patterns and also to be used in addressing water redistribution from canal flow to sheet flow.

k. Need estimates of groundwater flows and surface flows before canals.

l. Should develop means of redistributing canal discharges through mangroves and coastal marshes to improve nursery habitat for fish and foraging habitat for wading birds.

m. Need better understanding of wave climate for nearshore zone dynamics and turbidity.

RECOMMENDATIONS

There is a close relationship between water management, salinities, and water quality in Biscayne Bay. The temporal and spatial variation of salinity is a major controlling factor on the type and growth of fish populations and benthic communities. To properly estimate salinities and effects of point and non-point sources on Biscayne Bay water quality, better information on freshwater inflows and predictive models are needed, which will require the following developments:

1. Determine the quality, quantity and timing of fresh water discharges to the bay from all sources, present and predrainage.
2. Develop calibrated, verified hydrodynamic model of the Bay circulation, salinity distribution, and exchanges with the coastal ocean, and which is or can be coupled to atmospheric forcing, water quality, and biological models.
3. Use the hydrodynamic models to help evaluate the ramifications of issues 1.5
4. Hindcast predrainage circulation and salinity patterns.
5. Water quality including suspended solids resulting from point and non-point sources of pollution is a critical concern. "End effects" ecological models coupled with the hydrodynamic models are needed. Traditional nutrient/primary production type models are likely useful only as research tools for a long time to come. To prepare for these models, hydrodynamic transport and mixing data are needed.
6. A better understanding of the water wave climate and the effect of waves on bottom resuspension and surf zone mixing is needed.
7. Develop a long-term monitoring strategy of important physical/biological parameters that are transmitted in real-time for use in predictive models to detect changes in the state-of-the-bay.
8. Develop Biscayne Bay endpoints (important characteristics) and model output parameters for water quality and biological communities. Knowing the endpoints is helpful to numerical model selection, grid design, data collection, and model development.
9. Assemble a group of individuals with sufficient knowledge in oceanographic and hydrologic data collection, data analysis, modeling, model application, and with intimate familiarity with local conditions to participate in the above efforts.

WATERSHED HYDROLOGY

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BACKGROUND

INTRODUCTION

Biscayne Bay is dependent upon continued and sufficient freshwater inflow. The Bay historically and currently has received its freshwater from groundwater, surface water, and rainfall. Historic changes in land use and water management in the watershed have altered the volume, distribution, and timing of water flowing into the Bay. Freshwater inflow has been significantly shifted from groundwater to surface water and has been changed from sheet flow through coastal wetlands into point-source discharge from canals directly into the Bay. Recent evaluations predict that future urban and agricultural development and water withdrawals for urban drinking water will reduce the amount of water flowing to the Bay.

Two major regional water management planning processes are in progress that will affect freshwater flow to Biscayne Bay and require the input of scientific information. The Comprehensive Everglades Restoration Plan (CERP) has been developed under a Federal-State partnership and is designed to restructure the Central and Southern Florida [water management] Project to better meet water flow needs for ecological and human systems. The Lower East Coast Water Supply Planning (LECRWSP) process is a State initiative to meet the water supply needs for the environment and human uses. Both the LECRWSP process and CERP will use State water law to establish Minimum Flows and Levels (MFLs) [Section 373.042 F. S.] and provide reservation of water for preservation and/or restoration water deliveries [Section 373.223(4) F. S.]. The LECRWSP process provides for adopting these MFLs and water reservations as rules by 2004, before the South Florida Water Management District begins issuing new 20-year consumptive use permits for water users. These processes are to be based on sound science, using ecological and physical criteria. An understanding of freshwater flow quantity, timing, delivery, and quality and their biological effects is necessary to accurately design the State rules for these processes. In addition, this information is needed throughout planning, detailed design, and implementation phases of both CERP and the LECRWSP. Modeling will be used to predict biological effects when selecting among alternative components and designs under CERP. Monitoring will be used to evaluate each component and provide information on the success of each process, which will be used to make plan improvements.

Biscayne Bay's future depends upon having reliable scientific information and modeling tools to adequately protect its resources in the further development and implementation of regional restoration and water supply programs. The water management plans, as presently formulated, have major uncertainties concerning effects on Biscayne Bay. This is especially true with CERP, which will substantially restructure the regional water management system. Fortunately efforts are being made to reduce these uncertainties and improve the Plan, but major gaps exist in the information and modeling tools that are needed. Responding to these needs is urgent because of the rapid pace of watershed planning and population growth.

This chapter provides a brief description of the watershed and freshwater flows to Biscayne Bay, indicates where critical information is lacking, and makes recommendations to ensure a more sustainable future for Biscayne Bay.

PHYSICAL SETTING AND LAND-USE

The Biscayne Bay watershed contains a mix of highly urbanized, industrial, suburban, and agricultural lands that originally developed along the Atlantic coastal ridge. The Atlantic coastal ridge is an irregular geological feature of high land with a maximum elevation in Miami-Dade County of no more than 25 ft (near Coconut Grove). Prior to extensive drainage, land use patterns were determined by availability of higher land for development. Current population density and urbanization follow early development patterns; the highest density development is generally in the north and eastern portions of the County along the coastal ridge. The area north of Snapper Creek was largely drained by the mid-1920s, and land use intensified over the next few decades, pushing agricultural uses west and south. In South Miami-Dade, agricultural uses were predominant up until the 1960's, when the Central and Southern Florida Flood Control Project was completed. When flood control became possible in this low lying area, urban uses began to intrude on agricultural land uses and wetlands in this region, and has continued at a rapid pace to the present time. Although these areas are still mainly agricultural, urban sprawl has resulted in a change toward residential, commercial and industrial land uses. The canals of the northern Bay drain primarily urban and industrial land. Canals through the southern watershed drain land that is still primarily agricultural. The largest inputs to the Bay are from Snake Creek and the Miami River (Cooper and Lane 1987) in the northern Bay. The Miami River is part of the regional canal system, and, for this reason, Miami River flow can include water derived from Lake Okeechobee, the Everglades Agricultural Area (EAA) and the Water Conservation Areas (WCAs). (The Miami River is not used to drain the EAA, but rather to provide water to the southeast coast to prevent salt intrusion and supply urban wells.)

GEOLOGY AND HYDROGEOLOGY

Biscayne Bay is underlain by the easternmost edge of the Biscayne Aquifer and is hydrologically connected to the Everglades to the west. The Biscayne aquifer, which underlies and forms South Florida's eastern coastal ridge from roughly Boca Raton south, is highly permeable. The two principal formations of the Biscayne Aquifer are the Tamiami Formation, formed during the Pliocene Age, which forms its lower depths, and Miami oolite, of Pleistocene (Late Sangamon) Age, that overlies it (Parker and Cooke 1944). The Biscayne aquifer is an unconfined surficial aquifer recharged primarily by direct rainfall (SFWMD, 1992). Infiltration rate and transmissivity are very high except where inhibited by pavement. Under natural conditions, the groundwater hydraulic connection between Biscayne Bay and the Everglades was much stronger. Before drainage and even historically (which includes the period of record through the present), freshwater flowed to the bay as both surface and ground water. Surface water flowed to the Bay through tributaries, coastal creeks, and through depressional features known as transverse glades. Groundwater levels were much higher and therefore contributed much more to the total freshwater discharge to the Bay. As water built up on behind the coastal ridge, the hydraulic head drove ground water seepage into the Bay.

DESCRIPTION OF THE WATER MANAGEMENT SYSTEM

Currently, freshwater flow to Biscayne Bay is almost entirely through a system of canals, including those formed from the original natural rivers. Although many of these canals were originally dug during the first half of the 20th Century, the project as currently built and operated was authorized by Congress in 1948 as the Central and Southern Florida Project for Flood Control and Other Purposes and was later renamed the Central and Southern Florida (C&SF) Project. The original construction beginning the draining of the Everglades and the decline of groundwater levels was the ditch connecting Lake Okeechobee with the Caloosahatchee River in 1883 (see Dancy 1884, Duval 1884). The Miami Canal was connected to the Miami River and all obstructions removed by 1909 (SFWMD, 1992). By 1925, all the major canals north of Snapper Creek had been constructed. These canals were improved and additional canals dug for the C&SF Project. This project was authorized in response to disastrous flooding in South Florida from hurricanes in late 1947 and was designed primarily as a flood control system, although salinity control was also included in the design features to protect municipal well fields from salt water intrusion. Other purposes of the overall C&SF Project include: navigation; water supply for agricultural irrigation, municipalities, industry, Everglades National Park; regional groundwater control; enhancement of fish and wildlife; and recreation.

Currently nineteen canals discharge fresh water into Biscayne Bay. These canals maintain flood control in 17 eastern Miami-Dade County surface water management basins (Cooper and Lane, 1987). Water levels are controlled in Miami-Dade County by the regional canals of the C&SF Project including the South Dade Conveyance System (SDCS), smaller local drainage canals, and stormwater infrastructure projects. Criteria for operation of the Project canals, including the SDCS, are set by the U. S. Army Corps of Engineers and the canals are operated by the South Florida Water Management District (SFWMD). Project conveyance canals are used to regulate water levels in the Water Conservation Areas of the Everglades by releasing water to coastal waters, including Biscayne Bay. Canal levels are maintained to prevent flooding on the coastal ridge as well as in the historic wetlands, which were drained. Local drainage canals and stormwater projects are generally the responsibility of Miami-Dade County.

NEW AND PROPOSED WATER MANAGEMENT CHANGES AFFECTING WATER FLOW TO BISCAYNE BAY

The Comprehensive Everglades Restoration Plan (CERP) will restructure the regional water management system and will affect freshwater inflows to Biscayne Bay. Design changes may be needed to provide adequate water to the Bay. The components of the CERP and other projects are briefly described in Appendix 1. Currently three project components of the CERP are specifically proposed to benefit Biscayne Bay and Biscayne National Park. They would provide additional flow to the Bay, redistribute some canal flow to coastal wetlands, and replace existing freshwater flow with alternative technology. Some other components of CERP, if not revised, might decrease the groundwater flow to the Bay, reroute existing flow surface away from the Bay, or redirect surface water to well fields. Further evaluation of these potential effects and efforts to improve the Plan with respect to these effects are in progress.

The Biscayne Bay Coastal Wetlands component of the CERP is designed to redistribute water flow to the Bay. Its purpose is to divert some canal flow to create sheet flow through coastal marshes and tidal creeks to restore estuarine function and provide fish and wildlife habitat. The Biscayne Bay Coastal Wetlands component is still conceptual and remains to be further developed and its engineering feasibility evaluated. This component includes stormwater treatment areas that were designed to accommodate the treatment of canal flow. However, the currently proposed stormwater treatment areas may not provide enough treatment area for the reuse component. Additional water quality treatment areas may be needed to further treat re-use water. This component is time sensitive due to the need to acquire land as a part of this process.

A spreader canal from C-111N that is planned in the currently authorized C-111 Project will move water into the Model Lands/Southern Glades management area. The C-111N Spreader Canal component of CERP is proposed to enhance this feature to reestablish the hydrologic link between the freshwater wetlands of the southeastern Everglades, which lie west of U.S. 1, and coastal fresh and saltwater wetlands upstream from Manatee Bay that lie east of U.S. 1. The CERP component consists of construction of a stormwater treatment area, enlargement of pump station S-332E, and the extension of the canal under U.S. Highway 1 and Card Sound Road into the Model Lands. Currently, neither the volume of flow nor the capacity of this component are adequate to restore the downstream wetlands and coastal estuaries. The benefits of the Biscayne Bay Coastal Wetlands and C-111N Spreader Canal components of CERP depend upon an adequate supply of fresh water from the regional water management system.

The third component of the CERP is South Miami-Dade County Reuse. This feature is a plant expansion of the South District Miami-Dade Wastewater Treatment Plant to produce “superior, advanced treatment of wastewater” (CERP. 1999). This component was added late in the CERP alternative evaluation process when it was determined that other components of CERP would reduce water flow to Biscayne Bay. More detailed analysis is proposed to determine the quality and quantity of water needed for the Bay. In addition, due to the concerns raised over the potential quality of the water and uncertainties about the technology available for this component, the CERP provided that “other potential sources of water to provide required freshwater flows to the southern and central Biscayne Bay should be investigated before pursuing the reuse facility” (CERP, 1999). This is a key component of the process to guarantee that the Bay will receive adequate water of appropriate quality. As part of this process, additional land beyond that of the Biscayne Bay Coastal Wetland component may be needed for final water treatment prior to discharge to the National Park. The land must be identified and the treatment areas designed to accommodate the treatment technology chosen.

COMPUTER MODELS AND TOOLS AVAILABLE FOR BISCAYNE BAY

Several computer models have been developed or are under development that relate to Biscayne Bay and will be used in water management planning activities that affect the Bay. These models are listed in Appendix 2. While considerable effort has been spent to coordinate these various modeling efforts, the resources to provide critical links between them may be missing. Currently, the mechanism is missing to link the USGS groundwater model, which estimates groundwater flows to Biscayne Bay, to various simulation models operated by SFWMD, including the South Florida Water Management Model (SFWMM). The SFWMM is used to predict water stages and flows throughout southeast Florida under various proposed water management alternatives. Estimates of surface water inflows to Biscayne Bay were made using the SFWMM. There is a high degree of uncertainty in these estimates because this model's spatial resolution (2 miles x 2 miles) is too coarse for the elevational variation of the coastal ridge, it does not include a freshwater/saltwater interface, and estimates on its boundaries are considered less reliable. There are provisions in the implementation plan to refine estimates when higher resolution models are calibrated and tested. More about the need for linkage between models will be given below.

FRESHWATER INFLOW TO BISCAYNE BAY:
WHAT IS KNOWN AND NOT KNOWN ABOUT ITS FORMS, QUANTITY, DISTRIBUTION, TIMING, AND QUALITY

INTRODUCTION

Fresh water enters Biscayne Bay as direct rainfall, surface water, and ground water. Surface water is either canal discharge or overland flow. A discussion of what is known and what is not known about these mechanisms follows. Each discussion will address the mechanism as it was in pre-development conditions, as it is in the present (which includes the period of record and is often referred to as "historic"), and as it would be under the projected scenario of alternative D13R, the current CERP alternative.

GROUNDWATER DISCHARGE TO BISCAYNE BAY

Groundwater discharge to Biscayne Bay is affected by (1) the position of the freshwater-saltwater interface (drought history), (2) height of the water table, (3) geologic structure, including permeability and karst features, (4) canal levels, (5) water management operations, and (6) sea-level fluctuations (tidal, annual, multi-annual, and longer-term). Most of our understanding of groundwater discharges to Biscayne Bay is qualitative at best. It is reasonable to infer that present groundwater discharges are much less than earlier historic and pre-development discharges because the water table has been lowered substantially. For example, Leach et al. (1972) referred to a lowering of the water table of at least 6 ft (1.83 m) on the coastal ridge. Furthermore, the saltwater intrusion line has moved inland in some locations despite the control structures and other efforts to maintain it (Sonenshein 1997).

Freshwater springs once discharged into the Bay (Munroe and Gilpin 1966, Kohout 1966) and still do, but are less apparent. Springs may be associated with heterogeneities in the Biscayne Aquifer, however little is known about this subject.

Kohout and Kolipinski (1967) studied the biological zonation of the benthos in relation to groundwater discharge along the shore of Biscayne Bay. They found a benthic association indicating the influence of groundwater into the Bay almost 400 feet (121.9 meters) from the western shore in the Cutler area, immediately south of the Deering Estate, in the 1960s.

While there are no quantitative estimates of pre-drainage groundwater flow to Biscayne Bay, various written descriptions indicate that groundwater flow was much greater than today in the early 1900s or even the 1940s (Ferguson et al. 1947, p. 65, Dupuis 1954, p. 43). An estimate of the current groundwater discharge to Biscayne Bay was established recently through the development of a variable-density groundwater flow model. Results from the model, developed by the U.S. Geological Survey, suggest that current groundwater discharges to Biscayne Bay are approximately 3 to 10% of the current canal discharges to Biscayne Bay (Langevin, pers. comm.).

CANAL DISCHARGE TO BISCAYNE BAY

Both the quantity of fresh water reaching the Bay and the quantitative information about it is much greater for surface water than for groundwater seepage. Flow to the Bay is primarily through canals and is controlled by gated structures. The South Florida Water Management District (SFWMD) is responsible for the operation of C&SF project canals and water control structures, including those that discharge into Biscayne Bay. Water stage is measured automatically, and discharge quantities are calculated using rating curves and the upstream and downstream stage values at these structures. Surface water discharges have increased substantially since pre-development in order to drain interior wetlands, lower the water table, and prevent flooding.

Prior to the construction of canals, surface flow to the Bay occurred as stream flow and overland flow. Little quantitative information is known about river, stream, and overland flow of surface water to Biscayne Bay during pre-development times. Discharge quantities were presumably less than today. Pre-development streams, rivers, and sloughs were shallow and did not extend very far inland or penetrate much into the permeable Biscayne aquifer. The quantity of overland flow was related to water levels in the Everglades to the west. Channelization changed runoff rates and characteristics so that flow is carried off impervious surfaces in developed areas and moved directly into the Bay. Local stormwater programs have been established to better address this issue, but progress will take time due to the need for proper planning and design and the difficulties inherent in retrofitting existing development with appropriate infrastructure.

The potential effects of the CERP on freshwater flow to Biscayne Bay are uncertain because efforts to improve the plan are in progress. The flows to South Biscayne Bay predicted for D13R depend upon the use of advanced-treatment wastewater (reuse), which is controversial (Bellmund et al. 1999, Alpach et al. 1999), and CERP states that “other potential sources of water to provide freshwater flows to the central and southern Bay will be investigated before pursuing reuse.” Predicted discharge quantities with the 1995-base (95BSR), 2050-Base (without CERP), CERP, and all the components of CERP except the South-Miami Dade reuse component, are shown in Table 1. Table 1 was compiled from results presented in Appendix B, Figure B.3-87 (page 1591) of the Central and Southern Florida Project Comprehensive Review Study (U.S. Army Corps of Engineers 1999). The figures in Table 1 indicate the importance of reuse in CERP for reaching the target for South Biscayne Bay and that without reuse, there would be a reduction in wet season flow to the Bay.

Table 1. Target and model-estimated mean annual surface flow (in thousands of acre ft)

	Wet Season (Jun-Oct)					Dry Season (Nov-May)				
Region	Target	95BSR	50BSR	CERP	W/o*	Target	95BSR	50BSR	CERP	W/o*
Snake Creek	67	121	114	79	79	93	51	43	26	26
North Bay	99	95	97	97		41	37	38	38	
Miami River	132	82	42	43		60	39	18	19	
Central Bay	161	161	152	139	124	83	64	73	61	51
South Bay	158	158	152	181	136	68	52	52	92	43

*All components of CERP except South Miami-Dade reuse.

Targets in Table 1 were established by the Biscayne Bay Team of the Alternative Evaluation Team during the Comprehensive Review Study. The wet season target for Central Bay and South Bay was set equal to the average of the 31-yr output of 1995-Base. The dry season target was set equal to the average of the 31-yr 1995-Base output, plus 30%. The rationale for setting the wet season target equal to 95-Base was the “no harm” philosophy that, until such time as science-based long term targets for restoration could be established, Biscayne Bay should not be damaged by a change in the water management system. The dry season target was 30% higher than 1995-Base because restoring coastal wetlands and sheet flow in the Biscayne Bay Coastal Wetlands component of the planned project will require additional water. The Snake Creek target was set based on estimates of the flow needed to create a salinity regime favorable to oysters near the mouth of Snake Creek.

OVERLAND FLOW TO BISCAYNE BAY

Significant overland flow presently occurs only in the southern parts of Biscayne Bay and originates only from rainfall very near the coast. A substantially larger area contributed overland flow to the Bay prior to drainage. Furthermore, overland flow was augmented by seepage from adjacent areas of higher elevation and by water from the Everglades moving through the transverse glades. In the past, overland flow fed tidal creeks along the southern coast (Meeder et al. 2000). On the basis of soil coring and paleoecological analysis in association with remnant tidal creeks, Meeder et al. (2000) found evidence of a rapid change in salinity regime, with increasing salinity, in the coastal area immediately north of the Military Canal between 1940 and 1992, suggesting a loss of freshwater inflow to the Bay through overland flow and coastal creeks. Based on mollusk preferences, they concluded that salinities prior to 1940 ranged from 0 to 5 ppt from the present site of the L-31E levee eastward approximately 500 meters (which is largely scrub mangrove dominated coastal wetland habitat at present) and from 5 to 15 ppt nearer to the coast. They found a topographic high in place of what had appeared as a topographic low in a 1940 photo and concluded that loss of freshwater inflow had caused retention of silt, the establishment of mangroves, and blockage of a natural creek that had flowed to Biscayne Bay.

Reestablishment of overland flow to coastal wetlands and Biscayne Bay will require the purchase of coastal wetlands, modification of the canal system, and land for water storage. The ability to restore this beneficial delivery of water is dependent upon public ownership of sufficient coastal wetlands.

WATER QUALITY

Water quality in the nearshore areas of Biscayne Bay may change when CERP is implemented. Restructuring the water management system may result in different contributions of water to the Bay from the various source basins. Water quality depends largely on land use, and the different contributing basins have different land uses. Distributing water as overland flow rather than canal flow may also affect water quality, as may the introduction of advanced-treatment reuse water. For a more complete discussion of water quality relative to Biscayne Bay, see the Water and Sediment Quality Chapter.

SIGNIFICANT UNCERTAINTIES AND KNOWLEDGE GAPS

A synthesis of information that pertains to the magnitude of pre-drainage flow is a critical need. Biscayne National Park wants to restore its lands and waters to as nearly a pristine condition as possible. . Knowledge of pre- and post-drainage historic flows can provide a context in which to understand current inflows relative to past conditions. Pre-drainage freshwater inflow will likely have to be inferred from pre-drainage salinity, however, since there is much more information pertaining to salinity than to freshwater inflows. Biological information about the salinity tolerances and preferences of animals that live, or once lived, in the Bay are the primary source of information about the Bay's past salinity. A "natural system" computer model's estimates of pre-drainage flow to the Bay are not considered reliable because predicted flows are not only much lower than current flows but also appear unrealistically low based on other information about the pre-drainage Bay. For example, freshwater springs existed in the Bay and provided drinking water to vessels, estuarine-dependent fish species were found abundantly in the Bay in the late 1800s, and relict oyster bars occur along parts of the western shoreline of the Bay (Meeder et al. 2000). Furthermore, an analysis of sediment cores in Manatee Bay suggests that salinity in the extreme southern part of the Bay was lower at the turn of the century than in the 1960s and less variable than today (Ishman 1999). Current conditions in Manatee Bay are characterized by extended periods with little or no discharge, sporadically interrupted by large quantities of storm water discharged via the C-111 Canal.

Questions have been raised about the accuracy of the historic discharge data maintained and distributed by the SFWMD. Recently, the USGS and SFWMD conducted a joint study of the flow ratings of 19 water-control structures discharging freshwater into Biscayne Bay (Swain et al. 1997). The study indicated that, in some cases, there were differences between the ratings developed in this study and the ratings currently used by SFWMD to compute discharge at these structures. Based on 1994 discharge data, the overall computed difference in total flow volume discharged into the Bay from all 19 structures is only 3.35% (Swain et al. 1997, p. 57). The SFWMD is looking into the possibility of implementing new ratings on a case-by-case basis, but the implementation process may be delayed by the need to conduct additional studies to examine the effects of tidal influences on flows at the coastal structures (SFWMD 2000). Refinements to discharge estimates may be needed to improve predictions of salinity patterns in relation to freshwater inflows in the western part of the Bay by hydrodynamic models.

The development of scientifically sound performance measures and their linkage to water management decisions is crucial to the future well-being of Biscayne Bay and is a major activity that requires dedicated resources. A series of steps are necessary to link freshwater inflows to salinity, water quality, and other factors affected by freshwater inflows that influence the health and abundance of the fish, invertebrates, and other natural resources of Biscayne Bay. Linkages with salinity are particularly important to consider because of the strong relationship between salinity and freshwater inflow—and because salinity affects the growth, survival, reproduction, distribution, and abundance of animals in estuaries. Needed are (1) the salinity requirements and habitat needs of key species, communities, or processes that can be used as biological indicators; (2) predictions of salinity patterns resulting from a given quantity, timing, and distribution of freshwater inflow regime; and (3) predictions of freshwater flows for alternative water management scenarios. First, appropriate biological indicators need to be selected, then performance measures and desirable future states, or "targets", need to be articulated with respect to the selected biological indicators. The next step is to determine the desirable salinity range, or "salinity envelope", to support the biological indicators and the required location of this envelope to ensure that appropriate bottom or shoreline habitat will be available within the salinity envelope. Once this is determined, the final step is to determine the freshwater inflow regime that will establish and maintain the desired salinity envelope in the right place. Thus definition of biological targets leads to definition of target salinity envelopes that lead to definition of target freshwater inflows.

Development of the information and modeling tools necessary to link water management, salinity envelopes, and biological performance measures are still in their early stages with respect to Biscayne Bay. For example, thus far, it has not been possible to translate changes in freshwater flow into terms meaningful to the Bay ecosystem in more than a general sense. The salinity patterns that would result from a particular quantity and timing of freshwater inflow cannot yet be reliably predicted throughout the Bay. Salinity patterns in the western nearshore part of the Bay are expected to experience the greatest change, and plants and animals in this part of the Bay are expected to be the most affected by change in freshwater inflow. Yet there is too little data on the western nearshore area with which to prepare a model to predict salinity patterns in this important area. Furthermore, the present scale of the hydrodynamic models used to predict salinity may be too coarse to show the detail needed in the western nearshore area.

Until appropriate hydrodynamic models are developed and become operational, it will be necessary to have a short term, or "stop-gap", means of predicting salinity patterns in at least the nearshore Bay as a function of freshwater inflow. Simple regression relationships such as those developed for northern Florida Bay may best fit this need. Time series of synoptic salinity measurements in the western nearshore area and associated and freshwater inflow records will be needed to develop regression models.

Improvement in freshwater inflow predictive capability also is needed. The hydrologic models presently used to predict freshwater inflows to Biscayne Bay have scale and boundary problems. Flows to Biscayne Bay under alternative water management strategies were examined during the CERP development process using the South Florida Water Management Model (SFWMM), which has a 2 mile x 2 mile grid. Models with a finer resolution should be used to predict freshwater flows to Biscayne Bay under alternative water management scenarios. The appropriate models or set of linked models need to be identified and further developed for this use.

Current groundwater flow models to Biscayne Bay assume diffuse flow through porous aquifer material. Historically, springs emanated from the bottom of the Bay through natural leakage channels occurring in the rock formations (Alleman 1995). Thus, an unknown portion of the groundwater flow may be discharging via these springs. In order to determine the amount of freshwater discharging from springs, it is necessary to locate the springs to measure present discharge, as well as salinity and water quality characteristics. These investigations have the potential of improving existing models of groundwater flow to Biscayne Bay. The steps are to locate springs, locate channels that relate to springs, and, ultimately, to quantify the amount of discharge through channels to springs in relation to the surrounding aquifer.

One component of CERP has been proposed to recreate a more natural distribution of water to Biscayne Bay through coastal wetlands. Freshwater flow to Biscayne Bay will provide greater biological benefits if it is distributed along the coast and enters through coastal wetlands and tidal creeks rather than as a point source. The fresh to brackish wetland zone within the vegetated shoreline that will be created will provide valuable nursery habitat for estuarine fish, invertebrates, and other wildlife. There is little opportunity to redistribute surface flow through coastal wetlands to North Biscayne Bay because the land is largely occupied by urban uses. However, an almost continuous mangrove shoreline fringe still exists from Matheson Hammock Park to US 1 at Jewfish Creek. In this area there is an opportunity to redesign the surface water management system to more closely mimic natural drainage patterns by redirecting some surface flows through coastal wetlands. Land near the coast may be required to store water captured during the wet season for release to the Bay in the dry season, and/or provide groundwater recharge. Land used for these purposes must be in public ownership or flowage easements must be acquired.

The quality of water entering Biscayne Bay may change as a result of the restructuring of the water management system that is planned in CERP, and water quality changes might affect the biological integrity of the Bay. An ability to predict the loads, water quality, and biological effects of change in water management is needed to protect Biscayne Bay. Predictive models relating flows to water quality should be developed, and biological indicators of water quality should be selected. Selections should be on the basis of presence (or potential presence) in the Bay at locations most likely to experience change and sensitivity to the types of water quality changes that might occur, including changes in nutrient, toxicant, or other pollutant loading.

RECOMMENDATIONS

The following section contains a number of general recommendations. Each general recommendation is followed by an explanation, as well as a number of recommended specific projects and specific recommended management actions that are needed with regard to the recommendation. While the specific projects, research, or actions included below are important, the lists below are not intended to be exclusive or exhaustive.

1. **Review and refine estimates of predevelopment, historic, and present fresh water inflow to the Bay.**

   (Gaps and uncertainties in our knowledge of present and past freshwater inflows need to be resolved to more reliably determine the Bay's freshwater inflow needs. Post-drainage historic flow is incomplete because groundwater and overland flow information are lacking. A better understanding of natural, or "pre-drainage", freshwater flow to the Bay would provide perspective on Biscayne Bay's present freshwater needs and help develop restoration targets for Biscayne National Park. Paleoecological approaches to identifying the salinity requirements of species that once lived in the Bay provide an objective means of determining the Bay's past salinity patterns; and past freshwater inflows can be inferred from salinity.)

Related Specific Scientific Recommendations:

a) Conduct sediment and coral studies to determine past salinity patterns.

b) Use information about salinity tolerances and preferences of salinity dependent species, including estuarine dependent species, known to have once occurred in Biscayne Bay, to infer past salinity conditions in the Bay. Conduct biological studies to acquire additional information, where needed.

c) Complete finer-scale (than the 2 miles x 2 miles) and salinity interface modeling needed to evaluate water management effects on freshwater flows to Biscayne Bay.

d) Reexamine changes in flows to Biscayne Bay expected from CERP (excluding the Water Reuse option) using models with finer resolution and a salinity interface capability.

e) Develop and implement a practical routine protocol for estimating direct rainfall and evaporation on Biscayne Bay and its watershed, including the addition of rainfall measurement capability to existing fixed stations in the Bay. Extend the data spatially using NEXRAD and historically using existing nearby long-term meteorological stations.

2. **Characterize the chemical, biological, and physical environments in the near-shore areas of Biscayne Bay**.

   (The western nearshore part of the Bay is the area most subject to change in freshwater inflow and associated water quality, but little information is available on this dynamic area, partly because it is difficult to reach. More detailed knowledge of this area is needed to design restoration elements of CERP. Needed studies include; 1) surface and ground water flow characterization; 2) benthic and biologic surveys, 3) detailed water quality surveys, 4) detailed topographic and bathymetric data, and 4) long-term, detailed hydrodynamic studies of salinity, water movement, and water depth along the shoreline, in coastal creeks, and within the mangrove fringe.)

Related Specific Science Recommendations:

a) Conduct detailed survey of substrates and benthic community types.

b) Acquire detailed long-term water level and salinity and current measurements along the coast and within the mangrove *creeks (establish long term monitoring stations in the western nearshore area)*.

c) Determine spatial and temporal distribution and abundance of fish and invertebrates

d) Determine benthic flux of fresh water and water quality parameters

e) Couple an appropriate hydrodynamic model, which predicts salinity and circulation, with a model or other suitable tool that can predict water quality and indicator species distributions

f) Continue and expand sediment studies to determine historic and pre-drainage salinity patterns, especially in western nearshore areas.

g) Develop a model or other appropriate tool suitable for studying the interaction of the intertidal and nearshore regions of Biscayne Bay to support design and planning of CERP's Biscayne Bay Coastal Wetlands component.

h) Acquire information about the western nearshore part of the Bay needed by existing hydrodynamic models in order to improve their resolution and accuracy in this ecologically important area, including (i) vertically- and horizontally-detailed topographic and bathymetric data for use in determining wetting and drying under various tidal stages and mean, (ii) refined freshwater inflow data, and (iii) spatially detailed information on water level, salinity. *(This is particularly important in South Biscayne Bay, where an extensive, largely continuous fringe of coastal wetlands borders the Bay south of Matheson Hammock Park.)*

i) Design and establish an expanded long term monitoring network in the Bay to collect detailed salinity and water quality information, with particular attention to the western nearshore regions and the mangrove creeks. *(Integrate and expand existing water quality/salinity monitoring network, establish long-term monitoring stations in the western nearshore area, and employ continuous recording devices to collect data wherever feasible.)*

3. Identify indicator species for Biscayne Bay in terms of salinity and habitat needs to help develop targets for CERP and Minimum Flows and Levels.

(The key to establishing the freshwater needs of Biscayne Bay is to define these needs in terms of the salinity requirements of characteristic species and communities and then to relate magnitude and timing of freshwater inflow to salinity patterns. Information about indicators and their requirements will provide a basis for establishing biological criteria, or performance measures, that will be used to evaluate how well CERP is meeting restoration objectives with respect to Biscayne Bay and how well LECWSP is avoiding significant harm to the Bay. A scientific rationale for each selection must be provided, along with documentation on optimal salinity (a salinity envelope), optimal physical habitat (bottom type, bottom cover, depth, and distance from shoreline), and tolerance to salinity fluctuation.)

Related Specific Science Recommendations:

a) Identification, justification, and documentation of a set of appropriate indicator species and communities characteristic of the Bay whose distributions are likely to be influenced by changes in salinity.

b) Biologic studies on salinity and habitat requirements of juveniles of ecologically or economically important estuarine species that would be expected to use the western nearshore Bay as a nursery ground.

4. Set restoration salinity targets and locations (i.e. wet and dry season salinity envelopes in appropriate bottom or shoreline habitat).

(Definition of the appropriate range and placement of salinity envelopes is a critical link in determining Biscayne Bay's freshwater inflow needs. "Salinity envelope" is a simple term referring to the combination of appropriate salinity range, fluctuation, and habitat that should exist in an estuary. Salinity envelopes have been developed by the South Florida Water Management District for other South Florida estuaries as a prerequisite to the necessary determination of freshwater inflow restoration targets and minimum flows and levels.)

Related Specific Science Recommendations:

a) Use the information provided by the recommended biological studies to determine the salinity ranges and salinity fluctuations, specific to season and location, that would be appropriate to maintain key indicator species. Document this information and use it as the basis for biologic and hydrologic performance measures and targets that can be used to evaluate regional water management alternatives and to monitor the success of alternatives as they are implemented.

b) Determine the locations of appropriate bottom and/or shoreline habitat for the species and the appropriate placement of the salinity envelope to ensure that desirable salinity coincides with appropriate habitat.

5. Develop flow regimes (quantity, timing, and distribution) that produce the desired salinity envelopes.

(Appropriate predictive tools to relate water management to salinity patterns are critical to protect and restore the Bay in the detailed design stage of CERP and in setting Minimum Flows and Levels for implementation of LECRWSP. Water management for drainage and flood control has altered freshwater inflows to the Bay. CERP and LECRWSP, when implemented, will further change freshwater inflow to the Bay. These plans have an adaptive assessment process to restore, or at least protect, the Bay ecosystem. Their adaptive processes depend on predictive models to link the salinity requirements of key indicator species and communities to the freshwater inflows required to maintain these salinities in the specific locations where other suitable habitat conditions are found.)

Related Specific Science Recommendations:

a) Develop a regression or time series model to estimate salinity patterns in the western nearshore Bay as a function of the recent history of freshwater inflow. Development of a regression or time series model will require the acquisition of a time series salinity data synoptic with freshwater inflow data. The record must be sufficiently long and varied to cover a wide range of possible freshwater inflow and salinity conditions. *(The regression model will fulfill a vital function until hydrodynamic models to predict salinity patterns in the western nearshore Bay are operational.)*

b) Couple surface water and groundwater models to a hydrodynamic model to simulate and predict salinity distributions in response to water deliveries. The desired salinity envelopes can then be matched by adjusting freshwater inputs into the hydrodynamic model. Seasonal and year-to-year variations of freshwater inputs should be simulated in the coupled model.

c) Review and improve appropriate hydrodynamic models of the Bay and integrate them with ground and surface water models that can provide appropriate and accurate watershed boundary conditions. Seasonal and year-to-year variations of freshwater inputs should be simulated with the coupled model. Continue to improve the performance and resolution of the coupled surface water-groundwater-hydrodynamic model using data from the expanded monitoring network.

d) When operational, use the model to determine the quantity, timing, and distribution of flows (or refine estimates of flow provided by regression or time series models) required to maintain the salinity envelope (i.e., target salinity range) in areas of suitable bottom and/or shoreline habitat.

e) Apply performance measures to evaluate existing conditions in the Bay (baseline measurement), to test and compare proposed new managed inflow regimes, and to evaluate progress toward meeting biological and salinity targets. Define measurable success realistically (allowing for occasional departures from salinity envelopes).

f) Apply performance measures and targets to establish Minimum Flows and Levels for Biscayne Bay to ensure that significant harm from lack of freshwater inflow will not be experienced in any part of the Bay, including extreme southern areas (i.e., Card Sound, Little Card Sound, Barnes Sound, Manatee Bay) that are of particular concern because they are at the most downstream end of the water management system.

6. Identify and acquire additional coastal lands necessary for flow redistribution.

(Freshwater flow to Biscayne Bay will provide greater biological benefits if it enters through coastal wetlands and tidal creeks rather than as a point source because the fresh to brackish wetland zone provides essential nursery and feeding habitat for estuarine fish, invertebrates, and other wildlife. An almost continuous mangrove shoreline fringe exists from Matheson Hammock Park to US 1 at Jewfish Creek that provides an opportunity to redirect some canal flows through coastal wetlands. Land near the coast may be required to store water captured during the wet season for release to the Bay in the dry season, and/or provide groundwater recharge. Land used for these purposes must be in public ownership or flowage easements must be acquired.)

Related Specific Science-generated Management and Action Recommendations:

a) Assess land needs for flow redistribution and other restoration projects.

b) Assign the highest priority for public acquisition to needed parcels and move to acquire them immediately.

7. Develop the capability to predict water quality changes and resultant effects on the Bay's biological integrity that might occur with proposed water management changes.

(An ability to predict the loads, water quality, and biological effects of change in water management is needed to protect Biscayne Bay. Predictive models or other appropriate tools relating flows to water quality should be developed, and potential biological indicators of water quality should be selected. Selections should be on the basis of presence (or potential presence) in the Bay at locations most likely to experience change and sensitivity to the types of water quality changes that might occur, including changes in nutrient, toxicant, or other pollutant loading.)

Related Specific Science Recommendations:

a) Develop a model or other appropriate water quality tool to predict loading of nutrients, toxicants, and other pollutants to the Bay as a function of water management.

b) Develop, test, and verify a water quality model or other appropriate water quality tool that can be linked to the hydrodynamic model and receive input from the loading model to predict the effects of water management changes on water and sediment quality in the Bay.

c) Develop and document water quality indicators and performance measurs that can be used to evaluate effects of water management changes on the biological integrity of the Bay. Emphasis should be on the use of biological indicators that are sensitive to change in water quality.

8. Determine the importance of fresh water springs to the quantity and distribution of freshwater inflow to Biscayne Bay, past, present, and future.

(Historically, springs emanated from the bottom of the Bay through natural leakage channels occurring in the rock formations. An unknown portion of the groundwater flow may be discharging via these springs and their existence may affect predictions of groundwater flow by existing models. A series of projects are suggested to provide an indication of the significance of spring discharge to groundwaterflow to Biscayne Bay and to evaluate whether existing groundwater models can be improved by the acquisition of further information on springs in the Bay and associated channels in the aquifer. The steps are to locate springs, locate channels that relate to springs, and quantify the amount of discharge from these in relation to the surrounding aquifer.)

Related Specific Science Recommendations:

a) Interview fishermen and other knowledgeable locals regarding the existence of springs in the bay.

b) To locate possible channels within the aquifer, measure tidal propagation inland by comparing fluctuation in the water table or pieziometric surface in a series of groundwater monitoring wells at the same distance from the coastline with tidal amplitude in adjacent coastal waters. Wells with substantially higher ratios of surface fluctuation to tidal amplitude will indicate sites of greater permeability and higher rates of groundwater flow to the coast.

c) Conduct studies such as airborne thermal infrared surveys or resistivity surveys to locate springs within the Bay. Special emphasis should be placed on opportunistic sampling after high rainfall events.

d) Once located, install seepage meters on the springs to measure the flow and sample the discharged water to determine its salinity and other water quality parameters of interest.

e) Locate the inland points of recharge to investigate the possibly of maintaining higher ground water levels in those areas to promote spring discharge and also identifying and controlling potential sources of pollution.

CONCLUSION

Much of Biscayne Bay is in very good condition because of the large number of restoration projects and protective measures that have occurred over the past 20-30 years. However there is still considerable room for improvement when it comes to hydrological restoration. Some areas have been irretrievably altered from pristine conditions due to the changes in fresh water deliveries and cuts in the barrier islands, which have increased ocean flushing. In areas such as South Biscayne Bay, where some coastal wetlands remain, there are opportunities to change the quantity, timing, and distribution of flows to create salinity patterns that approach pristine conditions. Specifically, it may be possible to reestablish a relatively stable low salinity zone along the western boundary of the bay needed for the development of many salt-tolerant freshwater and juvenile estuarine-dependent species. Restoration goals and performance measures are needed immediately to evaluate CERP and other watershed planning processes already underway. Highest priority should be given to the following:

Priority Related Specific Science Recommendations:

a) Conduct studies to determine the magnitude and ecological ramifications of changes in and redistribution of freshwater inflows to Biscayne Bay.

b) Establish hydrologic, biological, and water quality indicators, benchmarks, and targets based on biological needs and historic and pre-drainage conditions to help establish minimum flows and levels for LECWSP and to provide design criteria and performance measures for CERP.

c) Determine the appropriate redistribution of water to restore fresh to brackish water wetlands and provide sustained freshwater flows along the western shoreline of South Biscayne Bay.

d) Review, refine, and integrate hydrologic and hydrodynamic models so that realistic predictions of freshwater flows to the Bay and resultant salinity patterns under different water management scenarios can be compared.

e) Provide a baseline of current conditions for comparison with post project monitoring.

Priority Specific Science-generated Management and Action Recommendations:

a) Redistribute point source canal discharges to sheetflow and natural creek systems. This includes the identification and purchase of needed lands.

b) Provide flexibility to the water management system to allow storage of wet season water excess to provide needed dry season flows.

c) Support the rapid development of restoration targets based on pristine and historic conditions and biological indicators.

d) Determine how best to redistribute water in the Biscayne Coastal Wetlands Component.

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APPENDIX I

MAJOR STUDIES, PLANS, AND PROJECTS THAT WILL AFFECT BISCAYNE BAY

Comprehensive Everglades Restoration Plan (CERP)

CERP will have many components that affect surface water flows to Biscayne Bay. These components, by their operation and structural design, are intended to provide more water for the Central and Southern Florida Project. The CERP components most directly associated with Biscayne Bay are the C-111N Spreader Canal, South Miami-Dade County Reuse, and the Biscayne Bay Coastal Wetlands. Other components of CERP, especially the Lake-Belt Water Storage Components and the East-Coast-Protective-Levee Seepage Control Component, (not a specific component of CERP. Is this the L-31N Levee Seepage Management?)will affect the timing and quantity of water received by Biscayne Bay. Finally, the Restoration and Coordination and Verification (RECOVER) process of CERP will apply scientific knowledge about the system to the selection of indicators, the formulation of performance measures, and modeling and monitoring of these measures to evaluate the performance of the Plan with respect to Biscayne Bay, other natural systems, and human systems. Results of evaluations will be used to improve the Plan.

C-111N Spreader Canal

The C-111N Spreader Canal feature includes levees, canals, pumps, water control structures, and a stormwater treatment area to be constructed, modified or removed in the Model Lands and Southern Glades (C-111 Basin) area of Miami-Dade County. This feature enhances the C-111 Project design for the C-111N Spreader Canal with the construction of a stormwater treatment area, the enlarging of pump station S-332E and the extension of the canal under U.S. Highway 1 and Card Sound Road into the Model Lands. The initial design of this feature pumps water from the C-111 and the C-111E Canals into a stormwater treatment area prior to discharging to Southern Everglades and Model Lands. This features also calls for filling in the southern reach of the C-111 Canal and removal of structures S-18C and S-197. The final size, depth, location and configuration of this feature will be determined through more detailed planning and design.

The purpose of this feature is to improve deliveries and enhance the connectivity and sheetflow in the Model Lands and Southern Glades areas, reduce wet season flows in C-111, and decrease potential flood risk in the lower south Miami-Dade County area.

Biscayne Bay Coastal Wetlands

The Biscayne Bay Coastal Wetlands feature includes pump stations, spreader swales, stormwater treatment areas, flowways, levees, culverts, and backfilling canals located in southeast Miami-Dade County and covers 13,600 acres from the Deering Estate at C-100C, south to the Florida Power and Light Turkey Point power plant, generally along L-31E.

The purpose of this feature is to rehydrate wetlands and reduce point source discharge to Biscayne Bay. The proposed project will replace lost overland flow and partially compensate for the reduction in groundwater seepage by redistributing, through a spreader system, available surface water entering the area from regional canals. The proposed redistribution of freshwater flow across a broad front is expected to restore or enhance freshwater wetlands, tidal wetlands, and nearshore bay habitat. Sustained lower-than-seawater salinities are required in tidal wetlands and the nearshore bay to provide nursery habitat for fish and shellfish. This project is expected to create conditions that will be conducive to the reestablishment of oysters and other components of the oyster reef community. Diversion of canal discharges into coastal wetlands is expected not only to reestablish productive nursery habitat all along the shoreline but also to reduce the abrupt freshwater discharges that are physiologically stressful to fish and benthic invertebrates in the bay near canal outlets.

More detailed analyses will be required to define target freshwater flows for Biscayne Bay and the wetlands within the redistribution system. The target(s) will be based upon the quality, quantity, timing and distribution of flows needed to provide and maintain sustainable biological communities in Biscayne Bay, Biscayne National Park and the coastal wetlands. Additionally, potential sources of water for providing freshwater flows to Biscayne Bay will be identified and evaluated to determine their ability to provide the target flows.

The component Biscayne Bay Coastal Canals as modeled in D-13R and the Critical Project on the L-31E Flowway Redistribution are smaller components of the Biscayne Bay Coastal Wetlands feature described above.

South Miami-Dade County Reuse

The South Miami-Dade County Reuse feature includes a plant expansion to produce superior, advanced treatment of wastewater from the existing South District Wastewater Treatment Plant located north of the C-1 Canal in Miami-Dade County. The initial design of this feature assumed that the plant will have a capacity of 131 million gallons per day. More detailed analyses will be required to determine the quality and quantity of water needed to meet the ecological goals and objectives of Biscayne Bay. Additionally, due to the water quality issues associated with discharging reclaimed water into Biscayne National Park, an Outstanding Florida Water, such as potential failures of the treatment system and the limited ability to control contaminant inputs to the sanitary sewer system serving the treatment facility, other potential sources of water to provide required freshwater flows to southern and central Biscayne Bay should be investigated before pursuing the reuse facility as a source. If it is determined that other, more appropriate sources are not available, the reuse project will be initiated by determining the parameters of concern, the necessary wastewater treatment requirements, and the appropriate treatment technology to be implemented.

The purpose of this feature is to provide additional water supply to the Biscayne Bay Coastal Wetlands component. In order to attain the superior level of treatment, construction of an add-on pretreatment and membrane treatment system to the existing secondary treatment facility will be necessary. Superior water quality treatment features will be based on appropriate pollution load reduction targets necessary to protect downstream receiving surface waters (Biscayne Bay).

Biscayne Bay Feasibility Study

The Biscayne Bay study began in the early 1980's with the completion of the reconnaissance report in March 1984. Feasibility phase studies were initiated in 1984, but funding was discontinued in 1985. The study was reactivated in 1994, but due to the lapse of time with a new set of priorities and concerns, an updated reconnaissance study was undertaken. The Biscayne Bay Florida Updated Reconnaissance Report completed in July 1995 recommended developing and operating a hydrodynamic simulation model, in addition to other ecosystem models of Biscayne Bay. The circulation, or hydrodynamics, of the system are critical to the understanding of many other issues such as water quality, sediment transport, and biological processes.

As part of the updated reconnaissance study, a project study plan was developed which addresses modeling purpose, scope, development priorities, linkages, data collection, research requirements, methods and costs. Three phases of model development were proposed.

- Phase 1 addresses the creation of a hydrodynamic model and associated ground water and surface water model of the Biscayne Bay study area.
- Phase 2 addresses the creation of a water quality model of Biscayne Bay.

- Phase 3 addresses the creation of a biological model, including plant and animal communities of Biscayne Bay.

Currently, the feasibility study is in the phase 1, and is scheduled to be completed in 2001.

L-31N Seepage Management – Pilot Project

The purpose of this feature is to reduce levee seepage flow across L-31N adjacent to Everglades National Park via a levee cutoff wall. Additionally, the feature was designed to reduce groundwater flows during the wet season by capturing groundwater flows with a series of groundwater wells adjacent to L-31N, then backpumping those flows to Everglades National Park. The pilot project is necessary to determine the appropriate technology to control seepage from Everglades National Park. The pilot project will also provide necessary information to determine the appropriate amount of wet season groundwater flow to return that will minimize potential impacts to Miami-Dade County's West Wellfield and freshwater flows to Biscayne Bay.

Wastewater Reuse Technology – Pilot Project

Currently, two features involve the advanced treatment of wastewater in CERP. This pilot project will address water quality issues associated with discharging reclaimed water into natural areas such as the West Palm Beach Water Catchment Area, Biscayne National Park, and the Bird Drive Basin, as well as determine the level of superior treatment and the appropriate methodologies for that treatment. A series of studies will be conducted to help determine the level of treatment needed.

Pilot facilities will be constructed to determine the ecological effects of using superior, advanced treated reuse water to replace and augment freshwater flows to Biscayne Bay and to determine the level of superior, advanced treatment required to prevent degradation of freshwater and estuarine wetlands and Biscayne Bay. The constituents of concern in wastewater will be identified and the ability of superior, advanced treatment to remove those constituents will be determined.

Restoration Coordination and Verification (RECOVER)

A Restoration Coordination and Verification (RECOVER) process has been established under the Comprehensive Everglades Restoration Plan to organize and apply scientific and technical information to help CERP achieve its objectives. Multi-disciplinary and interagency teams of scientists assigned to CERP by state, federal, and local governments will evaluate and assess Plan performance, recommend refinements and improvements to the Plan during the implementation period, review the effects of other restoration projects, and ensure that a system-wide perspective is maintained. The RECOVER teams are responsible for coordination of an Applied Science Strategy, components of which are conceptual ecological models, performance measures with restoration targets, and a system-wide monitoring and research program. Recommendations for refinements and improvements to the Plan or requests for assistance in resolving conflicting issues will be submitted to the Design Coordination Team, which determines structural or operational criteria changes needed to refine the Comprehensive Plan. RECOVER is made up of five teams, led by a leadership group that sets priorities, makes budget recommendations, issues an annual report card, and refines the overall vision of success of the Plan as knowledge about the system increases.

PROJECTS

C-111 Project

The C-111 Project, as recommended in the Corps' General Reevaluation Report dated May 1994, will create the operational capability and flexibility to provide restoration of the ecological integrity of Taylor Slough and the eastern panhandle areas of the Everglades and maintain flood protection to the agricultural interests adjacent to C-111.

The C-111 Project will protect the natural values of a portion of Everglades National Park, and will maintain flood damage prevention within the C-111 Basin, east of L-31N and C-111. Structural modifications of the project consist of the construction or modification of nine canals, several levees, construction of five pump stations, and replacement of the existing bridge over Taylor Slough within Everglades National Park. Non-structural components include acquisition of over 11,866 acres of land, including the Frog Pond and Rocky Glades. The project will restore the hydrology in 128 square miles of Taylor Slough and its headwaters in the Rocky Glades. In addition, the hydroperiod and depths in 1,027 square miles of Shark River Slough are beneficially impacted by the higher stages in the Rocky Glades, resulting in a net increase in water volume within Shark River Slough. The project will provide adequate operational flexibility to incorporate management strategies that will evolve as a result of continued monitoring and studies.

The Water Resources Development Act of 1996 (WRDA 96) authorized 50/50 Fed/Local cost sharing for the total project cost, which included providing credit for all lands needed for the project. It also authorized Federal cost sharing for any water quality features required for project implementation. Jacksonville District is working closely with the South Florida Water Management District, Everglades National Park, Fish and Wildlife Service, Florida Department of Environmental Protection and others to define water quality concerns and develop appropriate water treatment features. A Supplement to the C-111 GRR is now being prepared to identify potential water quality concerns, update project cost estimates and revise project cost sharing in accordance with WRDA 96 guidance.

Modified Water Deliveries To Everglades National Park

The Modified Water Deliveries to Everglades National Park Project was authorized by the Everglades National Park Protection and Expansion Act (Public Law 101-229). The purpose of the project is to provide for structural modifications to the C&SF Project to enable the restoration of more natural water flows to Shark River Slough in Everglades National Park. The project is being implemented by the Corps in conjunction with the acquisition of about 107,600 acres of land by the Department of Interior. Land acquisition for the levee, canal, and pump station for the flood mitigation system in the 8.5-square-mile area is underway.

This project is presently in the design and construction phase. Project construction is scheduled for completion in 2003. The Modified Water Deliveries Project will provide more natural flows to Shark River Slough in Everglades National Park. Water flows will be spread across a broader section of Shark River Slough to include the East Everglades between L-67 Extension and L-31N.

The addition of water control structures and culverts in L-67 A and C will help to reestablish the natural distribution of water from Water Conservation Area 3A into Water Conservation Area 3B. Outlets from Water Conservation Area 3B (S-355A & B) have been constructed to discharge into Northeast Shark River Slough. An existing levee and canal (L-67 Extension) along the eastern edge of the existing Everglades National Park boundary will also be removed. A Miccosukee Indian camp has been flood-proofed to avoid periodic flooding that would otherwise be caused by the project.

In order to prevent adverse flood impacts to the 8.5-square-mile residential area, the authorized project includes the construction of a seepage levee and canal around the western and northern edges of the area and a pump station (S-357) to remove excess seepage water. These project features are designed to maintain the existing level of flood protection in the residential area after the Modified Water Deliveries to Everglades National Park project returns water levels in Northeast Shark Slough to higher levels. A second pump station (S-356) will be constructed to pump excess seepage water from the L-31N borrow canal and residential area into the L-29 borrow canal. This water will then flow through culverts or bridges under US Highway 41 into Northeast Shark River Slough. A new Federal plan that would modify the project features in the 8.5-square-mile area by changing the alignment of the seepage canal and levee system, along with the pump station S357 location, is currently under consideration. The new Federal plan will direct the water south into the C-111 project area.

The structural modifications were designed to provide for maximum operational flexibility so that as more is learned through the continued iterative testing program, the operation of the project can be adjusted accordingly.

APPENDIX 2

BISCAYNE BAY AND RELATED WATERSHED MODELS

Model Name: **Biscayne Bay Hydrodynamic Model Phase I**
Developers: USACE-WES
Primary purpose: Hydrodynamic and salinity modeling in Biscayne Bay
Primary Contacts: Mitch Granat, Technical Leader USACE (904) 232-1839
Gary Brown, Modeler WES (601) 634-4417
Matt Davis, Project Manager SFWMD (305) 377-724
Gwen Burzycki, Project Manager DERM (305) 372-6789

Model Name: **DERM Storm Water Model**
Developers: DERM
Primary purpose: Stormwater and flood modeling
Primary Contacts: Dorian Valdez, Project Manager DERM (305) 372-6886
Victor Martin, Modeler DERM (305) 372-6992
Murry Miller, Project Manager SFWMD (305) 377-7234

Model Name: **Groundwater discharge to Biscayne Bay model**
Developers: USGS
Primary purpose: Simulation of groundwater discharge to Biscayne bay
Primary Contacts: Chris Langevin, USGS 305-717-5817
Model Name: **South Biscayne Bay Hydrodynamic**
Developers: John D. Wang, Applied Marine Physics, RSMAS, Univ. of Miami
Primary purpose: Salinity and flow modeling in Biscayne Bay due to tides, wind, and freshwater input. Possible Uses: Determination of salinity patterns and changes due to fresh water input. Hindcast/nowcast/forecast fate and transport of suspended or dissolved matter.
Primary Contacts: Dr. John Wang, Professor RSMAS (305) 361-4648

Model Name: **North Biscayne Bay Hydrodynamic**
Developers: John D. Wang, Applied Marine Physics, RSMAS, Univ. of Miami
Primary purpose: Flow modeling in North Biscayne Bay due to tides, wind, and freshwater input.
Primary Contacts: Dr. John Wang, Professor RSMAS (305) 361-4648
Model Name: **South Miami-Dade County ground water flow model**.
Developers: Florida Atlantic Universities, in cooperation with SFWMD.
Primary purpose: To support the Lower East Coast Water Supply Plan. It models ground water and wetland flow. It also looks at ground water quarry interaction.
Primary Contacts: Jorge Restrepo, FAU, (561) 297-2795
Angela Montoya, SFWMD, (561) 682-2002
Emily Hopkins, SFWMD, (561) 682-2002

Model Name: **South Florida Water Management Model**
Developers: SFWMD
Primary purpose: Simulating response to different regional water management strategies
Primary Contacts: Jayantha Obeysekera, SFWMD, 561-687-6503
Ray Santee, SFWMD, 561-682-6508
Ken Tarboton, SFWMD, 561-682-6017
Luis Cadavid, SFWMD, 561-682-6555

Model Name: **North Miami-Dade County ground water flow model**. Also known as version 3.0 of the Lake Belt ground water flow model.
Developers: SFWMD
Primary purpose: To support the Lower East Coast Water Supply Plan, and the Water Preserve Area Analyses for the CERP. It models groundwater and wetland flow. It also looks at ground water quarry interaction.
Primary Contacts: Mark Wilsnack, SFWMD, (561) 682-6713
Jayantha Obeysekera, SFWMD, (561) 682-6503
Dave Welter, SFWMD, (561) 682-6707

Model Name: **Integrated Wetlands Treatment Model**
Developers: University of Florida, in cooperation with SFWMD.
Primary purpose: Simulates the space and time dynamics of surface and shallow ground water hydrology and water quality. Used to simulate effects of spatial land use configurations, development intensities, and wetland network arrangements. Initially developed for rapidly-urbanizing sub-basins.
Primary Contacts: Dr. M.T. Brown, University of Florida (352) 392-2309
Matt Davis, SFWMD (305) 377-7274 ext. 7223

COUPLING BISCAYNE BAY'S NATURAL RESOURCES AND FISHERIES TO ENVIRONMENTAL QUALITY AND FRESHWATER INFLOW MANAGEMENT

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PROBLEM BACKGROUND

Biscayne Bay is a unique tropical coastal marine ecosystem renown for its diverse and abundant natural resources and scenic beauty. The Bay contributes to the multibillion dollar tourism and fishing industry in South Florida by providing critical nursery and feeding habitats for many important commercial and recreational fishery resources as well as other ecologically important species. The production dynamics of many natural resources in Biscayne Bay are inextricably linked to the quality of bay waters and habitats, which have been greatly affected by growing human uses and management practices. For example, many reef fish and invertebrate species use the Bay as a nursery ground. The Bay's resources are intimately related to the broader regional ecosystem through water movements and animal migrations, and any degradation to the Bay has consequences well beyond its inshore boundaries.

Biscayne Bay, as well as the south Florida coastal ocean ecosystem (e.g., Florida Keys and Florida Bay), has undergone dramatic environmental changes due to a century of extensive regional population growth that accelerated coastal and watershed development, habitat degradation/loss and pollution. Overall, there has been significant erosion of the Bay's estuarine functionality in the regional ecosystem. In the past, freshwater and brackish marsh habitats bordered most of the Bay's perimeter (Romans 1775; Smith 1896), but over the last century, western shorelines of the Bay and eastern barrier islands have undergone extensive loss of herbaceous marsh and mangroves. Biscayne Bay north of Rickenbacker Causeway is now a highly modulated coastal bay environment affected by more than 100 years of significant habitat destruction, development, and dredging. The area receives contaminants, sewage and disturbance due to its proximity to the influences of Miami and a steadily growing human population of several million along its coastline (see Water and Sediment Quality working group report). Despite this, some parts of the northern Bay remain highly productive (e.g., the basin between Julia Tuttle and 79th St. Causeways; Berkley and Campos 1984) and in recent years water quality has been improved through regulatory action. Much of the southern Bay, despite substantial coastal development, has retained its relatively pristine habitats, good water quality, and supports significant production of economically-important fish and shellfish, although fluctuating salinity due to water management practices continues to be a problem.

The western Bay was heavily impacted by the construction of 19 water management canals that drained wetlands and now release water in pulses to prevent intermittent coastal flooding and facilitate agriculture. The result is a highly modified delivery of fresh waters to the Bay that results in widely fluctuating salinity regimes. Consequently, many estuarine fishes and shellfish, typified by the larger drum species and oysters, have precipitously declined in abundance due to the reduction or elimination of once extensive freshwater and brackish habitats.

Abrupt canal-driven salinity fluctuations represent a stress on plant and animal communities; these have been shown to reduce growth of aquatic plants (Montague & Ley 1993) and lower animal diversity (Brook 1982, Serafy et al. 1997). Such salinity variations are not conducive for estuarine species. For example, the State of Florida's Florida Marine Research Institute, attempted to re-establish a fishery for the estuarine red drum (*Sciaenops ocellatus*) in Biscayne Bay. This species was "abundant in all seasons" during the late 19th Century (Smith 1896, FMRI 1996) when brackish marsh habitats existed, but virtually disappeared from the Bay by the late 1950s. Over a ten-year period, over 1.5 million red drum juveniles were released at 12 locations from near the Oleta River State Recreation Area to Card Sound (Serafy et al. 1999). However, this effort was largely unsuccessful, because juveniles were released into an environment that no longer contained suitable (i.e., consistently brackish) estuarine habitats (Serafy et al. 1996). On the other hand, the Bay's commercial blue crab fishery has been concentrated for at least 15 years in one of the areas most impacted by canal-driven salinity pulses (i.e., between Black Point and Turkey Point). This is consistent with the known tolerance of adults to large variations in salinity (Hill et al. 1989), however, the pattern of generally low densities of juveniles observed by Berkeley and Campos (1984) in the southwestern Bay may reflect poor growth and/or survival of early life stages at salinities below 20 ppt (Van Heukelem 1991). If improved estuarine conditions can be achieved along the Bay's southwestern shoreline we would *de facto* expect a decrease in reef fish abundance and diversity in that part of the bay, but there may be net benefits to other fisheries resources. It is possible that improved delivery of fresh water, in the form of consistent sheet and groundwater flow, would result in a stabilized salinity regime that would benefit larval recruitment dependent upon salinity or olfactory gradients as a directional cue and perhaps provide a more consistent support base for juvenile and adult blue crabs.

The Biscayne Bay Coastal Wetlands Component (BBCWC) is a component of the Comprehensive Everglades Restoration Plan (CERP) which is intended to ameliorate the pulsed, point-source, fresh water delivery problem along the Bay's southwestern shore (possibly from Deering Estate to Turkey Point). The intent is to re-hydrate coastal wetlands that are now drained by the canal system, and redistribute freshwater flow to the Bay across a broad front by means of pump stations, spreader swales, culverts, and other means. If adequate water is provided by the regional system, this component is expected to result in nearshore areas with more consistently brackish salinities for much of the year, which should provide better and more stable conditions for estuarine species to complete their life cycles.

This and other hydrologic programs of historical proportions are planned for south Florida as part of the Everglades restoration. These efforts will further change the timing, location and volume of freshwater inflows to Biscayne Bay, and likely change pollutant and nutrient loading, all of which will likely have substantial water quality and food web effects. Unfortunately, not enough is known about the current extent to which fishery and other natural resources are stressed due to alterations in freshwater flows. This is important information needed to more accurately evaluate the potential effects of proposed projects.

Physical alterations to Biscayne Bay have also substantially changed habitat quality in parts of the Bay. Harbor dredging projects to support an enormous growth of the shipping and cruise liner fleets serving the Caribbean, Central and South America, and Africa have been associated with degraded water quality and destruction of essential habitats. Substantial beach re-nourishment projects on Miami Beach and Key Biscayne are regularly conducted to support the tourism industry, but Lindeman and Snyder (1999) have shown the resultant turbidity, siltation, and destruction of habitats from these restoration activities can be deleterious to fishery resources.

Commercial and recreational fishing are thought to have contributed substantially to resource change in Biscayne Bay (Harper et al. in review). The Bay's resources have been exploited seasonally from the late 1700s by a migrant fishing fleet based in Gloucester, Massachusetts, and even earlier by the Tequesta Indians. Pink shrimp (*Farfantepenaeus duorarum*) is the most important species (by weight) in the Bay's commercial and recreational fisheries (Berkeley and Campos 1984). In the past 10 years a recreational fleet of shrimp "fly-netters" has rapidly grown during winter months representing additional fishing pressure on a resource already exploited by a large number of shoreline and bridge netters as well as the current 20-30 vessel, commercial live-bait rollerframe trawlers. The commercial live bait shrimp fleet damages hardbottom communities (evidence of breakage 12% to 38% above background levels) (Ault et al. 1997b) and also has a considerable fish bycatch (Berkeley et al. 1985). Berkeley et al. (1985) estimated that more than 20% Biscayne Bay's bottom is swept at least four times annually by this fleet.

The cumulative stress on natural resources is reflected in the dynamics of pink shrimp for which the interrelation among life history, habitats, and salinity regimes has received recent attention (Ault et al. 1999a). Pink shrimp is a keystone species that converts seagrass and macro-algal primary production into protein actively sought by a host of juvenile and adult marine predators, including man. Pink shrimp juveniles occupy a key trophic position in the estuarine ecosystem as a primary food source for juveniles of important food fishes, including many coral reef species that have an inshore juvenile phase (e.g., gray snapper). Adult and juvenile life stages are segregated spatially, a common feature of tropical penaeid species and many fish species. Adult shrimp reside in the soft bottoms of offshore shelf regions where they support intense and lucrative food fisheries. Major U.S. fishing grounds are located in the Dry Tortugas off southwestern Florida, and the Atlantic coastal ocean off northeastern Florida and North Carolina. Juvenile pink shrimp inhabit coastal bays and estuaries and have important nursery areas located along the Gulf and Atlantic coasts of Florida and the Atlantic coasts of Georgia and the Carolinas. In Biscayne Bay, juvenile pink shrimp are found in sufficient numbers to support a live bait fishery. Increasing fishing effort on large adult reef fishes, e.g., snappers, groupers, etc., fuels an increasing demand for juvenile pink shrimp as bait, which in turn may actually reduce the available food base for pre-recruit juveniles of many of the fishery-targeted reef species. Thus, sustainability of important south Florida reef fishes and sustainability of pink shrimp in the Bays are interrelated. However, much has still to be learned about the specific trophodynamic pathways of primary-to-secondary production in Biscayne Bay.

Other near-term threats to the integrity, function and dynamics of Biscayne Bay fisheries and natural resources include land use changes in the watershed that affect water quality and water management practices.

THE INFORMATION BASE FOR DECISION-MAKING

As a starting point for improved management decision-making, we must take stock of what information is at hand. The quantity of fresh water from the flood control canals that flow into the southern portion of the Bay is reasonably known. Comparatively less is known about freshwater inputs, mass transport and circulation north of Rickenbacker Causeway and the connectivity to the expansive southern portion of the Bay. Very little information exists on the amount, location and quality of groundwater that currently flows into Biscayne Bay, nor are there reliable estimates of what it was historically. In the past, Biscayne Bay was more estuarine in character, whereas today it can be described as a freshwater-pulsed marine lagoon. We are also uncertain about the quantity and quality of sheet flow, changes in inflows due to stormwater discharge and groundwater that currently enter the Bay. There are no solid data to quantify the historical change in groundwater, sheet flow or rain, nor how much of this reduced input is compensated by the direct discharge of water from the canal system. Nonetheless it is generally believed that the current freshwater delivery pattern is at odds with the maintenance and resilience of an estuarine biotic community.

Miami-Dade County, the EPA and Biscayne National Park conduct a limited monitoring of salinity and water quality distributions in Biscayne Bay, Card Sound, Barnes Sound and Manatee Bay. Since 1993, the Southeast Environmental research Center at Florida International University through funding from SFWMD has operated a monthly monitoring program for 16 physical, chemical, and biological variables at 25 stations throughout Biscayne Bay (Jones and Boyer 2000). The data they provide are essential to the calibration and validation of models. Several physical and biological modeling efforts have been or are being conducted in and around Biscayne Bay. The University of Miami (UM) has an operational two-dimensional finite element hydrodynamic model of southern Biscayne Bay that currently simulates currents and salinity (Wang et al. 1988). The model is quite accurate in salinity hindcasting (Wang et al., in review). A more extensive effort is underway by the Army Corps of Engineers (USACE). When complete that model will simulate Bay circulation the entire length of the Bay from the Oleta River at the Miami-Dade Broward County line to the Card Sound at the Miami-Dade Monroe County line. The U.S. Geological Survey (USGS) is currently developing a preliminary groundwater model that should eventually provide boundary conditions to the hydrodynamic models. A seagrass and sponge model dynamically links Bay habitats to water physics and chemistry (Cropper and DiResta 1999). Both the UM and USACE models were designed to couple with fate and transport modules to simulate water quality variability and the fate of pollutants, sediments and nutrients. Last, Ault et al. (1999b) have an operational spatial dynamic multispecies fishery model that, coupled to the UM hydrodynamic model, has the capability of simulating the spatial distribution and dynamics of pink shrimp, juvenile spotted seatrout and gray snapper in southern Biscayne Bay.

Plankton and icthyoplankton were studied in the 1970s in relation to siting of the Turkey Point nuclear power plant (Hale 1999), and more recently in association with the red drum stock enhancement program spearheaded by the State of Florida. Early studies by M. Roman and colleagues showed that zooplankton in Biscayne Bay can derive considerable nutrition from seagrass and macroalgal detritus in addition to their more typical phytoplankton food resource.

Serafy and Lindeman (in preparation) provide a brief overview of studies on Biscayne Bay fishes. One of the earliest summaries was 25 years ago by de Sylva (1976) who lamented the paucity of quantitative data on the bay's fishes and fishery resources, a situation that at that time severely limited the effectiveness of coastal management efforts. That situation did not improve substantially until the 2-year baywide fishery-independent and dependent surveys of Berkeley and Campos

(1984). Among the many products that they provided was a 35-station monthly rollerframe trawl survey that revealed population density data for 16 juvenile fishes, pink shrimp and callinectid crabs. A second penaeid shrimp species exists in Biscayne Bay (*Farfantepenaeus brasiliensis*), but is not economically important and probably only marginally important from an ecological perspective.

Since 1993, Serafy, Ault, Diaz and colleagues have conducted spatially-extensive nocturnal rollerframe trawl stratified random sampling surveys from Rickenbacker Causeway to the Arsenicker Keys (Serafy 1997, Ault et al. 1999a,b; Diaz et al. 2000). Their empirical surveys captured over 150 species of fish and 20 invertebrates and were designed to anticipate how changes in water management policy are likely to affect future resource dynamics. Their survey design used benthic habitats (i.e., seagrass, hardbottoms, and sand) and salinity regimes as the principal covariates to improve the precision of pink shrimp abundance estimates for sampling depths greater than 1 m. Benthic habitats of the bay have been digitized from aerial overflights and are available as GIS layers (NOAA/FMRI 1998); these are also in need of continual updating and refinement. The 1993-2000 rollerframe trawl surveys to date have collected over 1000 samples using both fixed and stratified random sampling designs. At a given sampling station, two nets are towed simultaneously on either side of the sampling vessel. Water temperature, salinity, dissolved oxygen, and depth were measured at each sampling station. A substantial digital database is available and can be used to design future sampling surveys (see Ault et al. 1999a). This work has resulted in an efficient, precise and cost-effective sampling survey design for southern Biscayne Bay that has been published (Ault et al. 1999a).

Recent sampling efforts have attempted to develop an integrated view of fishery resources across the seascape to capture the biological phenomena of bay to reef ontogenetic migrations of a host of key fishery resources (Ault and Luo 1998; Lindeman 1997; Lindeman et al. 2000). Many coral reef fishes use Biscayne Bay as a critical nursery area (Serafy et al. 1997, Ault et al. 1997a, 1998, 1999a). Mangrove lined shorelines appear to function as diurnal shelter for individuals that have outgrown the protection afforded by seagrass blades, but are, as yet, too small and/or immature to congregate on offshore coral reefs. North Biscayne Bay's mangrove-lined shorelines have largely been eliminated except, notably, in the Oleta River area, but South Biscayne Bay still has considerable mangrove-lined shoreline along its length. A biannual visual survey to quantify fish assemblages that utilize southern Biscayne Bay's mangrove-lined shorelines was begun in 1998 and is ongoing (Serafy, pers. comm.). This survey has expanded to include the mangrove shorelines of Card Sound, Barnes Sound and northeastern Florida Bay. The approximately 235 survey samples so far have uncovered very high densities of juvenile and subadult gray snapper, schoolmaster snapper (*Lutjanus apodus*), several grunt species (Haemulidae) and great barracuda (*Sphyraena barracuda*), among others, occupying the mangrove fringes. Adult snook (*Centropomus undecimalis*) have been detected in low numbers, primarily in mainland mangrove habitats. As yet, only one grouper species (Black grouper, *Myteroperca bonaci* in Barnes Sound) has been observed in these daytime surveys. This observation and some ongoing trapping studies on Florida's west coast suggest grouper presence and/or movement within mangroves is primarily nocturnal.

Our current understanding of Biscayne Bay fish population dynamics, abundance and spatial distributions, both past and present, remains incomplete for at least four reasons. First, virtually all quantitative fish studies were performed post-1970, after the construction of the coastal canal system. Second, since Berkeley and Campos' efforts, few studies have encompassed both the northern and southern portions of the Bay. Third, in most cases sampling efforts were of exceedingly short duration and not maintained over sufficient time periods to allow accurate evaluation of inter-annual changes in the inshore fish community. And fourth, observations reported as from inside the Bay proper have often been inappropriately combined with data from adjacent offshore waters.

Considerable information on juvenile fishes and pink shrimp obtained over the past few years presents an opportunity to make comparisons with juvenile fish and shrimp abundances of 20 years ago. The relatively extensive juvenile fish data set of Serafy, Ault and Diaz collected during the 1990s using rollerframe trawls has yet to be completely analyzed, and its results need to be rigorously compared to those of Berkeley and Campos (1984) and Campos (1985). At present, reliable quantitative data for the Bay are especially lacking for sub-adult and mature adult life stages of most fishes. There have been no scientific studies on native and exotic freshwater fish communities, known to inhabit in the lower reaches of the canals and natural creeks that flow into Biscayne Bay.

The effects of toxicants or other stresses on Biscayne Bay resources are not well known. The prevalence of fish with external abnormalities has fueled concerns of local fishermen and environmentalists concerning toxic materials entering the bay and their ecological consequences (Skinner and Kandrashoff 1988, Browder et al. 1993, Gassman et al. 1994, SFWMD 1995, Long 1999, Corrales et al. 2000), but a clear causative agent for the abnormalities has not yet been identified. The major types of deformities observed from rollerframe trawl and hook-and-line captures were stunted or missing fin rays, depressions in the dorsal profile, jaw deformities and scale disorientation. These deformities were particularly evident in sea bream (*Archosargus rhomboidalis*), bluestriped grunt (*Haemulon sciurus*), pinfish (*Lagodon rhomboides*), and gray snapper (*Lutjanus griseus*). Gassman et al. (1994) found a significant correlation between abnormality prevalence (all fish combined) and aliphatic hydrocarbon concentrations in the sediments. However with one exception, no correlations were detected between deformities in individual species and sediment concentrations of PCBs (polychlorinated biphenyls) or heavy metals like cadmium, copper, lead, mercury and zinc. The exception was between sediment copper levels and abnormalities in the bluestriped grunt (Gassman et al. 1994).

However, it remains uncertain as to whether observed fin ray and jaw deformities, respectively, reflect prior encounters with (and escapement/release from) nets and hook-and-line gear. All of the spiny-rayed species examined are routinely entangled in the rollerframe trawl nets and forcefully removed onboard before they are rapidly returned to bay waters. And certainly, physical injury to fish mouth parts is part-and-parcel of hook-and-line fishing (Gjernes et al. 1993; Albin and Karpov 1998). On the other hand, similar dorsal fin ray abnormalities and depression in the dorsal profile were reported in several generations of an aquaculture population of Tilapia, suggesting that something other than mechanical damage can cause these abnormalities (Browder et al. 1993, Gassman et al. 1994). More precise data on contaminant distributions and the ecotoxicological response of animals to exposure to contaminants found in Biscayne Bay sediments are needed to establish the causes of specific observed deformities in specific fish species. Recent laboratory experiments suggest that mechanical damage alone cannot cause observed scale disorientation abnormalities (Corrales et al. 2000). Based upon circumstantial and correlative evidence, the proportions of abnormal versus normal fish have been incorporated into Ohio's aquatic index of biological integrity as well as similar efforts in other states and nations (Simon 1999). Nevertheless, the role fishing-related mechanical damage as either cause or contributor to the deformities observed in Biscayne Bay fishes deserves particular attention.

CONCLUSIONS AND RECOMMENDATIONS

The future of Biscayne Bay is dependent on the how the effects from human population growth and economic activities are managed. The function and dynamics of the Bay's critical resources need to be understood to effectively address the myriad of management and sustainability issues currently faced. However, the most serious immediate problem requiring attention is alteration in freshwater inflows. What is required and urgently needed to predict with any confidence the effects of altered upstream water management is focused biological and physico-chemical research to develop an integrated view of the coupled anthropogenic and natural-physical processes regulating ecosystem dynamics within the Bay. A robust ecosystem-wide strategy to monitor the Bay's ecological condition is critical. What is required to make responsible recommendations to management is, therefore, an integrated program of monitoring, process studies and interdisciplinary modeling. Recommended critical activities follow.

1) **Investigate historical salinity conditions**

(Justification: while it is generally believed that Biscayne Bay was more estuarine in the past, the actual salinity distribution that obtained in the Bay prior to water management and human development impacts is not well known. It is needed to establish a reference point and perspective for ecological restoration)

Specific Science Recommendations

a) Conduct a background synthesis on the range and dynamics of 'pre-European settlement' salinity conditions that existed prior to 1700 using a strategic combination of literature synthesis, numerical modeling, and paleo-ecological studies on foraminifera abundance and oyster bar distributions.

2) **Monitor pink shrimp, blue crab and juvenile fishes**

(Justification: These species constitute something of a special case since they can be sampled (and have been sampled) as part of an integrated trawl-based monitoring effort. Given their trophic importance and demonstrated sensitivity to salinity distribution change these efforts need to be continued and expanded)

Specific Science Recommendations

a) Expand baywide and continue as restoration proceeds, a field monitoring effort directed at quantifying the abundance and distribution pink shrimp, blue crab and juvenile fishes.

b) A disease and abnormality component should be integrated within this effort with expertise and field personnel specific to this purpose.

3) **Monitor fish utilization of Bay's shallow and shoreline habitats**

(Justification: Shoreline habitats are the first and most significant areas to be affected by proposed changes in water management policies in Biscayne Bay).

Specific Science Recommendations

a) Particular attention needs to be paid to populations that utilize the bay's shallow (< 1 m depth), intertidal and mangrove-lined shoreline habitats wheres within the Bay salinity changes will be greatest.

4) **Conduct before-after ecological studies associated with Coastal Wetlands Component.**

(Justification: The Comprehensive Everglades Restoration Plan (CERP), Biscayne Bay Coastal Wetlands Component has the potential to effect major changes in the extent of available wetlands if implemented.

Specific Science Recommendations

a) Appropriate "before-after" ecological studies need to be done in conjunction with this restoration project since it directly affects one of the principal contiguous Sub ecosystems in the Bay.

b) These studies should be extended well beyond the immediate zone of influence of the project to ensure that a complete understanding of project effects is achieved and that effective and timely changes are made to improve project performance over the course of its' implementation

5) **Monitor exploited species populations and fisheries.**

(Justification: Changes in exploited species populations and fisheries have substantial social and economic consequences)

Specific Science Recommendations

a) Basic demographic and population-dynamic data on stock abundance, age, size structure, growth, and reproduction are needed.

b) Rates of fishing pressure/exploitation are also required for resource assessment, and fishery management purposes and to parse out restoration effects from over-fishing.

c) As part of this effort, further research is necessary to establish the extent to which mechanical damage from trawling and dredging activities directly and indirectly affect the bay's fish assemblages, including the quantification of habitat recovery rates of the resilience and stability of key resources.

6) **Determine habitat value of altered and restored habitats north of Rickenbacker Causeway.**

(Justification: This area is especially characterized by man-made structures, shorelines and altered benthic habitats and has unfortunately been inadequetely sampled over the last decade in comparison with south Biscayne Bay)

Specific Science Recommendations

a) Determine the fish and invertebrate diversity, distribution, population size structure, abundance and dynamics of the bay north of Rickenbacker Causeway.

b) Fishery resource monitoring of areas enhanced or restored by Miami-Dade County should be specifically included in this effort since local differences are expected as a result of these local actions and might confound interpretation relative to overall restoration effects.

7) **Conduct laboratory studies on salinity effects.**

(Justification: the primary effect of CERP is expected to be alteration of the Bay salinity regime. Given the canal structures pulsed introductions are typical and we need better understanding of physiological responses to such realistic stresses not just overall "salinity tolerance" determination to predict population consequences).

Specific Science Recommendations

a) Laboratory experiments on salinity effects on key (and sensitive) species are essential.

b) Specifically needed are controlled laboratory studies on the physiological impacts of variable salinity regimes (and freshwater pulse frequency, duration, and magnitude) on growth and survivorship of key life stages of ecologically and economically important species.

8) **Study creek and canal flora and fauna .**

(Justification: Additional freshwater entering the Bay will be introduced through the present network of creeks and canals the fauna and fauna of which has already been substantially altered and to which numerous exotic species have been introduced. We need to better characterize these populations if we are to determine what changes follow restoration actions.)

Specific Science Recommendations

a) Quantitative characterization not just of the Bay itself but of the native and exotic flora and fauna in the lower reaches of the canals and natural creeks that flow into the Bay is essential

9) **Investigate contaminant and physical stress effects on marine organisms.**

(Justification: Limited information already available suggests pollutants and toxicants are reaching the Bay and that some of the canals are particularly contaminated. Animal abnormalities have been reported but no clear cause and effect relationships have been established).

Specific Science Recommendations

a) The source and distribution of pollutants and toxicants entering the Bay as well as spatio-temporal distribution of abnormalities requires further attention.

b) Initial focus is recommended on laboratory research that examines the extent to which mechanical and toxicant stresses, both singly and in combination, are responsible for the two major abnormalities encountered in fish in the Bay, scale disorientation and fin ray deformity.

10) Develop coupled biophysical models.

(Justification: Quantitatively linking biological change to the physical changes resulting from upstream water management changes requires dynamic predictive modeling of physical – biological interactions given the highly non-linear responses typical of such complex systems).

Specific Science Recommendations

a) Coupled biophysical models that predict the spatial dynamics and distribution of key upper trophic-level resources need to be refined considerably to be useful in fishery management and coastal zone development to evaluate the ecological risks of certain development and restoration scenarios.

11) Develop spatially-explicit ecological databases.

(Justification: Testing scientific hypotheses and evaluating management alternative scenarios requires access by both the scientific and management communities to the same information base)

Specific Scientific Recommendations:

a) Very high priority should be given to development of an integrated database containing all biological and physical 'habitat' layers, hydrodynamic circulation, salinity and water quality variables, and commercial and recreational fisheries and ecological data.

b) High resolution habitat maps (in GIS or other visualization formats) are needed to clarify types and extent of static and dynamic habitats throughout Biscayne Bay.

c) The GIS tool should be embedded in a sophisticated database management,statistical, visualization, and modeling system to facilitate the assessments and risk analyses required by managers

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HABITAT AND SPECIES OF CONCERN

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INTRODUCTION

Biscayne Bay and its watershed are located on the southeast coast of Florida and extend from Miami-Dade County south to Monroe County. Biscayne Bay is a shallow, clear water subtropical estuary-lagoon system that supports a wide variety of fish and wildlife. Important habitats to the bay include terrestrial ecosystems, coastal wetlands, water-column, and benthic communities.

The bay and its coastal areas are home to over 172 species of concern as well as a vast array of other estuarine, marine, and reef plants and animals (Table 1). Specific habitat is provided in the bay for each of its resident animal species, as well as species that migrate in and out of the bay seasonally or daily. If their habitat becomes unsuitable or disappears, the animals lose their home and disappear and humans lose the value of these species. Loss of habitat for these species impacts ecosystem health, degrades the bay, and ultimately impacts its ability to provide aesthetic, recreational, and economic benefits to the people who use and enjoy it (Bader *et al*. 1972, Roessler and Beardsley 1974, Roessler *et al.* 1976).

The principal present threats to the Biscayne Bay ecosystem are: (1) changes in the quantity, quality, timing, and distribution of freshwater inflows; (2) water quality degradation and anthropogenic inputs of pollutants of all types, including nutrients, which stimulate algal blooms, and toxicants, which accumulate in the sediments and threaten animals directly; and (3) physical alteration or damage to the bay bottom. All of these threats have the potential to eliminate benthic communities, destabilize bottom sediments, and increase turbidity.

Our goal is to develop and use scientific information to (1) sustain critical bay habitats and species of concern into the next 25-50 yrs, (2) repair past damage to provide an optimal set of sustainable habitats in the future, and (3) prepare for inevitable accidents of man's activities, natural catastrophes and global warming with restoration techniques (e.g., for oil spills, hurricanes, sea level rise, ship groundings, and vessel scarring).

This report provides a brief discussion of Biscayne Bay habitats and some of the species that inhabit it. Different types of habitat are described, and threats to their functionality are identified. In addition, a review of some of the efforts to restore these habitats in Biscayne Bay is also included. Recommendations for addressing the threats facing Biscayne Bay habitats and species of concern are included, as well as a scientific and popular name list of protected animals and plants in the bay and the adjacent uplands.

BISCAYNE BAY HABITATS: AN OVERVIEW

The ecosystems flanking Biscayne Bay can be divided into four broad categories: coastal upland, freshwater wetland, transitional wetland, and mangrove swamp. Benthic habitat within Biscayne Bay includes seagrass, hardbottom, sand and mud bottom, coral-algal bank fringes, and rocky intertidal. Because nutrients, materials, and biota are exchanged or shared among these ecosystems and the bay, the health of the bay is inextricably linked to the ecological condition of these interconnected areas. Each of these categories of Biscayne Bay habitat is described below.

TERRESTRIAL HABITAT

Terrestrial ecosystems of the Biscayne Bay watershed have been dramatically altered by urban and agricultural development and the construction of a regional water management system, whose primary functions were provision of flood control and water supply for urban and agricultural interests in south Florida. In the uplands, the impacts of fragmentation, habitat loss, and exotic invasion have been especially acute. Most wetlands that bordered northern Biscayne Bay have been replaced by urban development, while the coastal wetlands in southwestern Biscayne Bay have shifted dramatically. Whereas previously a broad zone of freshwater marshes graded into transitional marshes and a thin fringe of coastal mangroves, today these wetlands include a narrowed freshwater swamp forest that gives way abruptly to a much broader zone of mangrove forest (Reark 1975, U.S. Environmental Protection Agency 1994).

The major categories of terrestrial ecosystems of the Biscayne Bay watershed are described below. While their characteristics differ, they are all sensitive and susceptible to changes in hydrology, nutrients and other contaminants, and water quality. Thus, looking for ways to protect and enhance these important ecosystems remains a challenge in the face of continuing development in the area.

1. Coastal Upland

The Miami Rock Ridge is the hydrologic divide that distinguishes the interconnected Everglades and Biscayne Bay watersheds. As recently as the early decades of the twentieth century, a nearly continuous mixture of pine forest and hardwood hammock cloaked these coastal uplands with the pine forest as the most abundant. The open canopies of the pine forests were maintained by periodic fires that killed encroaching hardwoods, allowing development of a rich flora of understory herbs and shrubs, many of them endemic to south Florida. The hardwood hammocks were located at slightly lower elevations and along the fringes of seasonal wetlands. They were, therefore, cool and moist, and resisted most fires. The mesic conditions of the hammock favored rich assemblages of epiphytes and trees, including a mixture of tropical and temperate species (Robertson 1955, Snyder *et al*. 1990). Wildlife of the upland forests was also rich, especially in birds, reptiles, and mammals (Robertson *et al.* 1994).

Today the few remaining upland forests are tiny fragments in an urban and agricultural matrix. Fragmentation, habitat loss, fire suppression, reduction in the water table, and the introduction and expansion of exotic plants and animals have changed the nature and threatened the long term stability of these ecosystems. The continued loss and deterioration of upland forests in the Biscayne Bay watershed is likely to have important consequences for adjacent ecosystems, due to loss of connectivity among habitats, reduction in groundwater recharge, increases in stormwater runoff, and other changes.

2. Coastal Wetlands

Historically, Biscayne Bay was bordered by a mix of mangroves, salt marsh, and herbaceous freshwater marsh. This mix was braided by tidal creeks that served the bay by spreading inflow, absorbing excess nutrients, and providing habitat — including critical nursery habitat — for fish and shellfish, as well as feeding habitat for wading birds. Local rainfall, groundwater seepage, and overland flow through the transverse glades and small coastal rivers fed tidal deltas and creeks. Maintained by freshwater inflow, the natural herbaceous wetlands, fresh-to-brackish tidal creeks, and low-salinity mangrove shoreline and delta provided a broad band of habitat for estuarine organisms having a variety of salinity needs. Coastal wetlands include the Southeastern Glades, the Saline Transitional Wetlands, and the Mangrove Wetlands.

a. Southeastern Glades

Freshwater wetlands in the Biscayne Bay watershed historically occupied the marl prairies immediately east of the Miami Rock Ridge (Egler 1952, Alexander and Crook 1974, 1984). They are most extensive in the southern reaches of Miami-Dade County, where the Ridge curves westward away from the coast. Prior to development, these marshes were dominated by sawgrass (*Cladium jamaicense*) and other freshwater herbs. Water reached them via direct precipitation, surface flow from the Everglades through breaks in the Ridge (transverse glades), or rising groundwater when the regional water table was high (Tropical BioIndustries 1990). Today surface water inputs are largely precipitation-driven and their hydrologic regime is artificially controlled largely by regional water management practices.

The marl prairies and transverse glades were extensively developed for agriculture in the early portion of the twentieth century. These areas were among the regions most desirable for production of winter vegetables, due to the combination of soils that were relatively deep, and seasonal flooding that kept agricultural diseases to a minimum (D. Gann, pers. comm.). By the mid-1950s, saltwater intrusion had affected many of the fields closest to the coast (U.S. Environmental Protection Agency 1994) and development of disease resistant crop varieties had made wetland farming unnecessary (D. Gann, pers. comm.). Abandonment of these disturbed areas was soon followed by invasion by exotic plants, especially Brazilian pepper (*Schinus terebinthifolius)* and Australian pine (*Casuarina* spp.). These trees were introduced around the turn of the twentieth century, and were widely distributed for horticultural uses. The combination of these factors provided a prime opportunity for spread of these invasive plants along the southwestern shore of Biscayne Bay (U.S. Environmental Protection Agency 1994).

b. Saline Transitional Wetlands

A natural feature of south Florida coastlines is a distinct band of transitional wetlands found between the freshwater wetlands of the interior and the coastal mangrove swamps. Characterized by a mixture of mangrove shrubs and salt-tolerant vegetation, (e.g., *Spartina spartinae*, *Borrichia* spp., *Distichlis spicata*, *Juncus romoerianus*), the transitional wetlands are structurally and compositionally distinct from neighboring vegetation types. They are lower in plant cover than the wetlands on either side, and are therefore readily identifiable as a “white zone” on black and white or color infrared imagery.

Salinity variation may contribute to the low productivity of white zone vegetation; soil salinities may range seasonally from brackish to hypersaline, depending on climatic conditions and tidal events. Plant communities of the white zone thus appear to be functionally equivalent to high marsh communities further north on the Atlantic Coastal Plain. Given their ecotonal position, several researchers have used historical shifts in the location and extent of the white zone as indicators of a changing balance between upstream freshwater sources on one hand and tidal saltwater on the other (Egler 1952, Teas *et al.* 1976, Ross *et al*. 2000).

c. Mangrove Wetlands

Pre-settlement mangrove forests lining the western shore of Biscayne Bay were typically narrow strips that gave way to marsh vegetation within a few hundred meters or less of the coast (Reark 1975, Teas *et al.* 1976). The width of the mangrove fringe was variable, with marsh vegetation fronting directly on the coast in places, and mangroves extending far into the interior near major concentrations of tidal creeks. Much of the original coastal wetlands adjoining the northern and central bay has been lost to urban development. There are isolated local stands of mangroves in north Biscayne Bay, but large ecologically functional stands of mangroves are limited to an area in and around the Oleta River and are now in public ownership. In central Biscayne Bay major ecologically functional stands of mangroves are located on Virginia Key and Key Biscayne. This area also contains other functional isolated freshwater coastal wetland habitat. Further south, an almost continuous fringe of mangroves is found on the western shoreline of the bay from Matheson Hammock south to Monroe County and Florida Bay.

BENTHIC HABITAT

Biscayne Bay’s principal benthic communities include seagrass (64 percent), hard bottom (17 percent), and sand and mud bottom (Markley and Milano 1985). Another important benthic community that covers a relatively small area is the coral-algal bank fringe. Seagrasses are found in all parts of the Bay where water depth and clarity allow sufficient light penetration, sediment depth is sufficient to support seagrass roots, bottom current velocities are appropriate, and past disturbances have not eliminated them. Approximately 15 percent of Biscayne Bay does not support conspicuous plant or animal life (Markley and Milano 1985).

Extensive shallow areas of exposed hard limestone substrate and sparse cover of seagrass exist along the axis of central and southern Biscayne Bay and along parts of its western edge. These areas are dominated by sea fans, sponges, and macroalgae and contain scattered hard corals. Massive low sediment banks are a major feature of the bay that separate it into semi-isolated basins, although to a lesser extent than in Florida Bay. While the bank tops are covered in large part by seagrasses, their dynamic leading edges are fringed with a mixture of coral and algae that forms the frontline against erosion.

The benthic communities of Biscayne Bay are supported by, and in turn contribute to,-the bay's natural water clarity. Seagrasses, in particular, have an important function in creating and maintaining water clarity and sediment stability, which they do by binding sediments with their roots, baffling bottom currents with their leaves and rhizomes, and taking up nutrients from the water column that would otherwise be used by phytoplankton (Onuf 1994). They not only stabilize bottom sediments, including banks, but also contribute to the structural stability of shorelines (Ginsburg and Lowenstam 1958, Wood *et al.* 1969, Fonseca 1996).

a. Seagrasses

Seagrasses create a supportive chemical and physical environment for the bay. They are important primary producers, sequestering carbon, producing oxygen, and converting the sun's energy into food and structure useful to fish, invertebrates, and wildlife (Wood *et al.* 1969). Productivity in some seagrass systems is equivalent to that of agricultural crops (0.3-16.0 gm C/m^2/day) (Zieman 1978, Thorhaug and Roessler 1975).

Many animal species are associated with seagrasses. Manatees and subadult and adult green sea turtles and many invertebrates feed directly on seagrass (Odell 1975; Bjorndahl 1980, 1982; Coyne 1994). Many other animals of the Bay are supported by seagrass-based food webs. The seagrass communities of the Bay provide food and shelter for fish, shrimp, and crabs—especially postlarval, juvenile stages—and other aquatic life. Studies in the bay and other south Florida estuaries indicate that the abundance of pink shrimp is greater in seagrass sites than on bare bottom (McLaughlin *et al.* 1983, Robblee *et al.* 1991, Sheridan 1992). Many fishery species commonly associated with reefs and found on them by day move onto seagrass beds to feed at night (Zieman 1982). Animals are more abundant in seagrass beds because they afford greater habitat complexity, food availability, increased living space, and protection from predators (Fonseca *et al.* 1992).

At least seven seagrass species occur in Biscayne Bay: turtle grass *(Thalassia testudinum*), shoal grass (*Halodule wrightii)*, manatee grass (*Syringodium filiforme)*, and three species of paddle grass (*Halophila)*, including the species federally listed as endangered, *Halophila johnsonii*. Widgeon grass (*Ruppia maritima)* has been found in the extreme south bay. Turtle grass is a major stabilizating force with persistent root systems up to 5-10 feet deep into the sediment (Ginsburg and Lowenstam 1958, Phillips 1960, Patriquin 1975). Manatee grass and shoal grass frequently are the first colonizers, rapidly growing into perturbed niches (Phillips 1960, den Hartog 1974, Humm, pers. comm.). The more slowly growing turtle grass cannot spread laterally as rapidly (Miller *et al.* 1986), but creates a dominant subsediment mass of root material as it does colonize (Patriquin 1975) and can grow vertically to keep up with increasing sediment depth (Fonseca 1996). Shoal grass usually forms the intertidal zone of a seagrass bed (Phillips 1960), however, in Biscayne Bay, manatee grass is frequently in the outer zone of a bed (den Hartog 1974). Paddle grass grows under conditions of depth and water clarity where other seagrasses may not grow. Seagrasses commonly occur in mixed-species beds.

Activities that disturb the bottom communities of the bay disrupt the balance between biological and physical forces that maintain the bay's water clarity and sediment stability. These activities include not only dredge and fill operations, which alters water depth or eliminates bottom area, and shoreline bulkheading, which increases wave forces, but also bottom disturbance and wakes of large vessels, prop scarring and scouring by recreational vessels, and bottom damage or disturbance by fishing activities. When seagrass coverage is lost, the services formerly provided by seagrass become unavailable.

Seagrasses cover large parts of the central and southern bay, but are found to a lesser extent in the northern bay, where dredge and fill activities have eliminated habitat, and resulting water depths and turbidity prevent reestablishment in many places.

b. Hardbottom habitat

The hard bottom assemblage is characterized by soft corals and small patch reefs of hard corals plus sponges and is found predominantly in Biscayne National Park in the southeast bay. These stabilize the bottom, filter the water, and add shelter and food. The most common soft corals are angular seawhip (*Pterogorgia anceps*) and the double forked plexaurella (*Plexaurella dichotoma*). The dense hardbottom community characteristically has a greater diversity of soft corals, including the purple sea plume (*Pseudopterogorgia acerosa*), slimy sea plume (*Pseudopterogorgia acerosa*), slimy sea plume (*Pseudopterogorgia americana*), and species of the genera *Eunicea*. The predominant hard coral species in the bay are finger coral (*Porites* sp.), star coral (*Solenastrea* sp.), and starlet coral (*Siderastrea* sp.). Fire coral (*Millepora* sp.) is typically present. The most common sponge species are loggerhead (*Spheciospongia vesparia*) and the basket sponge (*Ircinia campana*). Species once harvested commercially include sheepswool (*Hippiospongia lachne*), yellow (*Spongia barbara*), grass (*Spongia germinea*), and glove (*Spongia cheiris*) sponge. Biscayne Bay is one of the few bays in the U.S. in which soft and hard corals are found over large areas. Sea fans and corals are very sensitive to man's alteration of turbidity, salinity, physical abrasion by boats and nets, pollutants, severe recreational use, and changes in temperature. Once impacted, it takes years for regrowth. Fish and invertebrates inhabit the hardbottom habitat. Species associated with hardbottom habitat are primarily from Alleman*et al.* (1995) and a map by Miami-Dade County Department of Environmental Resources Management (1983).

c. Sand and mud bottom habitat

Benthic sand and mud bottom habitats occur both as natural and altered bottoms. Natural sand and mud habitats occur within the shallow Safety Valve and Featherbed Banks, as local patches within the bay, and as extensive sand zones seaward of the bay (Iversen and Beardsley 1974). Most are areas too frequently stressed by hurricane and winter storm waves and currents for seagrass or macroalgal communities to restabilize the bottom. Algal mats colonize these bottoms between erosion events, and the benthos is characterized by burrowing invertebrates.

Barren sand and mud bottoms produced by human modification dominate the deeper part of central-northern Biscayne Bay, the bottom of dredged channels and borrow areas that pervade the northern bay, and areas adjacent to canal mouths. The deeper dredged bottom areas (15-50 feet depth) characteristically receive insufficient light for colonization by seagrasses or macroalgae and have a flocculant ooze at the substrate surface that inhibits a viable macrobenthic community. Worms and a restricted suite of mollusks inhabitat this deeper soft mud bottom (McNulty *et al.* 1962a, 1962b; McNulty 1970). The natural 15-20 foot-deep central bay south of the Rickenbacker Causeway has historically lost seagrass cover, in part because of decreasing water clarity. Mainland nearshore barren areas adjacent to areas of pulsed freshwater canal discharge likely result from the combination of rapid, extreme salinity flux and possibly because of contaminant and high nutrient loads.

d. Coral-algal bank fringe habitat

The coral-algal bank-fringe community stabilizes the seaward and channel margin sand bottoms of the more exposed portions of the Safety Valve, Featherbed Bank, and the flood tidal delta in Bear Cut between Virginia Key and Key Biscayne (Voss and Voss, 1955, Wanless 1975, Wanless *et al.* 1995). This fringe community is dominated by the branching coral, *Porites divaricata*, and the calcifying branching red algae, *Neogoniolithon* sp. The skeletons are "bound" by anastomizing sponges, giving wave-resistant stability to the community. The corals, *Siderastrea radians*, *Manicina aerolata*, and *Cladocora arbuscula* are also common, as well as the calcareous algae *Halimeda* spp., *Penicillus capitatus, Utotea,* spp., and R*hipocephalus* sp. The open skeletal network provides habitat for a great variety of invertebrates, including brittle stars, mollusks, and octopi. Since 1950, this community has been lost as an effective living community in Bear Cut and the northern Safety Valve. Although they cover a relatively small area, these benthic assemblages are functionally very important because they help to stabilize the part of the bank that is most vulnerable to erosional forces.

e. Rocky intertidal

Rocky intertidal habitats occur as natural limestone shoreline adjacent to portions of central and southern Biscayne Bay, along the sea margin of most of the Upper Keys, and as human-created concrete seawalls and riprap (natural limestone boulders) shoreline. Since 1985, over 7 miles of unstable unconsolidated fill shoreline and seawalls in northern and central Biscayne Bay have been stabilized by installing natural limestone boulders to provide improved structure habitat.

f. Adjacent marine benthic habitat

The beds of seagrass located outside the barrier islands of the bay function similarly to those within the bay proper. Sand environments are common, especially off Miami Beach. The patch reefs were mapped by Marszalek (1984) and Lidz *et al.* (1997). Coral recruitment was studied by Miller *et al.* (2000), and the general ecology was reported by Voss and Voss (1955). Mobile animals, both vertebrate and invertebrate, move between the bay and nearshore habitats outside the bay.

SPECIES OF CONCERN

One hundred seventy two species occur in Biscayne Bay, its coastal wetlands, or on its barrier islands that are on some list of protected species (i.e., federal or state endangered or threatened species, state species of special concern, federal protected marine mammal, and federal essential fish habitat). Discussed below are endangered, threatened, or protected species that require special attention: the West Indian manatee, bottlenose dolphin, five sea turtle species, the crocodile, and several birds, including the Roseate Spoonbill and the White Ibis. For a more complete list, please consult Table 1, which lists plant and animals species occurring in the bay, its shoreline or adjacent upland habitat.

West Indian Manatee

The West Indian manatee occurs in Biscayne Bay and its tributaries on a year round basis. The number of animals and their distribution in the bay varies seasonally, with more than 120 individuals observed in the winter. They have been sighted during aerial surveys and tracking studies in virtually all parts of the bay system, but are most regularly and consistently found in canals and other tributaries, where they seek freshwater and shelter, and in seagrass beds, which provide a significant portion of their food. Some channels and artificial waterways also serve as travel corridors for seasonal or daily migrations and movements of individual animals.

Red tide and cold stress, the leading causes of natural mortality in manatees, generally do not occur in the Biscayne Bay area. Therefore, the majority of manatee deaths where cause can be determined are human-related. Miami-Dade County is among the five Florida counties with highest annual numbers of manatee deaths, averaging more than 10 per year in Miami-Dade County (approximately10 percent of its maximum population per year) in recent years. The leading known cause of manatee death in Biscayne Bay and associated water bodies is being crushed or entrapped in flood control gates. Vessel collision is the second leading cause. Miami-Dade County also has the highest historical levels in the state of other human-related manatee deaths, which include entrapment in drainage pipes, entanglement in fishing line or gear, and poaching (Mayo and Markley 1995, U.S. Fish and Wildlife Service 1999, Florida Fish and Wildlife Conservation Commission 1999). Miami-Dade County is one of only four counties statewide that has adopted a state-approved manatee protection plan, which contains recommendations for reducing human-related manatee mortality and maintaining or improving manatee habitat.

Bottlenose dolphins

Bottlenosed dolphins in Biscayne Bay consist of permanent residents and nearshore migrants. These are genetically distinct from an offshore population, which although the same species, is larger than the nearshore groups (Hoelzel *et al.* 1998). In a recent NOAA fisheries study, 167 distinct dolphin individuals have been identified in Biscayne Bay (J. Contillo, Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA, Miami, pers. comm.). Of these, 75 percent have been re-sighted routinely. The bottlenosed dolphin is a long-lived, resident, predator within the Biscayne Bay ecosystem. Within the bay, individual dolphins seem to have well-defined ranges, some in highly urbanized areas and others in more pristine environments.

The bottlenosed dolphin has a high metabolic rate and has been shown to consume large numbers of prey and to bioaccumulate environmental toxins in various tissues, including the subcutaneous blubber layer. In other locations, scientists have collected subcutaneous blubber to study bioaccumulation of toxicants (Long et al. 2000). Because of the report of high concentrations of toxicants in parts of Biscayne Bay and contributing waters, determining the status of the Biscayne Bay dolphin population is particularly important. Due to this need, opportunistic biopsy sampling of the Biscayne Bay resident dolphin population was begun in February 2000 by the Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA.

Sea turtles

The five documented species of sea turtles in Biscayne Bay include loggerhead, green, hawksbill, Kemp's ridley, and leatherback. The southeast coast of Florida is the largest Atlantic rookery for loggerheads and one of the four major loggerhead rookeries in the world. The Florida green turtle nesting population is significant, although so low that it is listed as "endangered." Nesting surveys are conducted on most ocean and some bay sides of many Biscayne Bay barrier islands.

Biscayne Bay sea turtle strandings from 1980 through 1999 totaled 212 animals, including 107 loggerheads, 79 greens, 12 hawksbills, and 14 turtles of unknown taxa. Of these, 36.35 percent showed evidence of boat interaction, 5.7 percent were entangled in fishing line, and 2.4 percent had tar or oil on the body or within the mouth (W. Teas, Southeast Fisheries Science Center, National Marine Fisheries Service, NOAA). In addition, green sea turtles suffer from diseases such as fibropapillomatosis, which has been observed on 40.5 percent of the stranded green sea turtles from 1980 to 1999. Fibropapillomatosis is a tumor-forming, debilitating, and transmissable disease that impedes foraging and movement. The cause of fibropapillomatosis is poorly understood and needs extensive study.

Sea turtle habitats of concern consist primarily of adequate nesting beaches and foraging habitats (National Research Council 1990). Seagrass, in particular turtle grass (*Thalassia testudinum)*, crustaceans, and other benthic invertebrates are important to various turtle species. While beach-nesting habitat needs protection, there is a less well-recognized need to protect habitats that are critical to juveniles and sub-adults to ensure population survival. In addition, effort must be made to reduce human-caused sources of mortality. Boaters, fishermen, and pollutants are the cause of many turtle deaths per year in Biscayne Bay (National Research Council 1990).

Crocodiles

Crocodiles were first discovered in Florida in Biscayne Bay. Historically, they occurred throughout the bay, although they disappeared from much of their former bay habitat in the mid-1970s as important predators. Presently, crocodiles nest at the Crocodile Lakes National Wildlife Refuge and the Florida Power and Light Turkey Point Power Plant, as well as in Florida Bay (Brandt *et al.* 1995, Kushlan and Mazzotti 1989). Juvenile crocodiles have an established need for freshwater. Laboratory experiments suggest that juvenile crocodiles may not grow to reach maturity without access to water of less than 25-ppt salinity (Dunson 1982), although field observations suggest that hatchlings have rapid growth in some highly saline areas in south Florida (Mazzotti and Dunson 1984, Mazzotti *et al.* 1986). The almost continuous fringing mangrove swamp that extends from the Coral Gables Waterway through Card and Barnes Sounds to Everglades National Park is potential crocodile nursery habitat, but the value of this area to juvenile crocodiles may have been reduced by past changes in freshwater flow to the area due to water management. Crocodiles might benefit from the redirection of canal discharges into adjacent freshwater and coastal wetlands that are presently degraded.

Birds

The Roseate Spoonbill, listed as a state species of special concern, nests in Florida Bay and Card Sound. The primary feeding area of the eastern Florida Bay and western Card Sound nesting colonies is the coastal wetlands of northeastern Florida Bay and extreme southern Biscayne Bay (Terrapin Point to Turkey Point). The long-term record of nesting suggests that the colony responds to water management practices that affect these coastal wetlands (Lorenz 1999). The spoonbills are dependent upon production of aquatic forage over broad areas during the wet season that is followed by a gradual, but relatively steady and predictable, concentration of forage in the dry season, which is their nesting season. Artificial pulses of water disperse prey and make it impossible for nesting spoonbills to capture sufficient food to feed rapidly growing young. Restoration of Biscayne Bay's extreme southern coastal wetlands and their natural pattern of wetting and drying would enhance feeding habitat for Roseate Spoonbills.

A nesting colony of White Ibis occurs in the central bay off Key Biscayne at Bear Cut (near the marina) (J. Browder, pers. comm.). White Ibis eat mainly crustaceans. Crustaceans do not osmoregulate and therefore have internal body fluids that have the same salinity as their environment. White Ibis nestlings have no mechanism for excluding salt; therefore, successful nesting depends upon access to prey from freshwater wetlands (Bildstein *et al.* 1990). The colony feeds extensively on Virginia Key and may be dependent on the interior wetlands of Virginia Key. In the past, wading birds at the Greynolds Park colony have been observed feeding in the coastal wetlands of north Biscayne Bay (J. Browder, unpubl. report).

Corals

A number of protected corals occur in Biscayne National Park, which includes Biscayne Bay and nearshore waters outside the bay (Table 1). In general, corals are fixed benthic, chiefly colonial animals sensitive to temperature extremes, incursions of freshwater, turbidity or high particle loads, and various pollutants. They stabilize the bottom sediment, filter the water, and provide habitat for many species. They are extremely sensitive to brown or red tide and plankton blooms. The corals found with the bay generally have evolved mechanisms to clean themselves and exclude sediments from occasional turbidity events. The corals in the bay also tend to be more tolerant of low salinity and wider salinity and temperature fluctuations than are reef corals. Direct physical contact by boat and humans on the corals, as well as turbidity produced by boat motors stirring the bottom, are harmful to corals.

RESTORATION AND PROTECTION OF LIVING HABITATS AND SPECIES OF CONCERN

Coastal wetland, shoreline, and seagrass beds and other benthic habitat such as coral and macroalgae are critically important to the healthy functioning of the bay ecosystem. These habitats are vital to sustainability into the future of fish and wildlife, including species of concern. Restoration of coastal freshwater sheetflow is the primary factor needed to reinvigorate coastal wetlands. Reduction in physical damage and chemical and physical factors producing turbidity are key to the reestablishment of seagrass and preservation of macroalgae and soft and hard coral. Salinity changes in terms of the amount, quality, duration, and location of salinity change may be the key to the future

Projects restoring living habitat in Biscayne Bay and its watershed consist of coral, macroalgae, seagrass, mangrove, coastal wetland, nearshore forest, and dune restoration or enhancement. Hydrologic restoration is planned for the purpose of restoring coastal wetland and estuarine habitat and associated fish and wildlife benefits. Goals for restoration include: restoring water clarity, improving circulation, improving water and sediment quality, and improving habitat for fisheries and/or species of concern. This is most successful when the underlying physical features and structural components of the systems are restored and the natural ecological processes are allowed to occur where natural adjacent communities occur. When damaged areas considered for restoration projects are isolated from natural community recruitment, some planting must be done. Active restoration has been shown to be effective for each of the major habitat types in the bay. Restoration efforts must be monitored to evaluate their effectiveness, provide quantitative information on relative effectiveness of alternative methods, and determine resultant improvements in water clarity and fish and wildlife benefits.

Science should continue to address questions about habitat restoration such as: (1) What are the opportunities to restore water clarity, reduce turbidity, and improve circulation, water and sediment quality, fisheries habitat, and habitat for species of concern? (2) How effective are present restoration efforts for various habitats important to the bay? (3) Do we have adequate restoration techniques required for recovery from catastrophic events, human or natural, that might alter large segments of benthic habitat? Some of the habitat restoration and enhancement projects that have been conducted or are underway in the Biscayne Bay area are described below, organized according to habitat type. Information about past restoration activities in the Bay is outlined according to habitat type in a series of tables (Tables 2-6) associated with these brief restoration overview sections. All tables presently have information that is either not available or could not be obtained within the time frame of this information gathering effort, but incomplete information was preferable to no information.

TERRESTRIAL RESTORATION EFFORTS

1. Upland Restoration Efforts

The largest restoration project in a Florida state park took place at Bill Baggs Cape Florida State Park at the southern end of Key Biscayne following Hurricane Andrew. This restoration effort included tropical maritime hammock, coastal strand, beach and dune, freshwater marsh and ponds, and mangrove wetlands. The Florida Department of Environmental Protection's Division of Recreation and Parks initiated the effort, developed the overall conceptual plan, and provided biological expertise and oversight for restoration activities, including removal and control of invading exotic vegetation (Bill Baggs Cape Florida State Park 1993, Schroeder 1994, Huck 1995). DERM, the American Littoral Society, and others participated substantially in the implementation of this project. Other groups, such as the Tropical Audubon Society, University of Miami Rosenstiel School of Marine and Atmospheric Science, and DERM, have been involved in monitoring its success.

Other maritime hammock restoration projects have been conducted near Biscayne Bay. DERM has created or restored over 60 acres of maritime hammock at Oleta River, Bear Cut, on islands in the bay, and in other areas (Milano 2000). Coastal tropical hammocks are seriously in need of restoration because the area covered by coastal hammock was always limited, and over a third has been lost to development (J. Maguire, pers. comm.). See Table 2 for examples of upland restoration projects.

2. South Miami-Dade Coastal Wetlands Restoration Efforts

The important functions of coastal wetlands were diminished or lost when the Everglades were diked and the coastal ridge was drained, eliminating overland flow and reducing groundwater seepage. Efforts to reestablish the open marsh communities that originally characterized the coastal freshwater wetlands will require either hydrologic restoration or topographic modification to restore more natural hydroperiods, plus the comprehensive treatment of invasive exotic plants throughout the region to restore habitat quality.

Reestablishment of freshwater flow through the Biscayne Bay coastal wetlands is critical to restoring a more natural quantity, distribution, and timing of freshwater flow to south Biscayne Bay and to restoring the bay's nursery value for estuarine-dependent fishery species. In addition, the acquisition and restoration of the Model Lands-South Dade Wetlands is critical to preserving the remnants of the coastal transverse glades, which once connected the Everglades to Biscayne Bay.

Restoration of more natural water delivery to South Biscayne Bay to improve the nursery function of the bay is the objective of the Biscayne Bay Coastal Wetland Restoration Project, which is one component of the Comprehensive Everglades Restoration Plan (CERP) (U.S. Army Corps of Engineers 1999). The project will divert a portion of canal flows into nearby coastal wetlands through a spreader swale. The Project also proposes to replace freshwater inflow that is being proposed for rerouting away from the bay. The goal is to restore sheet flow through wetlands and feed dormant tidal creeks whenever water is available for the Bay within the regional system. The Biscayne Bay Coastal Wetland process is not yet underway and requires substantial scientific guidance and information.

As presently proposed, this project covers 13,600 acres from the Deering Estate south to the Florida Power and Light Plant at Turkey Point, generally along L-31E. A major concern is that sufficient water of appropriate quality may not be available to support this system. In addition, the planning process for this component is expected to take several years, during which time land may become unavailable for restoration due to development. Immediate identification and acquisition of necessary land to support this component is critical.

3. Freshwater-Saltwater Coastal Wetlands Restoration Efforts

A great deal is known about wetland restoration (Woodhouse *et al.* 1976). Restoration projects have been carried out over the past 6 decades with a wide variety of species, many with great success. Many have occurred in Florida.

Miami-Dade County Department of Environmental Regulation (DERM) has restored and enhanced 300 acres of wetland in and adjacent to Biscayne Bay (Table 3). Included in this is the restoration of 10 acres of isolated freshwater wetlands and 75 acres of tidally-connected saltwater wetlands at Bill Baggs Cape Florida State Park in accordance with the comprehensive restoration plan developed under the leadership of the Florida Department of Environmental Regulation, Division of Recreation and Parks. Thus far, 100 percent survival of wetland species is being realized (Milano 1999a). Forty bird species have been recorded using the saltwater wetlands, including 18 shorebird species, seven egret and heron species, and four tern species. In addition, 12 bird species have been documented in the freshwater wetlands (Milano 1999a). The area attracts both least terns, an endangered species, and black-necked stilts, which now successfully nest there every year (R. Skinner, pers. comm., Florida Division of Recreation an Parks, Key Largo). At least 17 partnerships between DERM and other groups were responsible for this restoration activity.

3.1. Southeastern Glades Restoration Efforts

The C111 Project, the C111 Spreader Canal Component of CERP, and the Florida Power and Light Mitigation Bank are each designed to reestablish sheet flow in parts of the Southeastern Glades and will redistribute freshwater inflow to Biscayne Bay. EEL/SOR and the FPL Mitigation Bank both have exotic plant control components to help restore the native freshwater wetland vegetation of the Southeast Glades.

3.2. Mangrove Wetlands Restoration Efforts

Mangrove restoration techniques for the Biscayne Bay area were developed in the mid 1970s, and successful mangrove planting has been conducted since then (Table 4). Important early examples of independent planting contractors include H. J. Teas, P. B. Schroeder, J. B. Reark, and Dade Marine Institute at the following sites: Julia Tuttle Causeway, Coral Gables Canals, Cocoplum, Deering Estates, Interama, Baker's Haulover, Mariner's Bay, Villa Regina, and Crandon Island. Survival rates ranged from 0 to 100 percent.

Active restoration of mangrove wetlands and other coastal vegetation has been undertaken in Biscayne Bay by DERM in collaboration with governmental and non-governmental entities. DERM has restored or enhanced approximately 300 acres of wetlands (mangrove forest, salt marsh, and fresh/brackish water wetlands) on public lands and has also planted coastal upland communities (Milano 1999b). Mangroves planted by DERM in cooperation with other agencies (state of Florida Parks and Recreation, Florida. DEP and federal agencies) between 1980 and 2000 include Bear Cut, Cape Florida State Park, islands in the bay, Oleta River State Park, FIU Campus, Virginia Key, Quayside Island, and Dinner Key Island.

The restoration process of DERM involves archaeological examination of the sites, land recontouring, including modifying land elevations, creating flushing channels, removal of bulkheads and fill, removal of exotic vegetation, and planting native vegetation (Milano 1999b). DERM has also created wetlands as well as maritime hammock on spoil islands in the bay that were created when the Intracoastal Waterway was dredged (Milano 2000). Vegetative cover and bird life are routinely monitored at all restoration sites. A protocol for monitoring fish and macroinvertebrate use of wetland sites is presently being developed at the Cape Florida site and, when fully developed, will be expanded to other DERM wetland restoration sites (Milano 1999b).

BENTHIC RESTORATION EFFORTS

1. Living Coral and Coral Reefs Restoration Efforts

When compared to the science of mangrove or marsh restoration, which developed 50-100 years ago, the science of coral reef and single coral restoration, begun in the 1970s, is relatively recent. Coral restoration efforts have recently taken place throughout the world (Thorhaug, in press). Coral restoration after damage has been reported for the Florida Keys and Hawaii. Results at this early, partly experimental, stage of coral restoration have varied in success from 0 to 95 percent. Some successful Biscayne Bay coral projects from 1970s onward are listed in Table 5. Many useful coral restoration techniques were worked out at the Wellwood grounding site off Key Largo (Hudson 1988). Soft and hard coral restoration is an area in which more knowledge is imperative.

2. Macroalgae Restoration Efforts

The techniques used to restore macroalgae in Biscayne Bay are in their infancy, although other estuaries have shown success. Several attempts at restoring calcareous green and red algae Thorhaug and Keller 1972, Thorhaug and Garcia-Gomez 1972, Thorhaug and Voss1974, and Josselyn 1978) have been made to show that this is feasible (Table 5). In certain areas of the world, large-scale macroalgae restoration has been undertaken with significant success. (North and Gerard 1978, Doty 1989).

3. Seagrass Restoration Efforts

Past dredging and filling practices associated with development of the surrounding upland and navigation infrastructure destroyed tens of thousands of acres of seagrass and other benthic habitat. Deepening of broad areas and reduced water clarity prevented recolonization of submerged vegetation. Turbidity, caused by the resulting unconsolidated bottom sediments, did not allow normal regrowth of seagrass into disturbed areas previously occupied by seagrass, especially in deeper areas.

Lateral growth is normally a chief seagrass method of recolonization in the bay. In the areas of channels and causeways, lateral expansion of seagrass beds are blocked . This results in several basins remaining highly depauperate. Another major means of regrowth is seed dispersal. Only one of the seven seagrasses is known to produce seedlings in north bay, manatee grass *(Syringodium filiforme)*. However, scores of important previously damaged areas of large size are still without seagrasses after decades of water improvement. These areas have unstabilized bottom sediment and should be restored with seagrasses.

A series of seagrass plantings and test plots were conducted in Biscayne Bay between the mid 1970s and the mid-1980s (Thorhaug 1974, 1980, 1985, 1986, 1987, 1990, 2001). The larger plantings include Turkey Point (78 percent success), Julia Tuttle Causeway (82 percent success), Lake Surprise (95 percent success), and Margaret Pace Park (67 percent success), 24th St. NE (up to 87 percent success). The techniques for large-scale seagrass restoration were first carried out in Biscayne Bay in 1973 at the Turkey Point cooling canal site (Thorhaug 1974). The Turkey Point plantings were later monitored and found to be successful not only in terms of reestablishment of seagrass (78 percent survival) but also ecologically successful in that the benthic animal community was more diverse and abundant at the planted site than at a nearby control site (McLaughlin *et al.* 1983).

Extensive seagrass plantings in Biscayne Bay in the 1980s in connection with the Port of Miami expansion were variably successful. Monitoring of the two initial projects, including a large test plot program with experimental plantings, indicated survival ranged from 0 to 100 percent (Table 6, Gaby and Langley 1985, Thorhaug, 1985). Three subsequent phases had success rates ranging from 60-87 percent (Thorhaug 1987). Based on a report from Gaby and Langley (1985), alternative mitigation (mangrove planting) was approved for the Port.

In a demonstration project, maintenance dredge material was used by MD-DERM to fill a deep hole. The deep holes in Biscayne Bay created by dredging (Harlem 1979, Wanless *et al.* 1984) are a source of recurrent local turbidity because they trap flocculent material, which becomes resuspended with increased wave action generated by vessels or storms (Wanless *et al.* 1984). Seagrass planting has been generally more successful when restoration is conducted at sites where seagrass communities existed, but were disturbed by physical impacts that can be corrected or eliminated (Fonseca 1998). Seagrass restoration has flourished throughout the world in the 1980s and 1990s. See Table 6 for example seagrass restoration projects in Biscayne Bay.

HABITAT FOR SPECIES OF CONCERN: PROTECTION EFFORTS

1. Crocodile Habitat Protection Efforts

The United States Fish and Wildlife Service and the state of Florida have preserved habitat for the saltwater crocodile by purchase of the north Key Largo area starting at the junction of US 1 and C905 (Card Sound road) extending northward to the Miami-Dade/Monroe County Line (Broad Creek in Biscayne Bay). Florida Power & Light's Turkey Point nuclear power plant has also participated in preserving crocodile habitat in and adjacent to their cooling canals.

2. Osprey Nesting Habitat Protection Efforts

The Miami-Dade County Department of Environmental Resources Management has erected 10 osprey nesting platforms in north bay island areas. The Florida Power and Light Company has erected osprey nesting platforms in north bay island areas. The Florida Power and Light Company has erected osprey nesting platforms from U.S. Highway 1 to C-111 along the Card Sound Road. In addition, U.S. Highway 1 from Homestead south has osprey platforms.

3. Manatee Habitat Protection Efforts

The state of Florida, DERM and various marinas have participated in preparing and posting signage marking manatee habitat, and have distributed literature and other information about manatees to boaters. The Florida Department of Environmental Protection established vessel speed zones and other restricted areas to protect particularly sensitive manatee habitat. Each seagrass restoration project benefits manatees through increase and improvement in available habitat.

ACQUISITION AND PROTECTION EFFORTS

Miami-Dade County and South Florida Water Management District have purchased some major tracts of coastal wetland in South Miami-Dade County. More is slated for purchase in the CARL and Environmentally Endangered Lands (EEL) programs. These lands are still vulnerable to development until the process of acquisition is complete. Other lands will likely be identified for acquisition in the Biscayne Bay Coastal Wetlands component of the Comprehensive Everglades Restoration Plan (CERP).

RECOMMENDATIONS

1) **Delineate the distribution and quality of benthic marine, coastal wetland, coastal upland species, and species of special concern.**

(*Justification: The distribution of benthic environments must be carefully documented prior to freshwater inflow modifications to the bay margin and for comparison to changes that may occur in response to hurricanes, unanticipated pollution events and sea level rise.*)

Specific Science Recommendations

a) Evaluate existing maps and quantitative spatial data for accuracy, resolution, and expected needs and develop a protocol for the following: map and quantify coverage of benthic communities, including infauna, by species composition and density, in areas of soft-sediment seagrass cover, hard bottom, barren bottom, coastal wetlands, and coastal uplands. Especially focus on the western portions and edge of Biscayne Bay.

b) Delineate the distribution and density of endangered species and species of special concern in and marginal to Biscayne Bay and their relation the bottom habitat.

c) Compare a) and b) with previous mappings and estimates to determine change. Determine functions and processes causing benthic habitat shifts in the bay.

Specific Science-generated Management and Action Recommendations

a) Integrate current and future publicly funded monitoring activities into a coordinated monitoring and mapping program from Dumfoundling Bay through Biscayne Bay to Manatee Bay, with intensive, detailed observations in the western nearshore bay.

2) **Define the salinity and freshwater inflow parameters (timing, quantity, quality and distribution) that will permit the reestablishment of a viable estuarine ecosystem in the nearshore and coastal wetland zone of western and northern Biscayne Bay.**

(*Justification: The loss of an inshore estuarine habitat in Biscayne Bay has degraded the overall quality, diversity and functionality of the Biscayne Bay ecosystem. This degradation occurred as the result of historical lowering of water levels and converting to point source (canal) pulses of freshwater discharge. The Comprehensive Everglades Restoration Plan (CERP), which includes a Biscayne Bay Wetlands Restoration component, provides a unique opportunity to coordinate the requirements for reestablishing estuarine conditions in Biscayne Bay with the redesign and replumbing of water flow to the Everglades. It is of the highest priority to take advantage of this opportunity.*)

Specific Science Recommendations

a) Define a more natural quantity, quality, timing and distribution of freshwater flow to the wetlands marginal to western Biscayne Bay.

b) Expedite planning to determine the freshwater budget and land area needed to meet the goals of the Biscayne Bay Coastal Wetlands component of the Comprehensive Everglades Restoration Plan (CERP).

c) In designing the parameters for this restoration, attention should be given to increasing habitat for endangered species and species of concern and salinity requirements of habitat species on which they are dependent. *[Most if not all of these species are discussed in the U.S. Fish and Wildlife Service South Florida Multi-species Recovery Plan.]*

d) Restore freshwater and saltwater wetlands in association with the Biscayne Bay Coastal Wetlands Project of the Comprehensive Everglades Restoration Plan.

e) Provide baseline surveys and continued monitoring of wading bird and migratory bird use of restored coastal wetland and estuarine habitat.

Specific Science-generated Management and Action Recommendations

a) Expedite purchase plans for the remaining coastal wetland in south Miami-Dade County slated for acquisition in the CARL, EEL and other programs, and identify and acquire those additional lands needed beyond what is in current designs, including especially Bird Key *[if it is not already in an acquisition plan]*. Take appropriate steps to ensure the preservation in perpetuity of publicly owned properties, particularly Virginia Key (and especially the western shore of Virginia Key north of the marine stadium, now owned by the City of Miami).

b) Continue to remove exotic species from the intertidal and coastal wetland and upland habitats to create more area for native habitat species, especially as habitat for species of special concern, and maintain these areas to prevent reinfestation.

c) In conjunction with restoration, scientific management programs for the bay should be established for endangered species and species of special concern including turtles, manatees, dolphins, crocodiles, seagrasses, and selected birds such as the roseate spoonbill, brown pelican, turkey vulture, and various shorebirds. *[Note: DERM already has a manatee protection plan.] [Coordinate with U.S. Fish and Wildlife Service Multi-species Recovery Plan.]*

d) Restore coastal fresh to saltwater wetlands form Turkey Point to US1 in cooperation with the Florida Power and Light Mitigation Bank. Complete acquisition of land available east of US 1 from Palm Drive south and restore freshwater flows through these wetlands and into extreme southern Biscayne Bay, Card Sound, Barnes Sound and Manatee Bay.

e) Evaluate the potential effect of a change in freshwater flow to north Biscayne Bay.

f) Improve design of floodgates to reduce manatee mortalities.

3) Pursue aggressive efforts that will continue the reduction in turbidity within the waters of central and northern Biscayne Bay and will reduce physical damage to benthic communities and substrate.

(*Justification: Biscayne Bay is dominated by benthic communities that need clear water and a substrate that is not physically disturbed. Historical changes to the bay, its margins and nature of freshwater inflow have degraded the water clarity and reduced the quality and distribution of Benthic community coverage. Ongoing prop washing and scouring by boats are damaging the communities.)*

Specific Science Recommendations

a) Evaluate the impacts of turbidity on primary productivity and habitats in Biscayne Bay.

b) See section on turbidity in Geology, Sedimentology, and Sea Level portion of the Science Team report.

Specific Science-generated Management and Action Recommendations

a) Finish largely completed stabilization of public vertical seawalls with natural limestone boulders and/or planters for intertidal vegetation. Develop an incentive program to encourage private property owners to install natural limestone boulders in place of, or in front, of bulkheads.

b) Identify and implement ways to reduce or eliminate turbidity and bottom scour of benthic communities that are due to large vessel traffic.

c) Define channels for use by larger boats to enter and egress Biscayne Bay.

d) Mark channels more effectively and improve enforcement next to important species of concern feeding or resting areas and next to important shallow habitat areas such as seagrasses, hard bottom and coral-algal bank fringe communities so that turbidity and direct impact are minimized.

e) Limit turbidity laden effluents into the bay.

4) Conduct ecotoxicology studies to document and monitor stresses and damage to endangered species, species of special concern, and indicator species in benthic habitats. Use this information to guide reduction of point source pollution and cleanup of historical contaminant sources.

(*Justification: although partly urbanized it is a fundamental goal to restore and maintain Biscayne Bay as a healthy bay for all organisms who depend on it.*)

Specific Science recommendations

a) Continue toxicity monitoring of blood tissue samples of the resident dolphin population of Biscayne Bay as a health indicator of Biscayne Bay.

b) See recommendations in Water and Sediment Quality portion of the Science Team report.

Specific Science-generated Management and Action Recommendations

a) During and after proposed dredging operations in the Miami River and other channels and canals, use up-to-date technology to minimize or eliminate movements of contaminated sediment into the bay.

b) Reduce further toxic substance input form upland sources, especially during catastrophic events such as floods and hurricanes.

c) Review and update hazardous substance, petroleum, and sewage spill plans to make sure these provide adequate protection of habitat and for species of concern.

d) Critically review the risks of leachates to Biscayne Bay from present and past landfills, sewage discharge sites (land, sea and groundwater), and canals. Reconsider the siting of landfills and other waste disposal sites in proximity to the wetlands and waters of Biscayne Bay.

5) Document and compare the functionality and resilience of important benthic habitats throughout Biscayne Bay by conducting comparative turbidity, food web, and fisheries studies in habitats of varying density and species composition (within the various seagrass communities, hard bottom community, coral-algal fringe community and soft bottom barren and algal mat community).

(*Justification: The influence of density and species structure of different benthic habitats in supporting fish populations needs to be documented in order to guide and optimize restoration and protection plans. The role of various types of seagrasses in stabilizing sediment also needs to be evaluated. These studies will also serve as a baseline from which the quality of benthic community habitat can be monitored with changes management or following natural and human disasters in the bay.)*

Specific Science Recommendations

a) Document and compare the functionality and resiliency of the important benthic habitats throughout Biscayne Bay by conducting comparative turbidity, food web and fisheries studies in habitats of varying density and species composition (within the various seagrass communities, hard bottom community, coral-algal fringe community and soft bottom barren and algal mat community).

6) Review, develop, and apply scientifically and economically sound methods for restoration and maintenance of freshwater wetland, coastal wetland, coastal upland, and benthic seagrass communities.

(*Justification: Methods and approaches to ecological restoration and exotic control must be agreed upon so as to be able to effectively repair areas of damage and optimize bay restoration efforts.)*

Specific Science Recommendations

a) Hold workshops and, as necessary, conduct demonstration projects and evaluation of previous projects to assess approaches for coastal wetlands, coastal uplands, and seagrass restoration and for control of exotics in coastal and freshwater wetlands and coastal uplands.

b) Document rates and manner of natural re-establishment over disturbed bottom in different settings in different bay sectors so as to establish criteria to define when and how replanting is appropriate and necessary for maintaining healthy benthic and wetland communities in Biscayne Bay.

c) Review, develop, and apply scientifically sound, cost-effective, and reliable methods to restore seagrass cover on banks damaged by prop scars and scours and sites affected by high turbidity and persistent wave action (mostly by boats in portions of Biscayne Bay).

Specific Science-generated Management and Action Recommendations

a) Continue ongoing restoration projects at Virginia Key, Chapman Field, Snapper Creek, Bill Baggs State Recreation Area, and the Oleta River Corridor and support rehydration of Cutler Drain if feasible.

b) Ensure that restoration projects have a funded component that provides for scientific follow up and monitoring of restoration sites. Sufficient support should be provided for consistent monitoring using scientifically sound, systematic, and quantitative procedures.

c) Ensure adequate funding for continued maintenance and exotics control on coastal wetland and coastal upland restoration projects.

7) **Expand education on value of habitats, species of special concern, threats to the bay and how individuals can maintain and improve the quality of the habitats and species in Biscayne Bay.**

(*Justification: Understanding leads to support for efforts to improve the bay and leads to more respectful users of the bay.)*

a) Continue public education about the ecosystems losses that result from dumping in and polluting in the bay, damaging benthic habitats by boating activities, and not being respectful of species of concern. Provide information and warnings through dive shop and marina postings, posters, brochures and maps to inform users about habitats, species of special concern, areas to avoid or be watchful, damage caused by different types of boats, and regulations.

b) Enhance education and awareness about manatees, including posting signs in manatee feeding and congregation zones.

c) Create environmental education centers at specific bayside parks for primary, middle and secondary school children. Provide labs, full displays about habitats and species of special concern, material for teachers and exhibits, which can circulate into schools. Establish "Science Outposts" with programs and facilities for student science research, with pilots at Oleta River and Bill Baggs State Recreational Area. *[See full description in recommendations from Education Team.]*

d) Create curriculum for elementary schools that discuss habitats and species of concern.

e) Develop or support existing community service programs for cleaning up the bay and its margins.

f) Publicize and enforce laws and rules that prevent damage to the bay's resources.

g) Mark and enforce manatee-zone speed limits.

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TABLE 1 - SPECIES TABLE

Endangered and Threatened Species, Species of Special Concern, and Protected Species Found in Biscayne Bay and Adjacent Coastal Wetland and Upland Habitats

Names and status follow Florida Game and Freshwater Fish Commission 1- August- 1997 Official Lists and September 21, 2000 WWW listings. The federal lists of Endangered (E) and threatened (T) plants and animals are administered by the USFWS and are published in 50 CFR 17 (animals) and 50 CFR 23 (plants). The Florida animal lists of endangered (E), threatened (T) and species of special concern (SSC) are maintained by the Florida Game and Freshwater Fish Commission and constitute Rules 39-27.003, 39-27.004 and 39-27.005 respectively. Plant lists of endangered (E) threatened (T) and threatened by commercial exploitation (C) species are maintained by the Department of Agriculture and Consumer Services via Chapter 5B-40 FAC. Sea mammals are protected by federal law under the Marine Mammal Protection Act (MMPA) administered by the National Marine Fisheries Service (NOAA). Seagrasses, mangroves, and other species are designated as Essential Fish Habitat (EFH) by the South Atlantic Fishery Management Council, as required under the federal Magnuson-Stevens Fishery Management Act, also administered by NMFS/ NOAA. All corals occurring within the boundaries of Biscayne Bay National Park (BBNP) are protected.

Common Name	Scientific Name	Federal	State	Habitat
	Bay & Intertidal Animals			
	Mammals			
West Indian manatee Seagrass	*Triechus manatus*	E	E	Fresh to marine water,
Bottlenose dolphin	*Tursiops truncatus*	MMPA		Bay
	Reptiles			
	Crocodilians			
American alligator	*Alligator mississippiensis*		SSC	Freshwater Estuarine
American crocodile	*Crocodylus acutus*	E	E	Estuarine
	Turtles			
Atlantic loggerhead turtle	*Caretta caretta*	T	T	Marine/beach
Atlantic green turtle	*Chelonia mydas*	E	E	Marine/beach
Leatherback turtle	*Dermochelys coriacea*	E	E	Marine/beach
Atlantic hawksbill turtle	*Eretmochelys imbricata imbircata*	E	E	Marine/beach
Atlantic Ridley turtle	Lepidochelys kempi	E	E	Marine/beach

Common Name	Scientific Name	Federal	State	Habitat
Bay Birds	***Birds***			
Roseate spoonbill	*Ajaia ajaja*		SSC	Coastal marsh Mangrove
Limpkin	*Aramus guarauna*		SSC	Marshes
Little blue heron	*Egretta caerulea*		SSC	Marshes Mangroves
Reddish egret	*Egretta rufescens*		SSC	Coastal marsh
Snowy egret	*Egretta thula*		SSC	Marsh mangrove
Louisiana heron	*Egretta tricolor*		SSC	Marsh mangrove
White ibis	*Eudocimus albus*		SSC	Marshes mangroves
Arctic peregrine falcon	*Falco sparverius tundrius*		E	Migratory
Bald eagle	*Haliaeetus leucocephalus*	T	T	Forests, open water
Wood stork	*Mycteria americana*		SSC	Mangrove, open water
Brown Pelican	*Pelecanus occidentalis*		SSC	Mangrove, open water
Black skimmer	*Rynchops niger*		SSC	Open water
Least tern	*Sterna antillarum*	T	T	Beaches, open water
Bay Fish	***Fishes***			
Common snook	*Centropomus undecimalis*		SSC	Fresh to marine water
Mangrove rivulus	*Rivulus marmoratus*			Mangrove
	Bay & Intertidal Plants			
Bay seagrasses	***Seagrasses***			
Turtle grass	*Thalassia testudumun*	EFH		Bay
Cuban shoal grass	*Halodule wrightii*	EFH		Bay
Manatee grass	*Syringodium filiforme*	EFH		Bay
Johnson's paddlegrass	*Halophila johnsonii*	E	E	Bay
Engelman's paddlegrass	*Halophila engelmanii*	EFH		Bay
Paddlegrass	*Halophila decipiens*	EFH		Bay
Widgeon grass	*Ruppia maritima*	EFH		Bay
Bay mangroves	*Mangroves*			
Black mangrove	*Avicennia germinans*	EFH		Mangrove
Red mangrove	*Rizophora mangle*	EFH		Mangrove
White mangrove	*Laguncularia racemosa*	EFH		Mangrove

Common Name	Scientific Name	Federal	State	Habitat
Bay corals	***Corals***			
	Acropora cervicomis	BBNP		Offshore
	Acropora palmata	BBNP		Offshore
	Agaricia agaricites complex	BBNP		Offshore
	Agaricia fragilis	BBNP		Offshore
	Colpophyllia natans	BBNP		Offshore
	Dichocoenia stokesii	BBNP		Offshore
	Diploria clivosa	BBNP		Offshore
	Diploria labyrinthiformis	BBNP		Offshore
	Diploria strigosa	BBNP		Offshore
	Eusmilia fastigiata	BBNP		Offshore
	Favia fragum	BBNP		Offshore
	Leptoseris cucullata	BBNP		Offshore
	Madracis decactis	BBNP		Offshore
	Meandrina meandrites	BBNP		Offshore
	Millepora alcicornis	BBNP		Offshore, Bay
	Millepora complanata	BBNP		Offshore, Bay
	Montastraea cavernosa	BBNP		Offshore
	Mussa angulosa	BBNP		Offshore
	Mycetophyllia aliciae	BBNP		Offshore
	Mycetophyllia danaana	BBNP		Offshore
	Mycetophyllia ferox	BBNP		Offshore
	Oculina diffusa	BBNP		Offshore, Bay
	Porites astreoides	BBNP		Offshore, Bay
	Porites porites	BBNP		Offshore, Bay
	Scolymia lacera	BBNP		Offshore
	Siderastrea radians	BBNP		Offshore, Bay
	Siderastrea siderea	BBNP		Offshore, Bay
	Solenastrea bournoni	BBNP		Offshore, Bay
	Stephanocoenia michelinii	F	S	

Common Name	Scientific Name	Federal	State	Habitat
	Coastal Animals			
Watershed mammals	***Mammals***			
Florida Mastiff Bat	*Eumopus glaucinus floridanus*		E	coastal forest
Florida Panther	*Felis concolor coryi*	E	E	coastal forest
Key Largo woodrat	*Neotoma floridana smalli*	E	E	hammock edge
Silver rice rat	*Oryzomys argentatus*	E	E	marsh
Key Largo cotton mouse	*Peromyscus gossypinus allaparticola*	E	E	hammock
	Snakes			
Eastern indigo snake	*Drymarchon corais couperi*	T	T	pine, hammock, scrub
Atlantic saltmarsh snake	*Nerodia fasciata taeniata*	T	T	Coastal marsh
Miami black-headed snake	*Tantilla oolicta*		T	Hammock
	Turtles and tortoises			
Gopher tortoise	Gopherus polyphemus		SSC	scrub/pine
	Birds			
Cape Sable Seaside Sparrow	*Ammodramus maritimus mirabilis*	E	E	Freshwater marsh
White-crowned pigeon	*Columba leucocephala*		T	Hammock
Bachman's warbler	*Verivora bachmanii*	E	E	Migratory
Southeastern American kestrel	*Falco sparverius paulus*		T	pine rockland open
Snail kite	*Rosthamus sociabilis*	E	E	marsh. tree island
	Invertebrates			
Florida tree snail	*Liguus fasciatus*		SSC	hammock edge
Schaus' swallowtail butterfly	*Heraclides aristodemus ponceanus*	E	E	Hammock
	Coastal Plants			
Golden leather fern	*Acrostichum aureum*		E	mangrove edge
Giant leather fern	*Acrostichum danaeifollium*		C	mangrove wetlands
Brittle maidenhair fern	*Adiantum tenerum*		E	Hammock
Alvaradoa	*Alvaradoa amorphoides*		E	pine rockland
Crenulate lead plant	*Amorpha crenulata*	E	E	pine rockland
Sea lavender	*Argusia = Tournefortia gnaphalodes*		E	beach dunes
Bird's nest spleenwort	*Asplenium serratum*		E	Hammock
Slender spleenwort	*Asplenium trichomanes-dentatum*		E	Hammock

Common Name	Scientific Name	Federal	State	Habitat
Delicate spleenwort	*Asplenium verecundum*		E	Hammock
Pine pink orchid	*Bletia purpurea*		T	marshes edges
Florida brickell-bush	*Brickellia eupatotoides* v *floridana*		E	pine rockland
Locust berry	*Byrsonima lucida*		E	pine rockland
Long strap fern	*Campylocentrum phyllitidus*		E	Hammock
Wild cinnamon	*Canella winteriana*		E	Hammock
Powdery catopsis	*Catopsis berteroniana*		E	Hammock tree islands
Deltoid spurge	*Chamaesyce deltoidea deltoidea*	E	E	pine rockland
Satinleaf	*Chrysophyllum oliviforme*		E	hammock
Pitch apple	*Clusea rosea*		E	coastal strand
Silver palm	Cocothrinax argentata		E	pine rockland
Geiger tree	*Cordia sebesttena*		E	hammock
Christmas berry	*Crossopetalum illicifolium*		E	pine rockland
Rhacoma	*Crossopetalum rhacoma*		E	hammock
Florida tree fern	*Ctenitis sloanei*		E	hammock
Brown-hair comb fern	*Ctenitis submarginalis*		E	hammock
Beach star	*Cypress pedunculatus*		E	beach dune
Florida pineland crabgrass	*Digitaria pauciflora*		E	pine rockland
Dollar orchid	*Encyclia boothiana*		E	mangrove fringe
Clamshell orchid	*Encyclia cochleata*		E	hammock
Butterfly orchid	*Encyclia tampensis*		C	hammock mangrove
Night-scented orchid	*Epidendrum nocturnum*		E	hammock
Rigid epidendrum	*Epidendrum rigidum*		E	hammock
One-nerved ernodea	*Ernodea cokeri*		E	hammock
Beach creeper	*Ernodea littoralis*		T	beach dune, pinelands
Redberry stopper	*Eugenia confusa*		E	hammock
Red stopper	*Eugenia rhombea*		E	hammock
Wild coco	*Eulophia alta*		T	hammock edges
Small's milkpea	*Galactia smallii*	E	E	pine rockland
Helmet orchid	*Galeandra beyrichii*		E	pine rockland edge
Wild cotton	*Gossypium hirsutum*		E	coastal strand

Common Name	Scientific Name	Federal	State	Habitat
Lignum vitae	*Guaiacum sanctum*		E	open hammock
Sea Oats	*Uniola poaniculata*	Yes		Shorelines dunes
Sea Grapes	*Cocolobus oscifera*	Yes		Shoreline coastal shand
Manchineel	*Hippomane mancinella*		E	Coastal strand
Krug's holly	*Ilex krugiana*		E	hammock
Man-in-the ground	*Ipomoea microdactyla*		E	pine rockland
Rockland morning glory	*Ipomoea tenuissima*		E	pine rockland
Pineland clustervine	*Jaquemontia curtissii*		E	pine rockland
Beach clustervine	*Jaquemontia reclinata*	E	E	beach dune coastal strand
Joewood	*Jacquinia keyensis*		T	mangrove edge
Pineland lantana	*Lantana depressa*		E	pine rockland
South Florida flax	*Linum carteri*		E	pine rockland
Small-leaf melanthera	*Melanthera parvifolia*		E	pine rockland
Giant sword fern	*Nephrolepis biserrata*		T	hammock
Burrowing four-o-clock	*Okenia hypogaea*		E	beach dune
Hand fern	*Ophioglossum = Cheiroglossa palmatum*		E	hammock
Shell mound prickly pear cactus	*Opuntia stricta*		T	beach strand
Royal fern	*Osmunda regalis*		C	marsh/tree island
Ribbon fern	*Paltonium (Neurodium) lanceolatum*		E	hammock
Florida peperomia	*Peperomia obtusifolia*		E	hammock
Pineland poinseta	*Poinsettia pinetorum*		E	pine rockland
Small's milkwort	*Polygala smalii*	E	E	pine rockland
Pale-flowered polystachya	*Polystachya flavescens*		E	hammock
Buccaneer palm	*Pseudophoenix sargentii sargentii*		E	coastal hammock
Cretan brake fern	*Pteris bahamensis*		E	pineland/ edges
Bahama sachsia	*Sachsia polycephala = bahamensis*		E	pine rockland
Inkberry	*Scaevola plumieri*		T	coastal dune
Bay cedar	*Suriana maritima*		E	coastal strand
West Indian mahogany	*Swietenia mahogani*		E	hammock
Least halberd fern	*Tectaria fimbriata*		T	hammock

Common Name	Scientific Name	Federal	State	Habitat
Broad halberd fern	*Tectaria heracleifolia*		E	hammock
West Indian lilac	*Tetrazygia bicolor*		T	pine rockland
Abrupt-tipped maiden fern	*Thelypteris augescens*		T	hammock
Creeping star hair fern	*Thelypteris reptens*		E	hammock
Brittle thatch palm	*Thrinax morrissii*		E	hammock
Florida thatch palm	*Thrinax radiata*		E	coastal strand
Reflexed wild pine	*Tillandsia balbisiana*		T	hammock/ pine
Stiff-leafed wild pine	*Tillandsia fasciculata*		E	hammock/ pine
Twisted wild pine	*Tillandsia flexuosa*		E	coastal strand
Giant wild pine	*Tillandsia utriculata*		E	hammock/ pine
Soft-leafed wild pine	*Tillandsia* valenzuelana		T	hammock
Florida noseburn	*Tragia saxicola*		E	pine rockland
Krause's bristle fern	*Trichomanes krausii*		E	hammock
Florida bristle fern	*Trichomanes punctatum*		E	hammock
Florida gamma grass	*Tripsacum floridanum*		E	pine rockland
Young palm orchid	*Tropidia polystachya*		E	hammock
Worm-vine orchid	*Vanilla barbellata*		E	hammock mangroves
Vanilla orchid	*Vanilla planifolia*		E	hammock
Florida coontie	*Zamia pumila*		C	pine rockland
Biscayne prickly ash	*Zanthoxylum coriaceum*		E	beach strand

TABLE 2-RESTORATION EXAMPLE

Restoration of scrub, beach dune & maritime hammock in Biscayne Bay—selected examples

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
BBCFSRA 1993 Schroeder 1994 Huck 1995 BBCFSRA 2001 Draft FDRP	Cape Florida State Park, Key Biscayne, Central Bay	25 acres along seawall ~150 acres Pines Canal ~7 acres	Native tropical hardwoods Maritime Hammock *Serenoa repens* and others Coastal Strand *Pinus elliotti* var. dens[a] Pineland	Estimated high Unmeasured but not as high	Migratory Passerine Birds & hawks, local birds	$5,940,000 USACE-56%, USFS-27%, USSBA-9%, Florida Legislature-8%
Comments:	Initial cleanup and chipping of exotic vegetation felled by Hurricane Andrew ($3,360,000); Aerial survey and removal of standing exotics: ($32,200); Upland plant material and installation: ($2,403,800); Watering infrastructure and nursery infrastructure ($144,200). Cost relates to upland only and not to wetland or mangrove restoration.					
Milano 2000: DERM	Spoil Islands North Bay and Central Bay. Totals refer to 18 islands, referred to by name and number, that total 71 acres	32.3 acres 20 acres 1.8 mile	Native tropical hardwoods Maritime Hammock Coastal Strand Dune			$3,680,000 Primarily FIND-43% and BBEETF-44%, MD-Seaport-7% FDEP-4%, SFWMD-1%
Comments:	Cost also includes mangrove restoration and enhancement (see Table 4), selective clearing of exotics on 59.3 acres, 3 linear miles of shoreline stabilization with limerock boulders (with mangrove in some cases), and erection of osprey platforms.					

FDRP=Florida Department of Environmetal Protection, Florida Division of Recreation and Parks;
BBCFSRA=Bill Baggs Cape Florida State Recreation Area;
MD-DERM=Miami-Dade County Environmental Resources Management;
USACE=U.S. Army Corps of Engineers;
USFS=U.S. Department of Agriculture, U.S. Forest Service;
USSBA=U.S. Small Business Administration;
FIND=Florida Inland Navigation District;
BBEETF=Miami-Dade County Biscayne Bay Environmental Enhancement Trust Fund;
*High: >66%, Medium: <33%<66%, Low: <33%

TABLE 2B

Creation of habitat and shoreline stabilization on spoil islands in Biscayne Bay, by Miami-Dade County

Department of Environmental Resources Management—selected examples (Milano 2000).

ID	Name	Size Acres	Dune, lin. ft.	Coastal strand acres	Maritime hammock acres	Mangrove planted units	Mangrove planted acres	Mangrove enhancement acres	Shoreline stabilization lin. ft	Exotics cleared acres	Cost	Funding agency
1	Teachers Island	3.7	960	3					350	3	140,000	FIND-50% BBEETF-50%
2	Morningside Island	4	800	2.5					500	4	290,000	FIND-50% BBEETF-50%
3	Osprey Island	5	900	2.5		500	0.2	0.5	1000	2.8	210,000	FIND-50% BBEETF-50%
4	Mangrove Islands	2.8						2.8			5,000	FIND-50% BBEETF-50%
5	Frigate Island	0.5						0.5			1,000	FIND-50% BBEETF-50%
6	Legion Island	7		1	4	500	0.2	2	500	5	150,000	FIND-50% BBEETF-50%
8	Pelican Island	5	147	0.5	4			4	1180	5	300,000	FIND-50% BBEETF-50%
9	Sandpiper	2	1000	1.5					2000	2	150,000	FIND-50% BBEETF-50%
10	Tern	2	1000	1.5					2000	2	150,000	FIND-50% BBEETF-50%
11	Quayside Island	5	350	0.5	4	300	0.34		2000	5	590,000	FIND-40% BBEETF-41% FDEP-19%
12	Helkers	4	472	0.2	3.8	1000	0.27	0.5	866	4	300,000	FIND-50% BBEETF-50%
13	Crescent a & b	2	590	0.35			0.5		1000	2	200,000	FIND-40% BBEETF-40% FDEP-20%
14	Little Sandspur	1.5	216	1				0.5	610	1	170,000	FIND-50% BBEETF50%
15	Sandspur	15	1200	3.8	10		2.47		915	15	531,000	FIND-44% BBEETF-48% SFWMD-8%
16	Flagler Monument Island	4.5	740	1	3	500	0.2		885	4.5	220,000	FIND-50% BBEETF50%
17	Dinner Key Island	7		0.5	3.5		2		2000	4	275,000	Miami-Dade Seaport-100%
	Totals	71	9575	19.85	32.3	2800	6.18	10.8	15806	59.3	3,682,000	

TABLE 3-RESTORATION EXAMPLE

Wetland restoration in Biscayne Bay—selected examples

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Milano 1999b MD-DERM	Bear Cut Central Bay	5 acres	Salt marsh and limited isolated freshwater wetlands			MD-WASA-95%; BBEETF-5%
Comments:	Part of restoration listed under mangrove (Table 4) for $800,000 Milano 1999b MD-DERM, FDRP					
Milano 1999b MD-DERM, FDRP	Bill Baggs Cape Florid a State Park Central Bay	48,500 units[a] 10 acres	Isolated freshwater wetlands	High	40 species of birds	BBEETF-37%; USFS-34% FIND-12% SFWMD-11%; MD-WASA-10%;
Comments:	Part of the $2,800,000 in Bill Baggs Park (see Table 4).					

FDRP=Florida Department of Environmental Protection, Florida Division of Recreation and Parks;
MD-WASA= Miami-Dade County Water and Sewer Authority;
BBEETF=Miami-Dade County Biscayne Bay Environmental Enhancement Trust Fund;
FIND=Florida Inland Navigation District;
USFS=U.S. Department of Agriculture, U.S. Forestry Service;
High: >66%, Medium: <33%<66%, Low: <33%

TABLE 4-RESTORATION EXAMPLES

Mangrove restoration in Biscayne Bay and surroundings—selected examples

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Milano 1999b MD-DERM	Bear Cut, N. Key Biscayne, Central Bay	Red: ~31,700 units Black: ~130,250 units White: ~10,562 units 10 acres with additional 3-acre tidal pond	*Rhizophora mangle Avicennia germinans Laguncularia racemosa (Red, black, and white mangrove)*	High		$800,000, MD-WASA- 95%, BBEETF-5%
Comments:	Includes also 5 acres of salt and freshwater wetlands (see Table 3)					
Milano 1999a Milano 1999b FDRP, MD-DERM, UM, FAU	Bill Baggs Cape Florida State Park, Key Biscayne Central Bay	~300,000 units, 75 acres	*R. mangle*	High	40 bird species 1endangered crocodile	$2,800,000, BBEETF-37%, FIND-12%, SFWMD-11%, MD-WASA-10%, USFS-34%
Comments:						
Milano 1999b MD-DERM, FDRP	Oleta River State Park, North Bay	~150,000 units, 41.5 acres	*R. mangle*	TBA		$300,000 (13 acres), Miami-Dade Seaport; $1,700,000 (28.5 acres), TBA
Comments:	Cost includes excavation of dredged fill, removal of solid waste, creation of intertidal creek network, exotic vegetation removal.					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Milano 1999b MD-DERM	FIU Biscayne Bay Campus, North Bay	~10,000 units, 2 acres	*R. mangle*	High		$140,000 Miami-Dade Co Public Works Dept.
Comments:	Cost includes exotics removal, transplanting desirable native species, excavation and removal of dredged spoil, and creation of tidal flushing channels.					
Milano 1999b MD-DERM	Chicken Key South Bay	~20,000 units, 4 acres	*R. mangle*	High		$600,000 FDEP-34%, SFWD-24%, BBEETF-42%
Comments:	Cost includes 4 acres of exotics removed, dredge fill excavated, and 1200 ft of dune restoration.					
Milano 1999b MD-DERM	(MD#2) North Bay	Natural recruitment To create 0.2 acres of mangrove	*A. germinans*			$290,000, FIND-50%, BBEETF-50%
Comments:	Area created and naturally recruited, also dune community (see Table 2)					
Milano 2000 MD-DERM	Helkers Island (MD#12) North Bay	Red: ~655 units Black: ~220 units 0.27 acre	*R. mangle*	High		$300,000 FIND-50% BBEETF-50%
Comments:	Shoreline stabilization using mangroves; also cleared 4 acres of exotics, restored maritime hammock and coastal strand, and enhanced natural mangrove recruitment.					
Milano 2000 MD-DERM	Crescent Islands (MD#13) North Bay	~2000a units, 0.5 acre	*R. mangle*	High		$200,000, FIND-50% BBEETF-50%
Comments:	Shoreline stabilization using mangroves and limerock boulders. Cleared 2 acres of exotics and created 1 acre of dune and coastal strand					
Milano 1999b MD-DERM	Virginia Key Central Bay	~20,000 units, 4 acres	*R. mangle*	High		$180,000, City of Miami-33%, BBEETF-33%, FDEP-33%
Comments:	Includes 2 acres of dune creation, exotics removal, and excavation of fill.					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Milano 2000 MD-DERM	Little Sandspur island (MD#14) North Bay	Natural recruitment, 1 acre	*Natural recruitment*			$170,000
Comments:	Cleared exotics, created dune					
Milano 2000 MD-DERM	Sandspur Island (MD#15) North Bay	~12,500 units, 2.5 acres	*R. mangle*	High		$531,000, BBEETF-48%, FIND-44%, SFWMD-8%
Comments:	Shoreline stabilization with mangrove and boulders. Includes dune and maritime hammock creation.					
Milano 1999b MD-DERM	Quayside Island (MD#11) North Bay	~300 units, 0.34 acre	*R. mangle*	High		$590,000, FIND-40%, BBEETF-41%, FDEP-19%
Comments:	Cleared 8 acres of exotics, created dune, maritime hammock, and coastal strand.					
Milano 1999b MD-DERM	Dinner Key Island Central Bay	Red: ~3,450 units, Black: ~400 units 2 acre	*R. mangle* *A. germinans*	High		$275,000, Miami-Dade Co. Seaport
Comments:	Shoreline stabilization with mangrove and limerock boulders. Cleared 4 acre of exotics, created 4 acres of coastal strand and maritime hammock.					
MD-DERM et al. 1997	Tract C North Bay	~10,000 units, 1.9 acres	*R. mangle*			$100,000, FCT
Comments:	Excavation of fill and removal of 2 acres of exotics. Also salt marsh.					
Teas 1977 FDNR/Private	Julia Tuttle North Bay	320 units	*R. mangle* *A. geminans* *L. racimosa*	10% at 10 mo. 0% at 24 mo.	None	
Comments:	High winds brought debris.					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Teas 1977 FDNR/Private	Coral Gables Waterway Central Bay	57 units 13 units 18 units	*R. mangle* *A. germinans* *L. racimosa*	100% at 6 mo.		Private Developer
Comments:	Low energy					
Schroeder 1979 FDNR/ Private	Cocoplum Central Bay	3,300 units		High to moderate		Private developer
Teas 1990 USACE	Deering Estates South Bay	2,000 units	*R. mangle*	High		Private developer
Comments:	Hurricane Andrew did not destroy.					
Dade Marine Institute	No Name Harbor, Cape Florida State Park , C. Bay	1,385 units	*R. mangle*	11%		
Teas (1) FDNR/Private	S. Cutler Bay South Bay Sunny Isles North Bay	1,000 units 300 units	*R. mangle* *A. germinans* *L. racimosa* *R. mangle*	20% 0-50%		Private developer/
Comments:	Natural recolonization occurred. Planters, peat					
Teas (1) FDNR/Private	Baker's Haulover North Bay	1,300 units	*R. mangle* *A. germinans* *L. racimosa*	15% 15% 10%		
Comments:	Seeds and propagules					
Teas (1) FDNR/Private	Mariner's Bay	300 units		2%		
Comments:	Natural recruitment 34 red, 17 black, 33 white					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Teas (1) USACE	Villa Regina Central Bay	300 units	*R. mangle*	0%		
Comments:	2 yr					
Teas (1) USACE	Crandon Island, C. Bay	1,600 units	*R. mangle*	Oct 20% 30% after 3 yr.	Yes	
Comments:	Hurricane David struck. Natural recruitment					

FDRP=Florida Department.of Environmental Protection, Florida Division of Recreation and Parks;
USACE=U.S. Department of Defense, U.S. Army Corps of Engineers;
MD-DERM=Miami-Dade County Environmental Resources Management ;
UM=Univ. of Miami; FIU=Florida International University ;
FAU Florida Atlantic University ;
FIND=Florida Inland Navigation District;
FDNR Florida Department of Natural Resources (now FDEP, Florida Dept of Environ-mental Protection);
BBEETF=Miami-Dade County Biscayne Bay Environmental Enhancement Trust Fund;
FCT=Florida Community Trust; High: MD# are Miami-Dade number designations for spoil islands with created native communities (see Table 2 for summary of upland communities);
High >66%, Medium: <33%<66%, Low: <33%.
(1) In Alleman (1983).

TABLE 5-RESTORATION EXAMPLES

Coral & macroalgae restoration in Biscayne Bay & nearby areas—selected examples

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Hudson et al. 1989 USGS	Florida Keys National Marine Sanctuary off Ocean Reef	23 domes	11 hard and 6 soft corals: Coral	High	Many fish & invertebrates	~$200,000 USGS
Comments:	Hurricane Andrew passed directly over. No mortality. Cost estimated in 2001 dollars and included value of donated labor					
Hudson 1996 FDRP	Bill Baggs Cape Florida State Recreation Area, Central Bay	Hard coral:272 units Soft coral: 135 units	10 hard coral species 6 species of soft corals Coral	Hard: 89.7% Soft: 82.2% After 6 mo.	Fish, invertebrates	$16,500 FDRP
Comments:	Transplanted from vertical seawall to rocks in riprap. Also 55 sponges growing on loose rocks were rescued from construction and relocated at the base of the new riprap. Cost includes monitoring at 6 months.					
Hudson & Goodwin 1997 FKNMS-NOAA	Florida Keys National Marine Sanctuary off Ocean Reef	20 transplants	Dendrogyra cylindrus Coral	96%	Fish, invertebrates	
Comments:	After Hurricane Andrew, reestablished the coral. Included stainless steel pins to measure coral growth rates.					
Thorhaug 1965 Univ. of Miami	Biscayne Bay (Safety Valve) & Key Largo Central & South Bay	1,000' s	Penicillus capitatus, Rhipocephalus phoenix, Halimeda tuna, H.opuntia & discoidea	High	Fish & invertebrates	$1,000: Univ. of Miami
Comments:	Test plots after Hurricane and after					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Thorhaug & Keller 1972, Thorhaug & Garcia-Gomez 1972,Thorhaug & Voss 1975	South Bay	100's	Laurencia poitei L. obtusa Macroalgal	High	Invertebrates, especially shrimp	$3,000 Sea Grant
Comments:	Test of apparatus and methods and growth tests.					
Josselyn 1978 Univ. of Miami	South Bay	1,000's	*Laurencia poitei Macroalgal*	High	Invertebrates, especially shrimp	$ 3,000 Univ. of Miami
Comments:	Large scale cultivation					

USGS=U.S. Department of Interior, U.S. Geological Survey;
FDRP=Florida Department of Environmental Protection Division of Recreation and Parks;
FKNMS=U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Florida Keys National Marine Sanctuary.
High: >66%, Medium: <33%<66%, Low: <33%

TABLE 6-RESTORATION EXAMPLES

Seagrass restoration in Biscayne Bay & surroundings—selected examples

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Thorhaug 1974 USDOE /SG-NOAA	Turkey Point South Bay	20,000 in 2 barren areas	*Thalassia* Seagrass	78%	Fish, invertebrates, birds	$35,000
Comments:	Regrowth in 3 year.controls 12 yr. from 0 vegetation.					
Thorhaug 1980 FDEP	Margaret Pace Park North Bay	1,500 7,000	*Halodule Thalassia* Seagrass	High	Fish & invertebrates Manatee ,birds	$10,000: Port of Miami
Comments:	Spread into deeper water & along shoreline					
Thorhaug 1978, 1980 FDEP	Julia Tuttle North Bay	20,000 in 3 acres	*Halodule Thalassia* Seagrass *Thalassia*-enhanced	High High	Fish & invertebrates, birds, manatees	$10,000: MD-WASA
Comments:	Excellent Thal. growth , 0 orig. Good growth Hal.					
Thorhaug 1983 FDEP, USACE	Lake Surprise Card/Barnes Sound South Bay		*Halodule* Seagrass	96%	Fish, invertebrates, birds	Private road contractor
Comments:	Fast growth, high lateral growth, (2nd planter at edges) at excess damaged area.					
Thorhaug & Hixon 1975 SG-NOAA	Dredge Islands North and Central Bay	1,200 in a series of test plots	*Halodule Thalassia*	Varied by islands 15-55%, experimental	Not studied	$10,000: Sea Grant
Comments:	Varying with amt., energy & turbidity					
Thorhaug 1987 USACE, FDEP	24 – 28 ST NE North Bay	20 acres : Syr. Est. 12,000 Hal. 200,500 Thal. 73,500	*Syringodium Halodule Thalassia*	Syr. 66% Hal. 60% Thal. 87%	Fish & invertebrates, manatees heavily fed	$76,800 : Port of Miami 80%& Rickenbacker Authority20%
Comments:	Large site near former sewage outfall. Grew very long blades. Turbid, current					

Reference/ Institution	Location	Number of units planted/ Size of area restored	Species/ Type of Habitat	Survival of planted units	Wildlife benefits	Cost/ Funding Source
Thorhaug 1985 USACE, FDEP	13 Test Plots North and Central Bay	10.38acres 50,000 units	*Syringodium Halodule Thalassia*	Various. Experimental	Fish, invetebrates, manatees, porpoises, birds.	$62,280: Port of Miami
Comments:	2 techniques per species, through- out North Bay 13 sites; success dependent on species,technique, depth,turbidity,etc.					
Thorhaug 1987 USACE, FDEP	Deering Channel Central Bay	31,680 sprigs (S & H) & 21,120 Thal. Seeds in 2.7 acres	*Syringodium Halodule Thalassia*	H & S very Low, Thal. mod., Experimental	Fish	$12,500 Port of Miami
Comments:	Winter planting tests. Never done before anywhere in world .Nothing except Thal. seeds Survived in winter(Dec/Jan).					
Thorhaug 1987 USACE, FDEP	Mercy Hospital Central Bay	275,666 Hal.& 160,250 Thal. In 20 acres	*Halodule Thalassia*	68%	Fish invertebrates, manatees.birds	$169,750: Port of Miami
	Gale force winter storm 1/83 6 mo after planting reduced 68% to low %(35-16%)					
Gaby & Langley 1985 USACE, FDEP	Grove Isle Central Bay	acres	Thalassia, (80%) and Syringodium. (20%) plugs	Experimental	**Fish , invertebrates.**	Port of Miami
Comments:	Planting material from Key Biscayne beach fill area					

SG-NOAA=U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Sea Grant;
USACE=U.S. Army Corps of Engineers;
USDOE=U.S. Department of Energy;
FDEP=Florida Department of Environmental Protection;
MD-WASA=Miami-Dade County Water and Sewer Authority;
High: >66%, Medium: <33%<66%, Low: <33%

WATER AND SEDIMENT QUALITY

Chair:

Lee Hefty

Author:

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BACKGROUND

Biscayne Bay water quality has been the subject of monitoring and study for many decades. A network of surface water monitoring stations within the Bay was established by the Miami-Dade Department of Environmental Resources Management in the late 1970's, with support from the State of Florida. The network was expanded to include the Miami River and other canals and tributaries in the mid-1980's in connection with the Biscayne Bay Surface Water Improvement and Management Program. The database established through this ongoing program is shared with public and private sector organizations and includes approximately one-half million observations. Additional monitoring conducted by Florida International University focuses on nutrient parameters and links to other south Florida monitoring databases. The US Geological Survey (U.S.G.S.) has also monitored canals and groundwater in the Biscayne Bay watershed. Miami-Dade DERM conducts groundwater monitoring and stormwater monitoring in connection with selected regulatory activities. Sediment chemistry studies have been conducted by local, state, and federal agencies over the past 20 years.

Biscayne Bay's water quality has improved substantially in the past 30 years, and water quality generally meets or exceeds federal, state, and local standards for recreational uses and propagation of fish and wildlife. In recognition of its exceptional values, the State of Florida has designated the Bay and its natural tributaries as Outstanding Florida Waters, and as such they receive the highest level of protection from degradation. However, some portions of the bay have been significantly affected by past development and water management practices. Loss of wetland and seagrass communities has contributed to changes in physical and ecological water quality characteristics. Also, the Bay still receives dissolved nutrients, trace metals, organic chemicals, and particulates via stormwater runoff, canal discharge, and discharges from industrial facilities or vessels. Canal water typically has lower dissolved oxygen and clarity and higher concentrations of contaminants than receiving waters of the Bay, and so represents a source of degradation. The Biscayne Bay SWIM Plan provides a detailed analysis of water quality patterns and trends and includes numerous recommendations for protecting and enhancing the Bay (Alleman, et al 1995). The following brief review focuses on selected water quality issues.

WATER CLARITY

Because Biscayne Bay productivity is dominated by seagrass and benthic algae, which depend on light reaching the bay bottom, water clarity or transparency is of critical significance. Biscayne Bay is characterized by low turbidity levels, typically less than 2 NTUs, although wind-driven resuspension of bottom sediments can occur following storm events. In most areas of Biscayne Bay, water clarity is adequate to sustain growth of benthic vegetation. However, there are some areas where turbidity and transparency are a concern particularly in regions of the bay north of Coconut Grove/Key Biscayne.

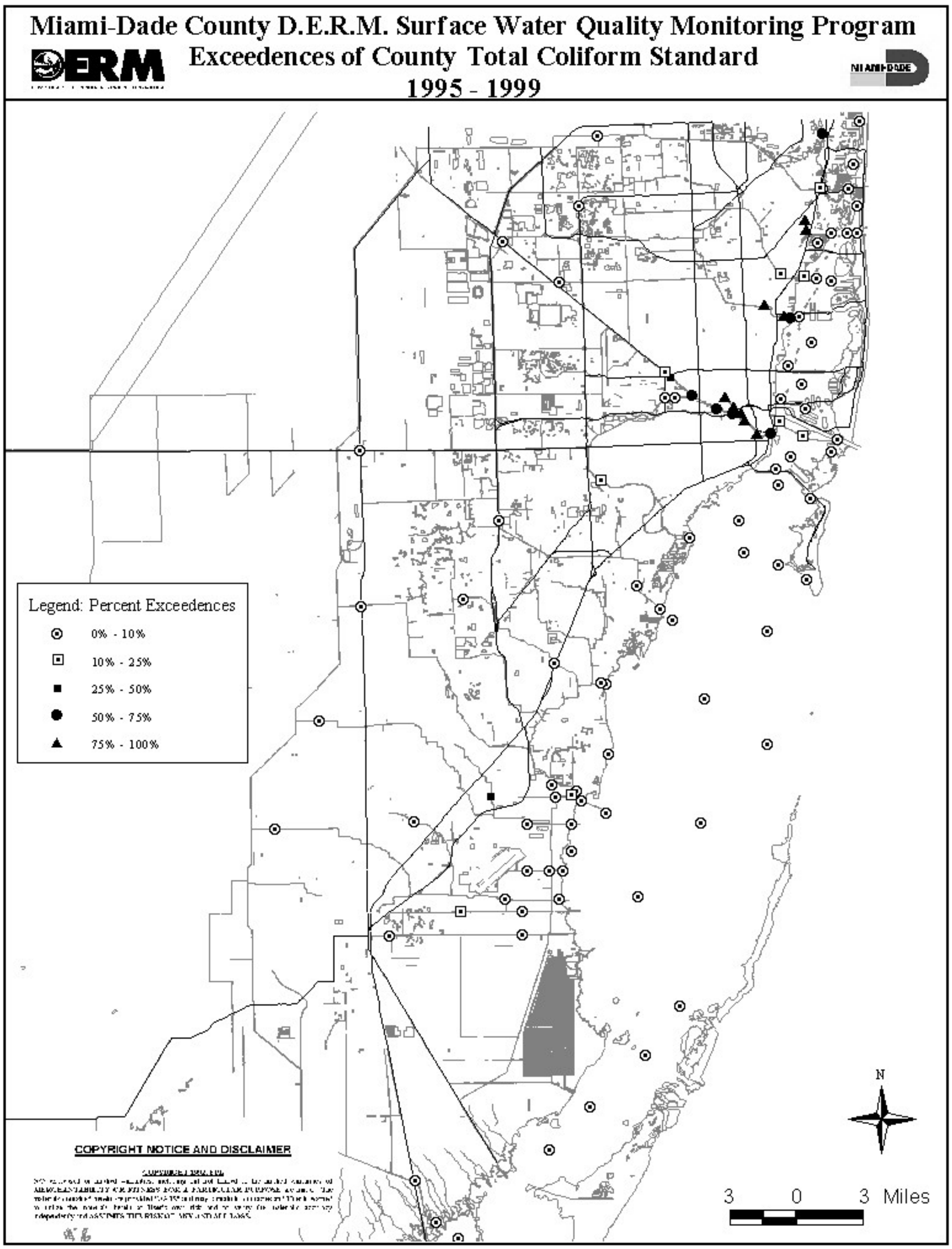
The Bay bottom and shorelines north of Coconut Grove/Key Biscayne were altered by dredging, primarily to provide fill for development of surrounding lands and for navigation channels in the 1920's and 1930's. Dredging of the Bay bottom eliminated seagrass and increased depths in portions of north Biscayne Bay, making it impossible for benthic vegetation to recover. Loss of stabilizing vegetation and continuing resuspension and erosion of unconsolidated sediment are the principal cause of chronic turbidity in some areas of north Biscayne Bay (Wanless, et al., 1984). Seawalls, which replaced some natural shorelines in north Biscayne Bay and reflect wave energy, also contribute to resuspension of bottom sediments. Although dredging and filling are strictly regulated, localized turbidity impacts sometimes occur in connection with dredging, coastal construction, or vessel traffic. Nutrient enrichment, particularly near canal mouths and in Dumfoundling Bay, can lead to intermittent declines in water transparency as a result of phytoplankton blooms. Tannin-colored water associated with canal discharges also reduces light penetration.

SEWAGE AND SANITARY QUALITY

Direct discharge of sewage effluent to Biscayne Bay was largely eliminated in the mid-1950's when regional sewage treatment plants were constructed, and consequently sanitary quality of the water improved dramatically (McNulty, 1970). However, indirect sewage contamination from improper or illegal discharges to storm sewers or groundwater remain problematic in some tributaries (DERM, 1993; Alleman et al. 1995). Use of appropriate indicators of sewage pollution for marine waters is the subject of ongoing scientific interest. Coliform and enterococcus bacteria are common in human waste and easy to culture in the laboratory. However, they may also be associated with other sources, such as soils and other animal waste, and are attenuated to varying degrees after exposure to saltwater. Despite these shortcomings, there has not been adequate epidemiological research to relate the occurrence and persistence of indicator organisms in tropical marine waters to the incidence of swimming-related human illness or to identify a superior indicator. Therefore, current state and local water quality criteria are based upon coliform or fecal coliform bacteria concentrations. See **figure 1**.

Based on these parameters, open water areas of the Bay rarely have exceeded standards for recreational contact over more than 20 years. In contrast, the Miami River and its tributaries chronically exceed standards, and occasionally exhibit coliform bacteria concentrations that exceed standards by several orders of magnitude (Markley, et al., 1990; DERM, 1993). With the exception of the Wagner Creek area, coliform bacteria concentrations in the Miami River have improved over the last five years, although they

Figure 1

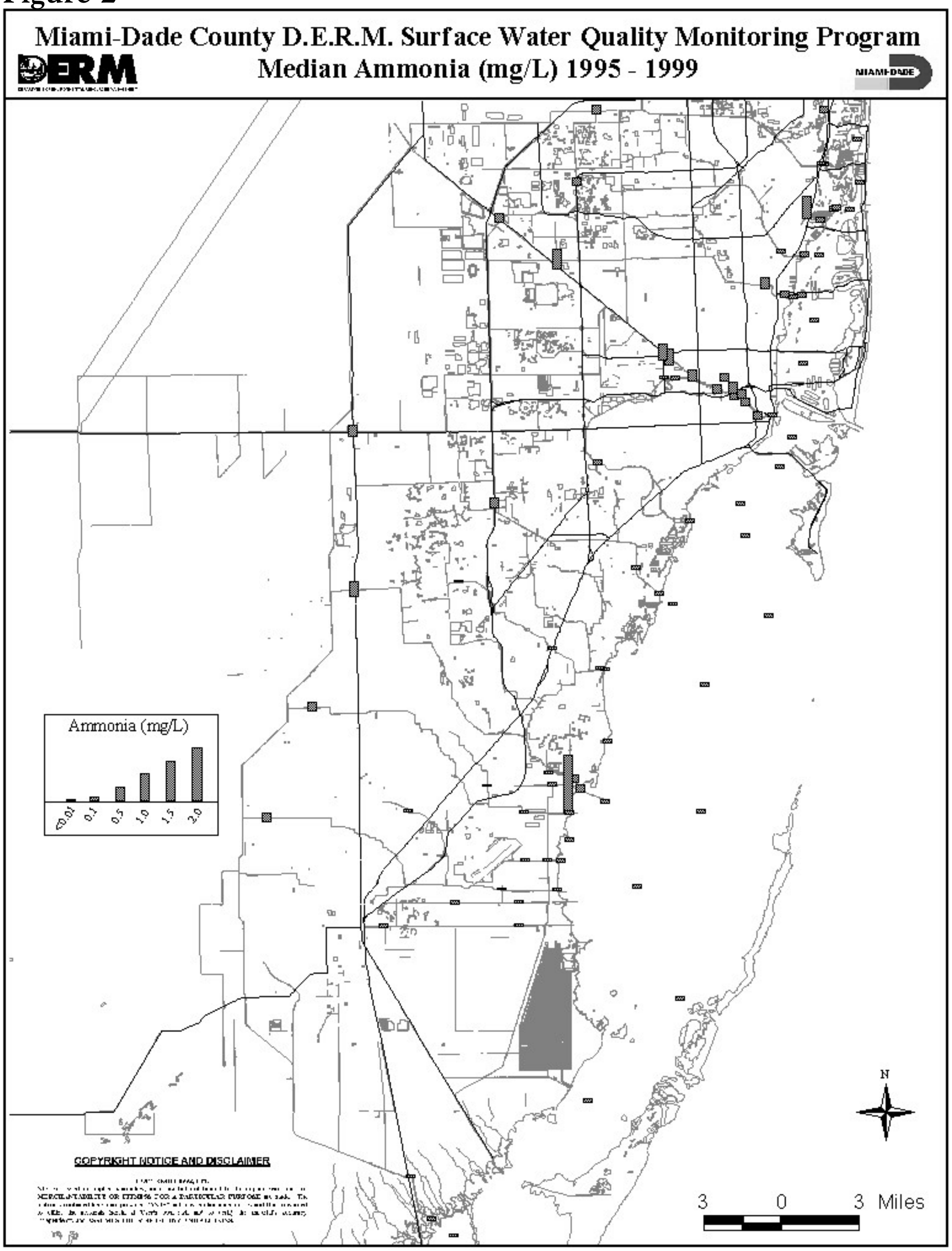


generally still exceed standards. Other highly urban canals, including the upper Oleta River, Arch Creek, and Little River also exhibit frequent incidence of sewage contamination. During tropical storms, flooding, or damage to sewer infrastructure, contaminated canal water periodically affects adjoining portions of the Bay. In view of the possibility that coliform data may not adequately characterize sewage contamination in saltwater comparative sanitary surveys, using other bacterial, viral, and chemical indicators of sewage pollution have been conducted in the Biscayne Bay area (Pierce and Brown, 1986; McQuorcodale, 1987). These studies generally confirmed the geographic patterns of contamination, showing evidence of sewage in the Miami River, urban tributaries, and poorly flushed nearshore areas. In 1999, the Florida Department of Health added routine sampling for Enterococcus to its beach monitoring program. In 2000, the Florida Legislature provided additional funding statewide for FDOH to continue monitoring this indicator.

NUTRIENTS

In general, water clarity in the Bay is high and inorganic nutrient concentrations are low. Since concentrations of nutrients in the bay are low, Biscayne Bay is vulnerable to nutrient loading. Brand (1988) determined that phosphorus is the limiting nutrient for phytoplankton growth in the bay. Excess nutrients can stimulate the growth of phytoplankton and epiphyte populations that can prevent sufficient light penetration to sustain the vital benthic communities. High levels of ammonia can be toxic to invertebrates and fish. The SWIM Plan describes several significant water quality trends for Biscayne Bay. It concludes that increases in ammonia and nutrient concentrations accounted for most negative water quality trends. Sources of ammonia and nutrients can include stormwater runoff, sewage contami-

Figure 2

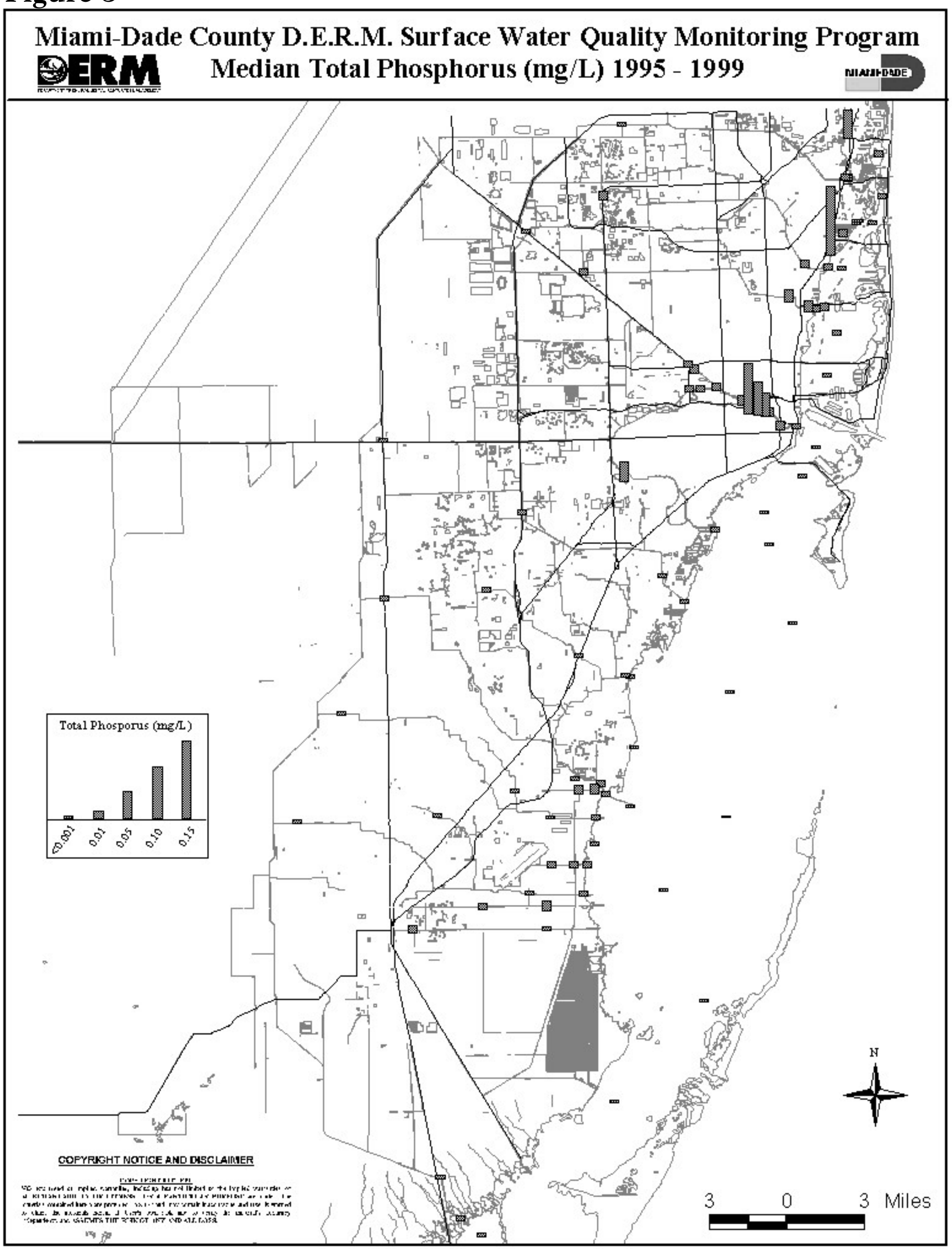


nation, leachate from landfills, fertilizers, and natural decay of plant material. These sources of contaminants can reach the Bay via surface water discharges from canals, direct upland runoff, or through groundwater pathways.

Rules governing protection of the water resources of Biscayne Bay contain a narrative standard that protects the Bay from degradation of water quality and the loss of its designated uses. However, there are presently no numerical water quality standards for nutrient levels in Biscayne Bay. A multi-agency review team was convened as part of efforts to define numerical targets or performance measures to ensure that water quality in Biscayne Bay, particularly Biscayne National Park, is not degraded by changes in water management practices or by development in the watershed. The group evaluated existing water quality data and identified nutrient concentrations in open areas of south Biscayne Bay. They concluded that in order to prevent degradation of water quality in Biscayne Bay, the following nutrient concentrations should not be exceeded: total ammonia, 0.02-0.05 mg/L (20 – 50 ppb) (dependent on sampling method); nitrate-nitrite, 0.01 mg/L (10 ppb); and total phosphorus, 0.005 mg/L (5 ppb). Although water quality performance measures have not been formally adopted for Biscayne Bay, the review team's determinations serve as valuable guidelines. While nutrient concentrations in the bay are low, levels observed in freshwater canals discharging to the bay are higher. More work is needed to define acceptable nutrient concentrations for a near shore estuarine mixing zone.

An evaluation of data from the Miami-Dade DERM Biscayne Bay Surface Water Quality Monitoring Program supports the conclusion of a land use based watershed effect on nutrient levels. **Figures 2,3, and 4** represent the median ammonia, phosphorus, and nitrate/nitrite levels for the five year period ending December 1999. Higher

Figure 3



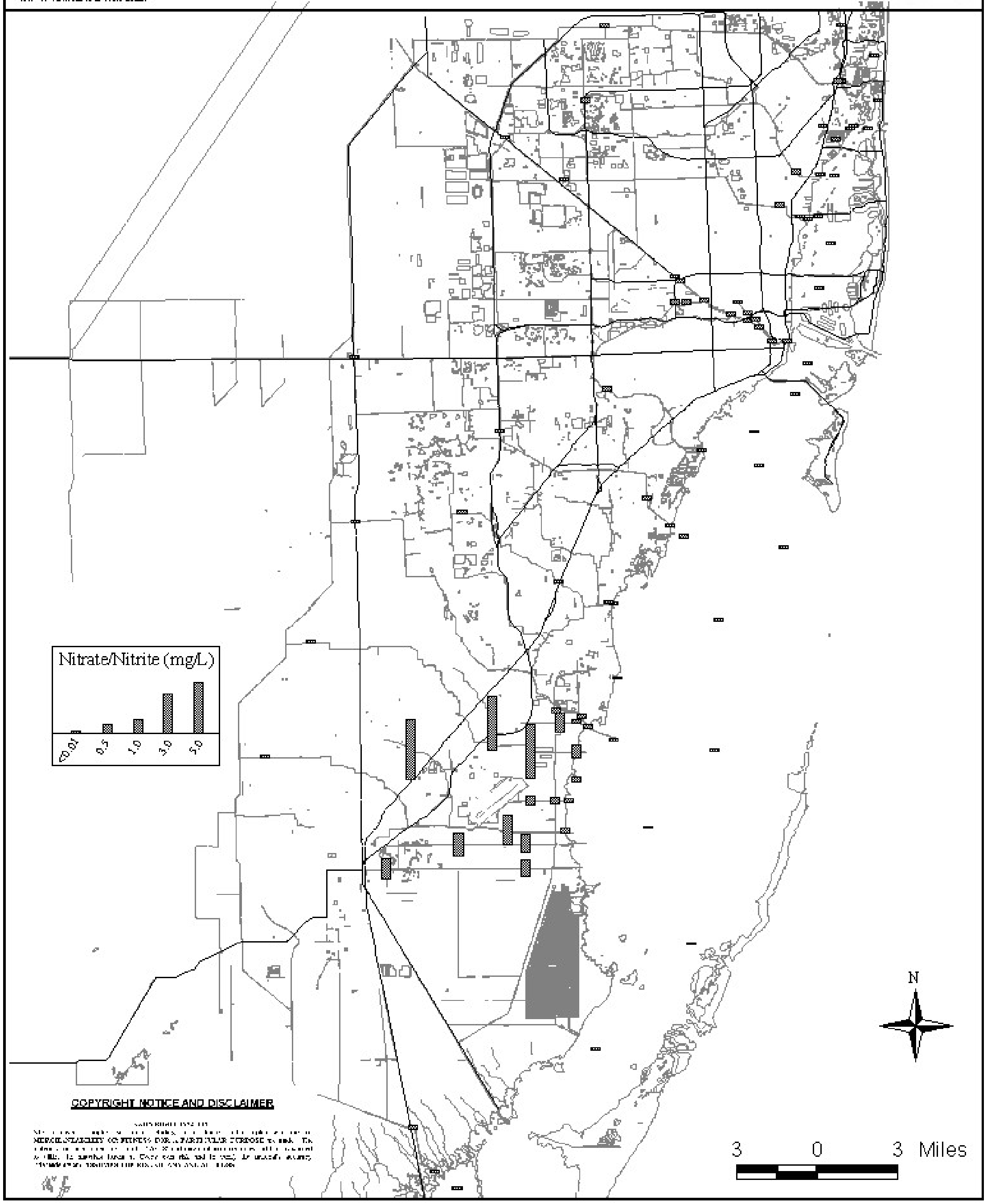
ammonia and phosphorous levels occur in the heavily urbanized portions of northern Miami-Dade County. Nutrient loading in this region of the bay is primarily related to stormwater runoff and sewage contamination. Studies by DERM in the late 1980's (Alleman, 1990) identified high ammonia levels in ground and surface waters near the South Dade landfill and nearby uncontrolled dumps. Ammonia contamination from landfills, particularly old dumps that have not been properly closed or remediated, is considered a significant threat to the natural resources of the Bay. Highest surface water ammonia concentration during the preceeding five-year data period occurred in Goulds Canal adjacent to older dumps and the active South Dade landfill. Efforts are underway to reduce the impact of the south Dade landfills on local groundwater and surface water quality. The South Dade Landfill program includes capping to reduce leachate formation, collection and treatment of existing contaminated groundwater, and stormwater management features. The old dumps are undergoing extensive remediation which include removal and relocation of old waste from areas east of the levee, treatment of contaminated groundwater, and establishment of a system to reduce formation of leachate.

Higher nitrate/nitrite levels occur in surface and groundwater in the southern region of the county in watersheds which support large areas of agriculture. Nitrate/nitrite concentrations in south Dade canals such as Mowry and Princeton are typically an order of magnitude higher than levels seen in other canals. This strongly suggests a connection to the agricultural based land use that dominates south Dade.

Lietz (1999) sampled nutrient concentrations in 15

Figure 4

Miami-Dade County D.E.R.M. Surface Water Quality Monitoring Program
DERM Median Nitrate/Nitrite (mg/L) 1995 - 1999



major canals for two years and developed models that predict load as a function of discharge. The study showed that the concentration of various nitrogen and phosphorus constituents was related to land use, categorized as urban, agriculture, or forested/wetland. Organic nitrogen concentrations were highest in urban and forested/wetland areas than elsewhere. Inorganic nitrogen was highest in agricultural areas. Ammonia and phosphorus concentrations were highest in urban areas. These conclusions are consistent with results reported by Miami-Dade County. Lietz also estimated loading from canals based upon estimated discharge rate and observed nutrient concentrations. For example, the model predicted that a discharge rate of 300 ft^3/second would result in a total nitrogen load of 3.2 to 4.76 tons per day from the Biscayne Canal, where the mean total nitrogen concentration was 1.10 mg/L. Miami-Dade DERM is currently developing watershed models to estimate pollutant loading in connection with stormwater management planning programs.

Groundwater inputs to Biscayne Bay are not very well understood. Modifications to the south Florida landscape during this past century are believed to have significantly altered historic groundwater flow to the Bay. Several studies do suggest that groundwater inputs to the Bay are a near shore phenomenon with most discharge occurring within 100 m of shore (Meeder et al 1997). Meeder's study of groundwater nutrient loading to the near shore areas of the Bay supports this conclusion and suggests that groundwater can contribute significant amounts of nutrients to the bay. This study identified elevated nutrient concentrations in both surface and groundwater and concluded that groundwater nutrient inputs to the bay can be significantly higher than loading from surface water discharges.

TOXIC POLLUTANTS IN WATER AND SEDIMENTS

Ongoing monitoring programs include sampling for pollutants such as trace metals and synthetic organic chemicals, which can be toxic at certain concentrations. Trace metals are detected in marine waters and occasionally in canals, but rarely exceed State or local regulatory standards. Organic chemicals are generally not detected in surface or groundwater. However, this is not unexpected, since metals and organic chemicals are not highly soluble. Rather than remaining in solution, they tend to bind to particulate matter and settle in sediments. For this reason, local, state and federal studies intended to examine the pollution climate of Biscayne Bay have included evaluation of sediment chemistry and toxicity.

Several studies have documented the presence of contaminants in the sediments of Biscayne Bay and adjoining canals (Corcoran et al, 1983, Alleman, 1995). Data on chemical concentrations show a familiar pattern: highest concentrations of most substances in peripheral canals, rivers, streams, and marinas and lowest concentrations down the central north-south axis of the bay. The Miami River and Wagner Creek exhibit higher levels of trace metals and organic contaminants, such as some pesticides and PCB's, than any other area in the State of Florida (Schmale, 1991; DERM, 1993; Gulf Engineers and Consultants, 1993; Seal et al, 1994). Other than relatively small-scale analyses performed in conjunction with dredging projects, very little toxicological data have been generated for the bay.

The toxicity of sediments in Biscayne Bay and many adjoining tributaries was investigated as part of a bioeffects assessments program managed by NOAA's National Status and Trends Program (Long et al., 2000). This study showed that contamination and toxicity were most severe in several peripheral canals and tributaries, including the lower Miami River. In the open basins of the bay, chemical concentrations and toxicity were generally higher in areas north of the Rickenbacker Causeway than south of it. Sediments from the main basins of the bay generally were less toxic than those from the adjoining tributaries and canals. The different tests indicated overlapping patterns or gradients in toxicity. The least sensitive test indicated severe toxicity (high mortality) in tests of sediments from the lower Miami River. Compared to conditions in the adjoining portions of the bay, the sediments of the Miami River were contaminated with mixtures of toxicants, were highly toxic in acute tests, and supported relatively depauperate benthic assemblages.

Results from four different toxicity tests, overall, indicated highest toxicity in samples from the lower Miami River, Black Creek Canal, other canals adjoining the south bay, and canals and tributaries adjoining the bay near Miami and Miami Beach. Samples that were least toxic were collected from the far north and far south ends of the study area. The causes of toxicity could not be determined in this study. However, the weight of evidence strongly suggests that for the lower Miami River, toxicity as measured in the amphipod survival tests could have been caused, at least in part, by mixtures of some metals and synthetic organic chemicals. In the canals of the south bay, both toxicity and contamination were less severe and the identities of chemicals that most probably contributed to toxicity were less clear. Concentrations of PAHs, PCBs, and several trace metals, however, may have been sufficient to contribute to toxicity in the more sensitive sublethal tests.

A section of southern Biscayne Bay showed remarkably high toxicity that could not be explained with the chemical data. Results of many of the toxicity tests were highly significant in the samples from this section of the bay, yet they were surrounded by many stations in which there was little or no toxicity. Concentrations of chemicals for which analyses were performed were uniformly low, usually near or below detection limits, in toxic samples from this region. Concentrations of ammonia in some toxic samples were sufficiently elevated to raise concerns that pore water ammonia may have contributed to toxicity. Therefore, the data suggest that chemical substances other than those for which analyses were performed likely caused or contributed to the toxic conditions in at least some samples. Both the degree and spatial extent of chemical contamination and toxicity in this study of Biscayne Bay were similar to or less severe than those observed in many other areas in the U.S. The spatial extent of toxicity in all tests performed throughout the bay were comparable to the "national averages" calculated by NOAA from previous surveys conducted in a similar manner.

Concurrent with NOAA's study of Biscayne Bay sediments, a similar study of sediment chemistry and toxicity in 28 freshwater canals was conducted by Miami-Dade DERM. In this study, sediments from Wagner Creek, Little River, near Miami International Airport, and Military Canal exhibited significant toxicity. Data from this study showed highest concentrations of several metals including mercury, silver, cadmium, and copper were found in Military Canal. A follow up study of Military Canal by the U.S. EPA confirmed these findings and linked contamination in the Canal to past activities at Homestead Air Force Base (U.S. EPA 1999).

Living resources of the bay are exposed to sediment contaminants through benthic food webs and when sediments are resuspended in the water column. Sediment resuspension and redeposition is an ongoing process. Mechanisms include sediment resuspension caused by wave action during periods of high winds and storms, and due to vessel traffic. Furthermore contaminated sediments in canals and the Miami River can move into the bay when discharge velocities are sufficient to cause resuspension or sediment transport.

WATER QUALITY ISSUES RELATED TO PROPOSED EVERGLADES RESTORATION

A component of the Comprehensive Everglades Restoration Plan (CERP) proposes to discharge advanced treatment wastewater from an upgraded South Dade Wastewater Treatment Plant into Biscayne Bay after routing it first through coastal wetlands in order to meet projected freshwater volume requirements for south Biscayne Bay. Although reuse of wastewater may be an appropriate water conservation strategy in urban or agricultural settings, this concept has raised concerns when coupled with discharge to sensitive oligotrophic natural systems. This component is controversial because (1) it is questionable whether a practical technology is available to provide the level of advanced treatment required to prevent harm to the bay, (2) other constituents in sewage (e.g., industrial wastes, heavy metals, and estrogen hormones and other pharmaceuticals) may not be adequately removed by treatment to avoid harm to the bay or wetlands, and (3) plant breakdowns or accidents could cause a spill that effects the bay or wetlands. Two of the first projects to be implemented by the U.S. Army Corps of Engineers in CERP will be a demonstration advanced treatment pilot plant and an experiment on the ecological effects of its effluent. The bay may not need this water source if improvements in the regional plan allow more water from other sources to flow to the bay.

RECOMMENDATIONS

1) **Quantify pollutant loading to Biscayne Bay.**

(*Justification: Extensive monitoring data provides a basis for description of geographic and temporal patterns, but this information must be coupled with hydrologic data to develop more dynamic estimates of pollutant loading and nutrient mass balance. Hydrologic models now under development are expected to provide the foundation for water quality models that should be useful in projecting changes in geographic patterns, trends, and loading of nutrients and contaminants. However, there are little or no data presently available on atmospheric deposition or flux rates, and little information available on sediment-water column exchange of nutrients or contaminants.*

Specific Science Recommendations

a) Conduct water quality and hydrologic studies necessary to quantify pollutant loading to Biscayne Bay. This should include studies to quantify groundwater inputs to the bay and address the role groundwater plays in pollutant loading.

b) Conduct additional studies to identify fate and transport mechanisms for contaminants in the bay system. This should include studies to address atmospheric deposition or flux rates, and provide information on sediment-water column exchange of nutrients or contaminants.

c) Conduct studies to evaluate impact of elevated nutrient levels in south Dade watershed on the receiving waters of Biscayne National Park.

2) **Refine water quality standards used to indicate the presence of sewage in surface water.**

(*Justification: Various techniques exist for identifying the presence of sewage in surface waters. However, each method has inherent limitations and method performance may vary with climate. Epidemiological data on the incidence of swimming-related illness is needed to refine standards for sewage indicator organisms used in South Florida.*)

Specific Science Recommendations

a) Conduct surveys to determine the incidence of swimmer related illness for public beaches in South Florida. Correlate results from the survey with beach water quality monitoring data results to identify the most effective indicator of sewage contamination, and use this information to develop an appropriate numerical standard.

b) Continue and expand water quality monitoring at public beaches to provide data necessary to evaluate survey results and provide to inform the general public.

3) **Determine the effect of exposure to contaminants in surface water and sediments on local plant and animal populations.**

(*Justification: With the exception of health-risk assessments conducted in the Military Canal area, there are little data available on levels of mercury or other toxic contaminants in fish and shellfish tissues for the Bay. There are also little or no information on the acute or chronic effects of these contaminants on resident plant and animal populations. Such data are necessary for directing resource management efforts, and are needed to evaluate potential human-health implications of subsistence fishing in urban surface waters with potential water and sediment quality degradation.*)

Specific Science Recommendations

a) Conduct studies of local plant and animals to determine body burdens for toxic contaminants detected in surface water and sediments. These studies should include evaluations of species of special concern such as the bottlenose dolphin.

b) Conduct studies of local plant and animal populations to determine effects of exposure to surface water and sediment contaminants. These studies should address issues such as the effects of herbicides on seagrasses.

4) Determine the causes for toxicity observed in sediments from south Biscayne Bay.

(*Justification: Recent studies conducted by N.O.A.A. have identified the presence of toxicity in sediments from south Biscayne Bay. However, evaluation of paired sediment chemistry data does not show contaminant concentrations at levels that can explain the observed toxicity. Further study is needed to identify the causes of toxicity in sediments from this region. In addition, while the use of standardized testing can be a valuable tool for identifying relative toxicity, it is suggested that further studies are needed to quantify the impact of sediment contaminants on resident biota.*)

Specific Science Recommendations

a) Conduct investigations to determine the cause for observed toxicity in sediments from southern region of the bay. These studies should include paired chemistry and toxicity analysis.

b) Conduct studies to quantify the impact of sediment toxicity on resident biota.

Management Related Recommendations

1) Develop a routine schedule of review and publishing scientific data for Biscayne Bay.

(*Justification: While there are many unanswered science questions for Biscayne Bay, various entities with ongoing monitoring programs are generating useful data. It is suggested that efforts be made to develop a program of regular evaluation, summarization, and publishing of results from these programs. In addition, it is recommended that standard analysis methods with lowest available detection limits be used to more accurately characterize contaminant levels in the bay.*)

2) Continue and expand efforts to reduce contaminant loading to the Bay.

(*Justification: Studies have identified the presence of contaminants in canal and bay sediments. Monitoring programs have identified exceedances of surface water and groundwater quality standards in the Bay and its watershed. Efforts to reduce sources of contaminants and minimize inputs to the bay should continue. These efforts should also be expanded to address continued pressures from future growth and development. This includes continuing efforts to reduce contaminant loading from surface water runoff, reducing contamination of groundwater from landfill leachate, and reducing nutrient loading to the bay.*)

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MANAGEMENT SURVEY TEAM

FINAL REPORT

BISCAYNE BAY
PARTNERSHIP INITIATIVE

BISCAYNE BAY PARTNERSHIP INITIATIVE

CONTENTS

INTRODUCTION

GETTING STARTED

The Management Team began to organize its work and started to develop a work plan at their first meeting. Team members felt that the place to start was an overview of current conditions. The team believed that quality management efforts were underway in Biscayne Bay and it was important to become better acquainted with the many components of the existing management system. The team also recognized that water bodies in other parts of the United States have grappled with similar issues as those affecting Biscayne Bay and a better understanding of their management efforts would be useful as well.

The Management Team also believed it was important to integrate its work with the work of the three other survey teams in the BBPI process. The Management Team wanted to understand the management goals and priority issues of the other survey teams.

Finally, the Management Team wanted to suggest refinements for an improved management system in Biscayne Bay based on an understanding of the current system, the management efforts in other water bodies, and the priorities issues of the survey teams.

TEAM OBJECTIVES

The Management Team adopted the following objectives to guide their work.

- Review existing management plans and efforts for Biscayne Bay and its watershed.
- Review selected management models implemented in other bays or watersheds and assess applicability to Biscayne Bay.
- Based upon coordination with Science, Regulatory, and Social and Economic Survey Teams, assess current management needs or goals.
- Assess whether existing plans (a) adequately address management goals; (b) are current; (c) are coordinated and compatible with each other; (d) could incorporate innovative elements that have been applied elsewhere.
- Develop recommendations to improve the effectiveness of existing management efforts.

MANAGEMENT ISSUES

The Management Team developed a list of issues that deserve consideration in the development and refinement of management efforts in Biscayne Bay. The Management Team did not set out to solve specific problems or develop yet another management plan to deal with the issues. The intent of the Management Team was to recommend refinements to current management efforts that might address some of the key issues.

The following are important issues from the perspective of the Management Team.

Management Approaches / Coordination Among Government Non-Profit, and Private Entities

- The ability of the existing management structure to adequately address the issues in Biscayne Bay
- Funding for bay initiatives
- Governmental communication with community organizations and the public
- Inter-governmental communication
- Goals and performance measures for key issues
- Stronger consideration of regional management efforts
- Balancing of societal goals and scientific understanding in the management of Biscayne Bay
- Coordination of land acquisition programs
- Coordination of enforcement activities

Public Awareness and Environmental Education

- Public education on bay issues
- Public involvement in implementing solutions
- Involving community organizations

Water: Quantity, Quality, and Timing

- Freshwater delivery and distribution needs
- An analysis and targets on a site specific basis
- Water clarity and turbidity
- Sewage discharge and pathogens
- Non-point source impacts (e.g. stormwater runoff)
- Waste disposal and point source pollution
- Airborne pollution
- User impacts

Habitat Quality and Restoration / Living Marine Resources

- Invasive exotic species
- Habitat and natural areas protection
- Buffer zones
- Appropriate level of access for sensitive habitats
- Habitat restoration

- Shoreline protection and enhancement
- Land acquisition
- Endangered and threatened species
- Fisheries
- Bay dependent flora and fauna

Physical and Visual Access / Development of the Shoreline

- Growth Management
- Impacts of development in the watershed
- Appropriate use of water front land
- Hurricane protection and preparedness
- Water supply needs
- Flood control
- Public access to the bay
- Appropriate use of public land on or in the bay
- Recreational uses
- Commercial uses
- Trash in the bay and clean up efforts
- Graffiti
- Natural soundscape
- Viewshed

SURVEY

CURRENT MANAGEMENT ACTIVITIES

Over the years, a variety of management plans and processes have been developed to address important Biscayne Bay issues. Many of those plans and processes are currently being implemented. The broad array of management plans and processes can be credited with many significant accomplishments in protecting and restoring bay resources. The goal is to do even more.

The Management Team began its deliberations by trying to develop an understanding of the existing management system in Biscayne Bay. There are a myriad of agencies and organizations that are involved in bay management. The Management Team heard and received summary information on the following existing or proposed management plans and studies that impact Biscayne Bay. Each management plan summary included: the author of the plan, the entities involved in the plan, the status and scope of the plan, and the key goals or objectives that directly relate to Biscayne Bay. A more complete summary of each plan is included as an appendix to this report.

Biscayne Bay Management Plan (adopted 1981)

The Biscayne Bay Management Plan was adopted in 1981 by Miami-Dade County, following a lengthy and inclusive public process involving advisory committees, workshops, and hearings. It is comprehensive, addressing environmental, user-related (e.g. recreation, access), and procedural management issues. The goals and objectives of the plan remain relevant, but its geographic scope did not extend very far into the watershed and it did not provide a mechanism for integrating with regional restoration, which was not envisioned at the time.

The principal implementation structure involved a 15-member "Biscayne Bay Management Committee made up of local, state, and federal officials from key agencies and members of the public. In 1993 the Miami-Dade County Commission attempted to improve efficiency and streamline local government by eliminating certain committees and ordinances, and the committee was "sunsetted," along with many other committees.

Biscayne National Park General Management Plan (completed 1983)

The Biscayne National Park General Management Plan is the primary management document for the park. It was completed in 1983. The plan is somewhat outdated with respect to issues and scientific understanding, but the management zones are still applicable. The goals and objectives are divided into three sections: Historical and Natural Resources, Public Enjoyment, and Physical Necessities. Over one half of Biscayne Bay lies within the Park Boundary. The BNP Management Plan also contains information on coordination of activities outside the park, i.e. funding, policies, etc. The National Park Service has begun a two to three year process to develop a new general management plan.

Biscayne National Park Resource Management Plan (completed 1999)

This plan implements the General Management Plan with regards to natural and cultural resources. It identifies resource problems and sets goals.

Biscayne Bay Aquatic Preserve Rules and Act (established 1974)

Florida Statutes and Florida Administrative Code Chapter 18-18 set forth basic management objectives for Biscayne Bay and authorize the development of a management plan. At least two drafts have been completed, one by Miami-Dade County and one by the Florida Department of Natural Resources (now the Florida Department of Environmental Protection).

258.397 F.S. and 18-18 F.A.C. set forth management criteria for Biscayne Bay including restrictions on dredging and filling within the preserve as well as conditions on uses, sales, leases or transfers of interests in lands or materials held by the Board. 18-18 has a provision for the development of additional management plans in cooperation with the department, consistent with the Act and the Rule.

Biscayne Bay Surface Water Improvement and Management Plan (revised 1995)

The Surface Water Improvement Management Plan was developed by the South Florida Water Management District and addresses protection and enhancement of water quality through a variety of management strategies. The plan was most recently approved and updated by the State in 1995. The plan has three goals: improve water quality, improve hydrology, and improve biological resources.

The SWIM Program received significant funds for the first several years. Due to lobbying efforts some projects continue to receive funds through direct appropriations.

State Park Plans (completed and revised 1997-2000)

State park plan information was provided for: Oleta River State Recreation Area, Cape Florida State Recreation Area, Barnacle Historic Site, and John Pennekamp State Park.

Central and Southern Florida Project Comprehensive Review Study and Comprehensive Everglades Restoration Plan (completed 1999)

The purpose of the study was to reexamine the Central and South Florida Project to determine the feasibility of structural or operational modifications to the project essential to the restoration of the Everglades and the south Florida ecosystem. The study recommends a comprehensive plan for restoration, protection, and preservation of the water resources for the natural system, as well as for urban and agricultural needs.

Coordinating Success: Strategy for Restoration of the South Florida Ecosystem

Volumes I and II were completed in July of 2000. This plan outlines how the restoration will occur; identifies resources needed to achieve the restoration; assigns accountability for accomplishing actions; and links the strategic goals established by the Task Force to outcome oriented annual goals.

South Florida Multi-Species Recovery Plan (finalized 1999)

This plan by the U.S. Fish and Wildlife Service provides baseline information and management recommendations on the federally listed endangered and threatened species in South Florida and their relation to the region's ecological communities. Important to Biscayne Bay are species such as American crocodile, West Indian manatee, wood stork, and Schaus swallowtail butterfly, and communities such as seagrasses, coastal salt marsh, mangroves, and tropical hardwood hammock.

South Dade Agriculture Area Study (proposed completion 2001)

The study describes the current situation and outlook for agriculture and should be completed in 2001. The main purpose of the study is the collection and analysis of data concerning the long-term economic outlook of the agriculture industry and the development of recommendations to enhance the industry's economic viability. The University of Florida, under contract with the Florida Department of Agriculture and Consumer Services, is conducting the study. A consultant to be hired by Miami-Dade County will utilize the information gathered in this study to conduct a more comprehensive land use study that will examine both agriculture and the retention of rural areas in South Dade.

South Dade Watershed Plan (proposed completion 2002)

This plan is currently being developed and should be completed in 2002. The South Dade Watershed is located in the southeastern portion of Miami-Dade County, between Everglades and Biscayne National Parks. The plan has received partial funding from the Florida Legislature. Completion of the plan is not yet funded.

The South Dade Watershed Plan will address the following: the identification and protection of lands essential for preserving the environmental, economic and community values of Biscayne National Park (BNP), numeric standards for quality, quantity, timing and distribution of waters into BNP, assurance of compatible land uses and zoning decisions in the watershed of BNP consistent with long-term objectives for sustainability, and methods and policies for Best Management Practices of all sources of run-off in the BNP watershed.

Dredged Material Management Plan for the ICW in Dade County, Florida (proposed completion 2000)

The Florida Inland Navigation District has established advisory committees to develop long-range dredged material management plans for each segment of the ICW. The portion extending through Biscayne Bay is currently under study.

The Port of Miami Comprehensive Master Plan (completed 2000)

The recently updated Port of Miami master plan contains several long-range environmental planning elements, including spoil disposal, mitigation banking, storm water system development, and sewage infrastructure improvements. The port anticipates economic growth and associated needs for additional slips for deep draft vessels, proposed navigation improvements in channels and turning basins, and upland space for supporting infrastructure.

Miami River Master Plan

The Miami River Master Plan Report was approved but no other formal action was taken by the City of Miami. There is currently a joint committee that will build on this plan to develop a new plan that can be adopted by the city.

The Miami River Study Commission Report (completed 1998)

The Miami River Commission was established by the Florida Legislature to serve as a clearinghouse and coordination body for all types of issues related to the Miami River. The "Miami River Call to Action" is a report prepared by the River Study Commission to highlight their activities. The Commission attempts to be inclusive of all Miami River stakeholders and seeks to build consensus among all those stakeholders.

The Florida Keys National Marine Sanctuary Management Plan (completed 1996)

This plan is aimed at protecting the coral reef and surrounding marine communities from the northern most portion of Biscayne National Park to west of the Dry Tortugas National Park and back to the Everglades National Park on the Gulf side of the Florida Keys. The plan was developed with the aid of an advisory committee composed of twenty-five stakeholders. The plan takes an ecosystem approach to natural resource management.

The Florida Keys National Marine Sanctuary Water Quality Protection Program (completed 1993)

This plan contains a Water Quality Action Plan that has specific solutions to addressing water quality problems and establishes corrective actions to solve water quality problems in the Florida Keys National Marine Sanctuary.

The Final Habitat Plan for the South Atlantic Region: Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council (completed 1998)

This plan and its accompanying comprehensive amendment integrate habitat management with federal fishery management. Biscayne Bay is identified as essential habitat for species such as pink shrimp, spiny lobster, and Spanish mackerel.

Management Plans in Other Water Bodies

The Management Team was also interested in how other water bodies were managed to see if there were relevant applications to Biscayne Bay. At the initial symposium in January, 2000, a presentation was made about the management and restoration efforts in Chesapeake Bay. The Team requested and received information on the management of the four estuaries in Florida that are part of the National Estuary Program: Indian River Lagoon, Tampa Bay, Sarasota Bay, and Charlotte Harbor. In addition, during a Management Survey Team meeting, representatives from the Indian River Lagoon National Estuary Program and the Charlotte Harbor National Estuary Program gave presentations about the management efforts regarding their water bodies.

The Chesapeake Bay Program

William Matuszeski, Director of the EPA Chesapeake Bay Program Office, spoke at the BBPI symposium in January, 2000. The Chesapeake Bay Program is recognized as one of the premier watershed restoration efforts in the United States.

The Indian River Lagoon National Estuary Program

Martin Smithson, Director of the Indian River Lagoon National Estuary Program, gave a presentation on the management structure at the IRLNEP. He provided information describing the institutional arrangements for coordinating and conducting the implementation of the Comprehensive Conservation Management Plan for Indian River Lagoon. The CCMP was approved in 1996.

Mr. Smithson indicated that partnering with organizations like the Water Management District is key to success in their program. The IRLNEP does not get involved in land use decisions and the group has no regulatory authority.

The IRLNEP does provide a forum for discussing and recommending land use decisions that affect the Indian River Lagoon on a limited basis. They also take part in comprehensive plan reviews.

The Charlotte Harbor National Estuary Program

Tiffany Lutterman, Director of the Charlotte Harbor National Estuary Program gave a presentation on the management structure at the CHNEP. The CHNEP is a relatively new program.

In the CHNEP, partnering agencies fund the program, prioritize projects and share in implementation of projects. The CHNEP recommends conservation of priority areas (land) in their management plan but does not address other land use issues.

FINDINGS

The management of Biscayne Bay is often guided by the management plans created by individual agencies. Management plans encompass a variety of activities including: public involvement, education, access, protection, restoration/enhancement, monitoring, enforcement, research, and evaluation. In this document, the Management Team will use the term "management processes" to mean all management activities which include the development, implementation, and coordination of management plans.

The Management Team recognizes that there are a significant number of quality management efforts currently underway in Biscayne Bay. Those management efforts are based on years of experience and have resulted in significant improvements to the bay. **The Management Team finds that any future management activities should build upon existing efforts, rather than "reinventing the wheel."**

Funding is an important issue in the implementation of management processes and plans. The existing management processes and plans have received some significant funds in the past. Many plans and projects designed to enhance the bay exist but funds are not currently available for implementation. **The Management Team finds that a greater and more consistent level of funding would help management processes be more effective in the restoration and enhancement of Biscayne Bay.**

In addition, matching funds can be a significant resource to assist with the implementation of management processes. The Surface Water Improvement and Management Program (SWIM) is a good example. During the late 1980's and early 1990's, the Florida Legislature provided regular appropriations through SWIM for Biscayne Bay water resources projects. This investment, which totaled more than $10 million over an eight year period, was more than tripled by matching contributions provided by local governments and the South Florida Water Management District. These appropriations supported priority stormwater improvement, habitat restoration, monitoring and studies, pollutant source removal, and public awareness projects that had been identified through the Biscayne Bay SWIM Plan. Although the Legislature has continued to allocate funding for Biscayne Bay on a project-by-project basis, a renewed commitment to SWIM would provide financial support for Biscayne Bay water projects that have already been identified and create incentive for matching-fund partnerships with local and regional governments. **The Management Team finds that State funding for many Biscayne Bay projects would leverage matching funds greatly enhancing the value of the initial allocation.**

The management of Biscayne Bay involves a large number of local, state, and federal agencies as well as non-governmental organizations and individuals. Communication and coordination among so many entities are always challenging. In many ways, inter-agency coordination is good and in other ways, improvement is needed. **The Management Team finds that improved inter-agency coordination would enhance management processes and result in better protection and restoration of bay resources.**

Biscayne Bay is a significant resource and it is used by the citizens and visitors of South Florida in a multitude of different ways. Users of the bay are impacted by the management decisions concerning Biscayne Bay. **The Management Team finds that all stages of the management process should include community stakeholder input.**

Protection and enhancement of Biscayne Bay are dependent on public support. Public education and outreach help create enthusiasm and support for Biscayne Bay. Current educational and outreach programs for the public are disjointed and sporadic. **The Management Team finds that coordinated education and outreach programs for the public should be implemented.**

Biscayne Bay is part of a larger ecosystem and it is directly impacted by the activities on the land around it and by the waters connected to it. Also, the Biscayne Bay watershed will be affected by implementation of the Comprehensive Everglades Restoration Plan, and managers must be prepared to deal with issues such as potential changes in freshwater inflow. **The Management Team finds that the existing management processes for Biscayne Bay would be more effective in protecting the bay with a stronger consideration of ongoing regional restoration plans and land-based activities occurring in the watershed.**

RECOMMENDATIONS

BACKGROUND: ACHIEVING CONSENSUS RECOMMENDATIONS

The Management Team believes that management efforts in Biscayne Bay are effective but they see a number of areas where management efforts might be improved by: an increased level of funding, greater involvement of community stakeholders, increased public education, and more inter-agency coordination. The Management Team has spent a significant amount of time discussing methods to better address these areas. The team had lengthy discussions about forming a group of individuals to address these and other important management issues. Several types of groups were identified and discussed including an advisory committee, an inter-agency task force, issue-based teams, and public forums. Ultimately, the Management Team selected an issue team incorporated into the existing structure of the Working Group of the South Florida Ecosystem Restoration Task Force.

The Management Team spent several months designing a group to deal with Biscayne Bay issues that would carry little or no risk with its creation. For instance, the proposed group would strongly support the important safeguards in place to protect the Bay, such as the Biscayne Bay Acquatic Preserve Act. The proposed group would not have any authority over agencies or any regulatory authority. Recognizing that the bay impacts a large variety of interests and that it is important to include all perspectives in management processes, the proposed group would be representative of stakeholder interests and include citizens in its membership.

The Management Team discussed the potential benefits and the possible drawbacks of creating an advisory committee to deal with Biscayne Bay issues. In the end, some members of the Management Team believed that the potential problems that may arise with the creation of an independent advisory committee were too great to recommend it. The potential that an independent advisory committee might evolve into something that is not acceptable to the Management Team was too great a risk to overcome.

The only type of group that enjoys the support of the Management Team is a Biscayne Bay Project Coordination Team as part of the Working Group of the South Florida Ecosystem Restoration Task Force. The Management Team took great care to design a group that would be acceptable to all members of the team and that would be able to meet the challenges facing Biscayne Bay. Members of the Team remain concerned, however, that their recommendations might be modified and that a group might be formed that does not include all of the elements that they included in their proposed model. The elements of their proposed group are the result of months of discussion in order to produce a group that is representative of Biscayne Bay interests, inclusive of both key public and private stakeholders, and focused upon protecting and enhancing the values of the bay. The Management Team believes that all of the components of their proposed model are important and necessary for an effective and acceptable group.

Recommendations

- Any future management activities should build upon existing efforts, rather than "reinventing the wheel."
- The State should provide a greater and more consistent level of funding to help management processes be more effective in the restoration and enhancement of Biscayne Bay.
- The State should fund additional Biscayne Bay projects in order to leverage matching funds, greatly enhancing the value of the initial state allocation.
- Inter-agency coordination should be improved to enhance management processes and result in better protection and restoration of bay resources.
- All stages of the management process should include community stakeholder input.
- Coordinated education and outreach programs for the public should be implemented.
- Existing management processes for Biscayne Bay should include a stronger consideration of ongoing regional restoration plans and land-based activities occurring in the watershed.

Overarching Recommendation

- In order to achieve implementation of the above recommendations, the Management Survey Team recommends the formation of the Biscayne Bay Project Coordination Team as part of the Working Group of the South Florida Ecosystem Restoration Task Force as outlined below.

The Biscayne Bay Project Coordination Team as part of the Working Group of the South Florida Ecosystem Restoration Task Force.

Goal

The goal of the Biscayne Bay Project Coordination Team is:

To preserve, protect, and enhance Biscayne Bay and its connected waters so that the ecological and aesthetic values of Biscayne Bay may endure for the enjoyment of future generations.

Funding

Funding for establishment, administrative costs, and dedicated staff of the Biscayne Bay Project Coordination Team should be provided through an appropriation from the Florida Legislature (see Establishment and Staffing below).

Establishment

The Working Group of the South Florida Ecosystem Restoration Task Force should establish the Biscayne Bay Project Coordination Team according to the structure outlined below. The Task Force should provide administrative support similar to what it provides for other teams.

Staffing

The Biscayne Bay Project Coordination Team shall have dedicated staff who are funded by the State Legislature and employed by an agency on the Project Coordination Team. Dedicated staff will help insure the success of the Team and help insulate the Team from shifting agency priorities. Ad hoc staff support from participating agencies should be used as warranted.

Membership

The Biscayne Bay Project Coordination Team shall have eighteen initial members. The team shall have the following membership:

1-Member of the Florida State Legislature from Dade County

1-Miami-Dade County Commissioner selected by the Commission

2-Municipal representatives selected by the Dade League of Cities

8-Agency members, one from each of the following agencies:

- Florida Department of Environmental Protection
- Florida Fish and Wildlife Conservation Commission
- South Florida Water Management District
- Army Corp of Engineers
- Florida Keys National Marine Sanctuary
- Biscayne National Park
- Miami-Dade Department of Environmental Resources Management
- Miami-Dade Department of Planning and Zoning

6-Citizens, two representing each of the following interests:

- environmental
- marine user group(s)
- at large

The Working Group of the South Florida Ecosystem Restoration Task Force shall select the six citizen members from a candidate list prepared by the designated members of the Biscayne Bay Project Coordination Team.

Functions

The Biscayne Bay Project Coordination Team shall perform the following functions:

- Provide a forum for the public to be involved
- Provide information to the public about activities and issues related to Biscayne Bay
- Provide a forum for interagency coordination and communication
- Identify priority issues for action and create Biscayne Bay issue teams as needed to assist the Project Team
- Make recommendations on key issues to agencies and organizations
- Identify goals and performance measures related to key issues
- Assess the achievement of goals
- Identify and pursue funding on key issues
- Review elements of the Comprehensive Everglades Restoration Plan that affect Biscayne Bay

Guiding Principles

As the Biscayne Bay Project Coordination Team conducts its activities, it shall adhere to the following guiding principles:

- The team shall not supplant agency authority or have any regulatory authority.
- The work of the team shall be consistent with the Biscayne Bay Aquatic Preserve Act.
- The team shall serve in an advisory role and shall not serve as a direct granting agency.
- Team membership shall be representative of Biscayne Bay interests.
- Team members shall be knowledgeable of Biscayne Bay issues.
- The team shall recognize the importance of watershed management for the protection of Biscayne Bay.

APPENDIX

MANAGEMENT PLAN SUMMARY DOCUMENTS

BISCAYNE BAY AQUATIC PRESERVE RULE AND ACT

Who did the plan?

Florida Department of Environmental Regulation (now Department of Environmental Protection).

When was the plan completed?

On June 11, 1974, House Bill No. 4018 provided for the establishment of Biscayne Bay as an aquatic preserve. The preserve's management authority and criteria are currently contained in 258.397 (originally 258.165) and 18-18 F.A.C. (Transferred from 16-Q, F.A.C., effective March 20, 1980). The aquatic preserve rule was adopted by the Board of Trustees of the Internal Improvement Trust Fund under authority found in 258.165(4)(a), F.S.

What is the status of the plan?

Current (18-18 F.A.C. under authority of 258.397, F.S.). Please find 18-18 F.A.C. and 258.397 F.S., attached.

What is the geographic area of the plan?

Biscayne Bay Aquatic Preserve encompasses the entire bay including Card Sound in both Dade and Monroe Counties, less Biscayne National Park. A complete description of the preserve boundaries can be found in 18-18.002. Please find attached a state map approximating the preserve.

What is the scope of the plan?

The Biscayne Bay Aquatic Preserve was established for the purpose of preserving and enhancing Biscayne Bay and all natural waterways tidally connected to the bay in essentially natural condition so that its biological and aesthetic values may endure for the enjoyment of future generations. The Biscayne Bay Aquatic Preserve Rule was promulgated to clarify the responsibilities of the department in carrying out its land management functions as those apply within the preserve.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Implementation and responsibility for environmental permitting of activities in the preserve are vested in the Florida Department of Environmental Protection. 18-18 F.A.C. is considered cumulative with other applicable rules. Management criteria contained in 18-18 include restrictions on dredging and filling within the preserve as well as conditions on uses, sales, leases or transfers of interests in lands or materials held by the Board. Additional provisions are provided for in the rule under 18-18.013 (2), (3) as follows:

(2) The board encourages the creation of further management criteria or plans to enhance or protect the preserve. A management plan, which includes an inventory of resources and a management scheme to further aid in the maintenance and enhancement of the biological and aesthetic qualities of the preserve shall be prepared by the department or by other public or private entities in cooperation with the department. Such criteria and plans, when developed, may be submitted to the board for consideration and inclusion in the board's management plan for the preserve.

(3) Nothing in these rules shall serve to eliminate or alter the requirements or authority of other governmental agencies, including counties and municipalities, to protect or enhance the preserve provided that such requirements or authority are not inconsistent with the Act and these rules.

For further information, contact David Mayer, Biscayne Bay Aquatic Preserve, (305) 372-6583.

BISCAYNE BAY MANAGEMENT PLAN

Who did the plan?

Miami Dade County

When was the plan completed?

March 1981

What is the status of the plan?

Adopted by the Board of County Commissioners in 1981.

Major recommendations have been implemented, incorporated into the Code of Miami-Dade County or the Comprehensive Development Master Plan, or continue to be implemented through ongoing monitoring, restoration, recreation, water management and acquisition programs. For more details, see list of Restoration and Enhancement projects at the end of this outline.

What entities were involved in the plan?

The Biscayne Bay Management Plan (BBMP) was jointly prepared by the Miami Dade County Planning Department and Department of Environmental Resources Management (DERM). The County Manager appointed a five-member Policy Advisory Committee to oversee the general scope and direction of the project. Additionally, a large Scientific/Technical Committee was selected from universities, federal and state agencies to provide input and insure accuracy. A Local Government Liaison Committee composed of representatives of shoreline municipalities was established to assure that cities were informed of and had an opportunity to review various waterfront land use policies.

Over a period of several years, staff compiled data and drafted documents, which were then reviewed by the advisory groups, as well as numerous Bay users and community interest groups at workshops and hearings. The draft plan was revised to reflect this input and approved by the Board of County Commissioners.

One of the principal recommendations in the plan involved the establishment of the Biscayne Bay Management Committee, a 15-member coordinating body composed of representatives of local, state and federal government, as well as citizens. This committee provided a forum for ongoing public discussion of major policy issues and developed recommendations for action by various public agencies.

DERM's Biscayne Bay Restoration and Enhancement Program, a major implementation tool of the Plan, has been funded over the years by Miami-Dade County with assistance from the State of Florida, the Florida Department of Environmental Protection, FIND, and the South Florida Water Management District.

What is the geographic area of the plan?

The Plan focused on Biscayne Bay and adjoining waters from the Broward County line to Card Sound. The planning area extended inland a short distance to include the lower reaches of canals and waterfront.

What is the scope of the plan?

The BBMC is comprehensive in scope and addressed a broad range of interests and concerns. These were broadly categorized into three major headings: 1) ENVIRONMENTAL, 2)USER-RELATED, and 3) MANAGEMENT. Concerns under each of these major categories include the following:

- ENVIRONMENTAL: canal discharge and stormwater runoff; water clarity; recreational and developmental user impacts; and habitat management.
- USER-RELATED: conflicts among user groups; need for more marine-oriented recreational facilities; need to improve visual and physical access; persistent trash and litter
- MANAGEMENT: need for less duplicative, more locally accountable Bay management program; need to resolve overlapping and fragmented jurisdictions

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The goals and objectives of the BBMP are generally identical to the process outlined by the BBPI. Although almost 20 years old, the BBMC purposes and list of major objectives remain relevant. The following information is quoted directly from the BBMP.

"Purpose of the Bay Management Plan. This plan is intended to serve five basic purposes: (1) to define the scope of concerns and programs that should be addressed within a comprehensive, coordinated approach to Bay Management, (2) to recommend programs and actions that should be undertaken in order to move towards comprehensive and coordinated management of Biscayne Bay, (3) to identify a coordinating committee structure to oversee the scope and direction of programs that are recommended, (4) to identify those agencies and community based groups that have responsibility for implementing certain management programs, and (5) to identify sources of funding or community based resources that can be utilized to achieve a coordinated approach to Bay management."

"Primary Goal. The primary goal of BBMP project is to develop a unified, Countywide management plan for the entire bay system, including its adjacent wetlands, embayments and contiguous developed shorelands in a manner that will maintain or enhance where necessary, those physical, chemical, biological and aesthetic qualities that provide the basic character and value of this resource."

"Program Objectives. In order to realize this primary goal, the following program objectives shall be achieved:

- To address and resolve the jurisdictional issues relating to Biscayne Bay in order to provide long-term management capability;
- To provide a wide array of water oriented opportunities at the water's edge, consistent with the Primary Goal;
- To enhance physical and visual access thereby increasing the potential for environmentally sound utilization and attractiveness of Biscayne Bay for the public at large
- To identify and maintain, or enhance where necessary, those biological communities that are essential to the long-term viability of Biscayne Bay;
- To optimize the quality and quantity of marine life
- To maintain, or enhance where necessary, water quality that permits safe water contact, recreation and propagation of fish and wildlife;
- To provide protection for endangered, threatened or rare species of plants and animals that exist within the waters of Biscayne Bay or the adjacent coastal wetlands;
- To avoid irreversible or irretrievable commitments of Bay resources;
- To seek funding for activities which are necessary to achieve the Primary Goal;

- To promote water transportation and enhance the Bay's contribution to the economic health of the community through marina development and other appropriate measures consistent with the Primary Goal;
- To provide continuing monitoring of the Bay in order to assemble an adequate data base for Bay management."

Additionally, during development of the Plan, the Policy Advisory Committee and the Board of County Commissioners developed a prioritized list of Restoration and Enhancement projects as follows (*indicates project completed; +indicates project continuing):

1. Improve public awareness*+
2. Improve access*+
3. Identify areas that need stabilization or wave energy abatement*
4. Obtain baseline data on fisheries and fisheries pathology*+
5. Monitor existing mitigation/restoration efforts*+
6. Develop fisheries management program*+
7. Obtain baseline water chemistry obtain baseline circulation data*+
8. Stabilize shorelines*+
9. Map benthic community*
10. Riprap public areas*
11. Identify sources of turbidity*
12. Obtain baseline data on water epidemiology and pathology {sanitary quality}*+
13. Plant mangroves*+
14. Install artificial reefs*+
15. Plant seagrass*
16. Fill deep holes*
17. Redistribute circulation
18. Remove fine bottom sediments

Additional Comments and Observations:

The advantages of this particular plan are that it has a broad, comprehensive scope and was developed through a community-inclusive process. Many of the most significant policies and recommended actions have been largely implemented and have formed a foundation for continuing science-based management activities. Most remain relevant today. The Biscayne Bay Management Committee coordinating structure was generally successful, until its sunset by the Board of County Commissioners in 1993.

The disadvantage of the BBMP is that it is older and not familiar to some present-day interests. Also, the planning boundary did not extend fully into the watershed, and although the Plan recognized canal discharge and freshwater delivery as principal concerns, it did not envision a major South Florida/Everglades restoration. These deficiencies could be addressed by updating the supporting data in the Plan, utilizing information collected for the local CDMPs, the Biscayne Bay SWIM

Plan, the C & SF Restudy and other more narrowly focused ongoing planning projects. Goals and objectives could also be updated or expanded to address current concerns and regional restoration programs.

For further information, contact: Dr. Susan M. Markley, Miami-Dade DERM, (305) 372-6863.

BISCAYNE BAY SURFACE WATER IMPROVEMENT AND MANAGEMENT PLAN

Who did the plan?

South Florida Water Management District.

When was the plan completed?

First version was completed in 1988. The last major version was completed November 1995.

What is the status of the plan?

The plan is still used as a reference and to justify projects, however, it is need of revision. The plan has been quite successful in the implementation of a wide range of projects and promoting strategic partnerships. Implementation of projects related to the SWIM plan is believed to have resulted in significant improvements in water quality in Biscayne Bay. Unfortunately, the Legislature has not provided full funding for SWIM implementation. A new plan: the South Florida Water Management District Florida Forever Work Plan will likely supersede the SWIM plan, but will include the same goals and objectives with land acquisition added.

What entities were involved in the plan?

South Florida Water Management District and Florida Department of Environmental Protection were the lead State agencies. State review also included FDACS, FDCA, FG&FC. Local participation included Miami-Dade County, especially DERM, and several municipalities, especially the City of Miami. Federal participation included the Department of Interior and U.S. Army Corps of Engineers.

What is the geographic area of the plan?

The plan boundary included the primary watershed and coastal water areas from the Miami-Dade Broward line to U.S. Highway 1 at Barnes Sound.

What is the scope of the plan?

Project activities included basin actions plans, monitoring, wetland restoration, urban stormwater systems retrofitting, modeling, diagnostics and enforcement, public education, and research.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The plan included three goals that should be considered by the Initiative:

- Maintain and improve water quality to protect and restore natural ecosystems and compatible human uses of Biscayne Bay.

- Improve the quantity, timing and distribution of freshwater flows and circulation characteristics of Biscayne Bay as needed to protect and restore natural ecosystems.
- Protect environmental resources of Biscayne Bay and adjacent areas.

The plan includes 16 objectives, and 60 specific strategies.

For further information, contact: Rick Alleman, SFWMD, (561) 682-6716.

BISCAYNE NATIONAL PARK GENERAL MANAGEMENT PLAN

Who did the plan?

The National Park Service.

When was the plan completed?

January 1983. [Biscayne National Monument was established in 1968 "in order to preserve and protect for the education, inspiration, recreation, and enjoyment of present and future generations a rare combination of terrestrial, marine, and amphibious life in a tropical setting of great natural beauty" (PL 90-606). The monument was expanded in 1974 (PL 93-477) and again in 1980 (PL 96-287) when it was re-designated as a National Park.]

What is the status of the plan?

This plan is adopted and largely implemented. Begun in 1981, this plan has become outdated in some respects but in general the management concepts are still appropriate. It is scheduled for update in the next year when it will be revised with extensive public input.

What entities were involved in the plan?

In addition to the National Park Service, consultants listed in the plan included:

US Fish and Wildlife Service

Advisory Council on Historic Preservation

Florida State Historic Preservation Office

Florida Dept. of Environmental Protection

Florida Park Service

Dade County DERM

Dade County Parks and Recreation Dept.

Dade County Dept. of Planning

University of Miami Rosenstiel School

What is the geographic area of the plan?

The geographic area covered by the Plan encompasses Biscayne National Park (BNP) boundaries. Biscayne National Park covers 181,000 acres (733 km^2). BNP is a marine park with emergent land representing only 5% of the total park area. The total land area within the Park is 9,075 acres and a marine/estuarine area of 171,925 acres. The Park is divided into three major environments: coral reef, estuarine (the Bay), and terrestrial. The terrestrial portion of the Park is comprised of a narrow fringe of mangrove shoreline along the Park's western boundary and 42 keys or islands. These islands, with the exception of the Arsnickers Keys, form a north-south boundary between Biscayne Bay and the coral reef tract.

What is the scope of the plan?

This is the primary management document for the Park. It describes the laws upon which the plan is based, establishes management zones, and formulates management objectives. It was developed with extensive public input. It defines comprehensive programs for the management of the Park's natural and cultural resources, designed to protect Park values from the imminent threats perceived by Congress. In addition, it recognizes the interconnection of the natural and human dominated systems and provides for work on issues affecting the Park that originate from outside of the Park boundaries.

This plan provides for all aspects of the Park and serves as a superstructure for planning. All other plans are derived from this document. It serves as the means of implementing congressional intent and Park Service charge under its legislative authority.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Because the area within the boundaries of Biscayne National Park encompasses such a large part of Biscayne Bay, it may be stated that the goals and objectives set forth in the BNP General Management Plan directly relate to the Biscayne Bay Partnership Initiative. Especially relevant are the sections dealing with laws, regulations, and the management of the resource.

For further information, contact Linda Canzanelli, BNP, (305) 230-1144.

BISCAYNE NATIONAL PARK RESOURCES MANAGEMENT PLAN

Who did the plan?

Biscayne National Park (BNP) and the National Park Service.

When was the plan completed?

This plan was completed in 1995. This plan is currently in draft form but is scheduled for updates and final changes for final approval by December 2000.

What is the status of the plan?

Adopted. Some action plans have been funded, implemented, or are in progress.

What entities were involved in the plan?

Biscayne National Park; the National Park Service; consultants have varied with each specific problem statement, but generally have included relevant county, state, and federal agencies or reference documents from those agencies.

What is the geographic area of the plan?

Biscayne National Park covers 181,000 acres (733 km^2). BNP is a marine park with emergent land representing only 5% of the total park area. The total land area within the Park is 9,075 acres and a marine/estuarine area of 171,925 acres. The Park is divided into three major environments: coral reef, estuarine (the Bay), and terrestrial. The terrestrial portion of the Park is comprised of a narrow fringe of mangrove shoreline along the Parks western boundary and 42 keys or islands. These islands, with the exception of the Arsnickers Keys, form a north-south boundary between Biscayne Bay and the coral reef tract.

What is the scope of the plan?

It implements the BNP General Management Plan with regard to natural and cultural (i.e., historic and pre-historic) resources. Identifies resource problems and sets goals. Some problem statements have specific action plans.

This plan addresses the resource management issues facing Biscayne National Park. It proposes a strategy to deal with these issues in the context of a final desired condition. The geographic area covered by the Plan encompasses BNP boundaries. In addition it recognizes the interconnection of the natural and human-dominated systems and provides for work on issues affecting the Park that originate from outside of the Park boundaries.

The water resource issues covered by this plan include: water quality; water quantity; estuarine recharge; turbidity from vessel operations; health of seagrasses, hardbottom, fish and coral reef communities; oil spill containment; protection, status and trends of protected species; and general baseline monitoring. The goals of this plan are divided into several categories: 1) Maintain and improve water quantity and quality; 2) Develop and understanding of the Parks resources, their interrelationships, and various components required for management; 3) Protect and preserve natural resources of the park and adjacent areas; 4) Develop a better understanding and appreciation of Biscayne's cultural resources; and 5) Protect and preserve cultural resources.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Because the area within the boundaries of Biscayne National Park encompasses such a large part of Biscayne Bay, it may be stated that the goals and objectives set forth in the BNP Resources Management Plan directly relate to the Biscayne Bay Partnership Initiative.

For further information, contact Linda Canzanelli, BNP, (305) 230-1144.

CENTRAL AND SOUTHERN FLORIDA PROJECT-COMPREHENSIVE REVIEW STUDY

Who did the Plan?

U.S. Army Corps of Engineers, Jacksonville District

South Florida Water Management District

When was the plan completed?

April 1999

What is the status of the Plan?

Plan will be sent to congress for approval and funding on July 1, 2000

What entities were involved in the Plan?

- U.S. Army Corps of Engineers, Jacksonville District
- South Florida Water Management District
- U.S. Fish and Wildlife Service,
- U.S. Environmental Protection Agency
- National Park Service
- Florida Game and Fresh Water Fish Commission
- U.S. Geological Survey
- Natural Resources Conservation Service
- Florida Department of Environmental Protection
- Governor's Commission for a Sustainable South Florida
- South Florida Ecosystem Restoration Task Force
- NOAA, National Marine Fisheries Service

What is the geographic area of the Plan?

The sixteen county area of central and south Florida which comprise the Kissimmee – Lake Okeechobee – Everglades Watershed.

What is the scope of the plan?

The purpose of the Restudy is to reexamine the C&SF Project to determine the feasibility of structural or operational modifications to the project essential to the restoration of the Everglades and the south Florida ecosystem. The restudy will also provide for other water-related needs such as urban and agricultural water supply and flood protection in those areas served by the project. The intent of the study is to evaluate conditions within the study area and make recommendations to modify the project to restore important functions and values of the Everglades and south Florida ecosystem and plan for the water resources needs of the people of south Florida for the next 50 years.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The following projects, directly relate to the enhancement of Biscayne Bay:

Biscayne Bay Coastal Wetlands

The feature includes pump stations, spreader swales, stormwater treatment areas, flowways, levees, culverts, and backfilling canals located in southeast Miami-Dade County and covers 13,600 acres from the Deering Estate at C-100C, south to the Florida Power and Light Turkey Point power plant, generally along L-31E. The purpose of this feature is to rehydrate wetlands and reduce point source discharge to Biscayne Bay. The proposed project will replace lost overland flow and partially compensate for the reduction in groundwater seepage by redistributing, through a spreader system, available surface water entering the area from regional canals. The proposed redistribution of freshwater flow across a broad front is expected to restore or enhance freshwater wetlands, tidal wetlands, and nearshore bay habitat. Sustained lower-than-seawater salinities are required in tidal wetlands and the nearshore bay to provide nursery habitat for fish and shellfish. This project is expected to create conditions that will be conducive to the reestablishment of oysters and other components of the oyster reef community. Diversion of canal discharges into coastal wetlands is expected not only to reestablish productive nursery habitat all along the shoreline but also to reduce the abrupt freshwater discharges that are physiologically stressful to fish and benthic invertebrates in the bay near canal outlets. More detailed analyses will be required to define target freshwater flows for Biscayne Bay and the wetlands within the redistribution system. The target(s) will be based upon the quality, quantity, timing and distribution of flows needed to provide and maintain sustainable biological communities in Biscayne Bay, Biscayne National Park and the coastal wetlands. Additionally, potential sources of water for providing freshwater flows to Biscayne Bay will be identified and evaluated to determine their ability to provide the target flows. The component Biscayne Bay Coastal Canals as modeled in D-13R and the Critical Project on the L-31E Flowway Redistribution are smaller components of the Biscayne Bay Coastal Wetlands feature described above.

South Miami-Dade County Reuse

This feature includes a plant expansion to produce superior, advanced treatment of wastewater from the existing South District Wastewater Treatment Plant located north of the C-1 Canal in Miami-Dade County. The initial design of this feature assumed that the plant will have a capacity of 131 million gallons per day. More detailed analyses will be required to determine the quality and quantity of water needed to meet the ecological goals and objectives of Biscayne Bay. Additionally, due to the water quality issues associated with discharging reclaimed water into Biscayne National Park, an Outstanding Florida Water, such as potential failures of the treatment system and the limited ability to control contaminant inputs to the sanitary sewer system serving the treatment facility, other potential sources of water to provide required freshwater flows to southern and central Biscayne Bay should be investigated before pursuing the reuse facility as a source. If it is determined that other, more appropriate sources are not available, the reuse project will be initiated by determining the parameters of concern, the necessary wastewater treatment requirements, and the appropriate treatment technology to be implemented. The purpose of this feature is to provide additional water supply to the South Biscayne Bay and Coastal Wetlands Enhancement Project. In order to attain the superior level of treatment, construction of an add-on pretreatment and membrane treatment system to the existing secondary treatment facility will be necessary. Superior water quality treatment features will be based on appropriate pollution load reduction targets necessary to protect downstream receiving surface waters (Biscayne Bay).

C-111N Spreader Canal

This feature includes levees, canals, pumps, water control structures, and a stormwater treatment area to be constructed, modified or removed in the Model Lands and Southern Glades (C-111 Basin) area of Miami-Dade County. This feature enhances the C-111 Project design for the C-111N Spreader Canal with the construction of a stormwater treatment area, the enlarging of pump station S-332E and the extension of the canal under U.S. Highway 1 and Card Sound Road into the Model Lands. The initial design of this feature pumps water from the C-111 and the C-111E Canals into a stormwater treatment area prior to discharging to Southern Everglades and Model Lands. This features also calls for filling in the southern reach of the C-111 Canal and removal of structures S-18C and S-197. The final size, depth, location and configuration of this feature will be determined through more detailed planning and design. The purpose of this feature is to improve deliveries and enhance the connectivity and sheetflow in the Model Lands and Southern Glades areas, reduce wet season flows in C-111, and decrease potential flood risk in the lower south Miami-Dade County area.

Central Lake Belt Storage Area

This feature includes pumps, water control structures, a stormwater treatment area, and a combination above-ground and in-ground storage reservoir with a total storage capacity of approximately 190,000 acre-feet located in Miami-Dade County. The initial design of the reservoir assumed 5,200 acres with the water level fluctuating from 16 feet above grade to 20 feet below grade. A subterranean seepage barrier will be constructed around the perimeter to enable drawdowns during dry periods and to prevent seepage losses. A pilot test of this technology will be conducted prior to final design of this component to determine construction technologies, storage efficiencies, impacts upon local hydrology, and water quality effects. Since this facility is to be located within the protection area of Miami-Dade County's Northwest Wellfield, the pilot test will also be designed to identify and address potential impacts to the County's wellfield which may occur during construction and/or operation. The stormwater treatment area was assumed to be 640 acres with the water level fluctuating up to 4 feet above grade. The final size, depth and configuration of these facilities will be determined through more detailed planning and design to be completed as a part of the Water Preserve Areas Feasibility Study.

The purpose of the feature is to store excess water from Water Conservation Areas 2 and 3 and provide environmental water supply deliveries to: (1) Northeast Shark River Slough, (2) Water Conservation Area 3B, and (3) to Biscayne Bay, in that order, if available. Due to the source of the water (Water Conservation Areas 2 and 3), it is assumed that water stored in this facility is of adequate quality to return to the Everglades Protection Area and Biscayne Bay; however, the final size, depth and configuration of these facilities, including treatment requirements, will be determined through more detailed planning and design to be completed as a part of the Water Preserve Areas Feasibility Study. Excess water from Water Conservation Areas 2 and 3 will be diverted into the L-37, L-33, and L-30 Borrow Canals, which run along the eastern boundaries of the Water Conservation Areas, and pumped into the Central Lake Belt Storage Area. Water supply deliveries will be pumped through a stormwater treatment area prior to discharge to the Everglades via the L-30 Borrow Canal and a reconfigured L-31N Borrow Canal. If available, deliveries will be directed to Biscayne Bay through the Snapper Creek Canal at Florida's Turnpike. A structure will be provided on the Snapper Creek Canal to provide regional system deliveries when water from the Central Lake Belt Storage Area is not available.

For further information, contact: Julio Fanjul, OED—SFERTF, (305) 348-1833.

COMPREHENSIVE DEVELOPMENT MASTER PLAN

Coastal Management Element for Miami-Dade County

Who did the plan?

Miami-Dade County's Planning Department with considerable public input provided by a Citizen's Advisory Task Force

When was the plan completed?

Miami-Dade County's Comprehensive Development Master Plan (CDMP) was originally adopted by the Board of County Commissioners in 1975. Although the original CDMP did not contain a discrete Coastal Element, it included objectives to minimize shoreline development and drainage practices detrimental to Biscayne Bay. A separate Coastal Management Element first appeared in the 1988 CDMP, pursuant to the Growth Management Act of 1985. Chapters 163 (Intergovernmental Programs) and 380 (Land and Water Management), F.S., require that all local governments abutting the Atlantic Ocean, or which include waters of the state where marine species of vegetation constitute the dominant plant community, include a Coastal Management Element (CME) in their CDMP.

What is the status of the plan?

As noted above, the plan has been adopted and is being implemented.

What entities were involved in the plan?

As noted above, Miami-Dade County's Planning Department wrote the plan with considerable public input provided by a Citizen's Advisory Task Force.

What is the geographic area of the plan?

The coastal area in Miami-Dade County includes the embayments from Dumfoundling Bay to Card Sound, their tributaries and contiguous shore lands and the sedimentary barrier and reef islands that form the oceanic boundaries of the coastal lagoons, the offshore reef tracts and submerged communities on the continental shelf.

What is the scope of the plan?

The stated purpose of Miami-Dade County's CME is to protect coastal resources, protect human lives and property from natural disasters, improve public access to beaches and shores, maintain or increase the amount of shoreline devoted to water-dependent or water-related uses, and to preserve historical and archaeological sites within the coastal area.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The stated goals of the CME are to provide for the conservation, environmentally sound use and protection of all natural and historic resources; limit public expenditures in areas subject to destruction by natural disasters; and protect human life and property in the coastal area of the county.

Miami-Dade County's current CME contains 12 objectives. Objectives 1 through 7 are most closely related to the Biscayne Bay Initiative, while Objectives 8 through 12 focus on natural disaster planning, preparation, response and recovery. This summary will, therefore, focus on the first seven objectives, which are to: 1) Protect, conserve and enhance coastal wetlands and living marine resources in Dade County; 2) Protect, conserve, or enhance beaches and dunes and offshore reef communities; 3) Reduce the number of exceedances of water quality standards for coastal and estuarine waters; 4a) Increase the acreage of benthic, coastal wetland and coastal hammock habitat that is publicly owned; 4b) Improve wildlife values by protecting endangered and threatened animal species and restoring and managing coastal habitats; 5) Increase the amount of shoreline devoted to water-dependent, water-related, and publicly accessible uses in Dade County; 6) Preserve traditional shoreline uses and minimize user conflicts and impact of man-made structures and activities on coastal resources; and 7) Improve the public's awareness and appreciation of Dade County's coastal resources and water-dependent and water-related uses.

The Port of Miami is addressed through a separate Subelement included in the CDMP Transportation Element. One of three major goals in this Subelement states that the Port shall minimize detrimental effects on the environment in carrying out its daily operations and expansion program. Under this goal, specific reference is made to detaining stormwater prior to discharge to Biscayne Bay and minimizing turbidity associated with dredging.

For further information, contact: Cindy Dwyer, Miami-Dade County P & Z, (305) 375-2835.

COORDINATING SUCCESS: STRATEGY FOR RESTORATION OF THE SOUTH FLORIDA ECOSYSTEM

Who did the plan?

The South Florida Ecosystem Restoration Task Force (the task force), which sought extensive involvement from local agencies, citizen groups, nonprofit organizations, and other interested parties as part of its assessment for this strategy.

When was the plan completed?

What is the status of the plan?

The authorization of the *Comprehensive Everglades Restoration Plan* (CERP), a major component of the restoration effort, is currently pending before the Congress. The estimated $7.8 billion cost of the CERP will be split 50-50 between the federal government and nonfederal sponsors.

The task force meets regularly to report on progress, coordinate consensus, and identify opportunities for improvement.

What is the geographic area of the plan?

The South Florida ecosystem is an 18,000-square-mile region of subtropical uplands, wetlands, and coral reefs that extends from the Chain of Lakes south of Orlando through the reefs southwest of the Florida Keys. This ecosystem not only supports the economy and the quality of life of the Floridians and the Native American Indians who live there, but also enriches the legacy of all Americans. It encompasses many nationally significant conservation areas, including Everglades and Biscayne National Parks, Big Cypress National Preserve, the Arthur R. Marshall Loxahatchee National Wildlife Refuge, and the Florida Keys National Marine Sanctuary.

This ecosystem is sustained by water, and it has been seriously degraded by disruptions to the natural hydrology. Engineered flood control and water distribution systems for agriculture and urban development have dewatered large areas and greatly altered the quantity, timing, and distribution of water flows in other locations. Agricultural runoff and urban stormwater have introduced phosphorus and other contaminants into the water systems, polluting lakes, rivers, and wetlands. Discharges of stormwater into estuaries and coastal waters have severely degraded aquatic habitats. Groundwater is threatened by saltwater intrusion and other pollutants. These impacts have stressed the natural system, as evidenced by

- Fifty percent reduction in the original extent of the Everglades
- Ninety percent reduction in wading bird populations
- Sixty-nine species on the federal endangered or threatened list
- Declines in commercial fisheries in Biscayne and Florida Bays
- Nineteen percent decline in living corals in the last decade

What is the scope of the plan?

The purpose of the document is to describe the existing federal and nonfederal programs designed to restore and sustain the imperiled South Florida ecosystem. Many federal, state, tribal, and local entities are working to address the deteriorating ecological conditions in South Florida. The South Florida Ecosystem Restoration Task Force (the task force) coordinates and tracks the work. Congress directed the task force to produce a restoration strategy. The document provides the information needed to coordinate and integrate the restoration effort.

Congress identified four elements to be included in the document. They wanted it to outline how the restoration effort will occur, identify the resources needed, establish responsibility for accomplishing actions, and link the strategic goals established by the participants to outcome-oriented goals. The document describes how the restoration effort is being coordinated: The task force members have agreed upon a vision for the results; they have established three broad goals and measurable objectives for the work that needs to be accomplished to achieve that vision; they have identified the projects needed to achieve the objectives; they are coordinating those projects so that they are mutually supportive and non-duplicative; and they are tracking progress toward both the work-oriented goals and the results-oriented vision. This strategy, along with the vision, goals, objectives, performance measures, and individual project data (including cost, responsible agency, and targeted completion dates) are all included in the document.

The strategy document is for planning purposes only, is subject to modification, and is not legally binding on any of the task force members. Each task force member and the interests they represent retain all of their sovereign rights, authorities, and jurisdiction for implementation of the projects contained within the document.

The integrated federal and nonfederal effort to restore, preserve, and protect the ecosystem will take many decades. The document and funding needs may be revised over time based on information gained through monitoring and study.

What entities were involved in the plan?

Six federal departments (twelve agencies), seven Florida state agencies or commissions, two American Indian tribes, sixteen counties, scores of municipal governments, and interested groups and businesses from throughout South Florida are participating in the restoration effort. Four sovereign entities (federal, state, and two tribes) are represented.

The task force was created in 1993 as a federal interagency partnership, with informal participation by the State of Florida, the Seminole Tribe of Florida, and the Miccosukee Tribe of Indians of Florida. The Water Resources Development Act of 1996 authorized the operation of the task force and provided for specific membership and duties. Pursuant to its statutory duties, a task force working group of agency and tribal representatives (the working group) works to resolve conflicts among participants, coordinate research, assist participants, prepare an integrated financial plan, and report to Congress. The task force does not have any oversight or project authority, and participating agencies are responsible for meeting their own targeted accomplishments. The task force's role as a forum in which ideas are shared and consensus is sought enhances the productivity of each member government or agency effort

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The participants in the task force share the vision of a healthy South Florida ecosystem that supports diverse and sustainable communities of plants, animals, and people. To this end, hundreds of different entities have been working for over a decade to restore and preserve more natural hydrology in the ecosystem, to protect the spatial extent and quality of remaining habitat, to promote the return of abundant populations of native plants and animals, and to foster human development compatible with sustaining a healthy ecosystem. The past, current, and future efforts of governmental entities in South Florida involve more than 200 projects related to three primary work goals. Subgoals and objectives have been established for the first two work goals and will be reported for the third goal in future updates to the document.

Goal 1: Get the water right

Subgoal 1-A: Get the hydrology right

Objective 1-A.1: Provide 1.6 million acre-feet of surface water storage by 2037

Objective 1-A.2: Develop aquifer storage and recovery systems capable of storing 1.7 billion gallons per day by 2020

Objective 1-A.3: Modify 279 miles of impediments to flow by 2019

Subgoal 1-B: Get the water quality right

Objective 1-B.1: Construct 122,000 acres of stormwater treatment areas by 2036

Objective 1-B.2: Prepare plans, with strategies and schedules for implementation, to comply with TMDLs *(total maximum daily loads)* for 100 percent of impaired water bodies by 2011

Goal 2: Restore, preserve, and protect natural habitats and species

Subgoal 2-A: Restore, preserve, and protect natural habitats

Objective 2-A.1: Acquire 1.95 million acres of land for habitat protection by 2015

Objective 2-B.2: Protect 20 percent of the coral reefs by 2020

Subgoal 2-B: Control invasive exotic plants

Objective 2-B.1: Prepare management plans for the top twenty South Florida invasive exotic plant species by 2010

Objective 2-B.2: Achieve maintenance control status for Brazilian pepper, melaleuca, Australian pine, and Old World climbing fern in all natural areas in the region by 2020

Objective 2-B.3: Complete an Invasive Exotic Plant Prevention, Early Detection, and Eradication Plan by 2005

Goal 3: Foster compatibility of the built and natural systems

The task force members believe through accomplishing these objectives they will achieve the restoration of the ecosystem. The region's rich and varied habitats will become healthy and productive. Imperiled species will recover, and the large nesting rookeries of wading birds will return.

The appropriate agencies will track progress toward restoring the ecosystem through approximately 200 performance measures developed as part of the *Comprehensive Everglades Restoration Plan*, plus additional measures for areas not covered by the CERP, such as the *South Florida Multi-Species Recovery Plan*. These measures, which range from the number of acres of periphyton in Everglades marshes to the frequency of water supply restrictions in urban and agricultural areas, represent the myriad physical, biological, and human elements that interrelate as parts of the ecosystem and are important to ecosystem health. The agencies will provide data to the task force, which will update the document for transmittal to Congress, the state legislature, and the councils of the tribes.

The following measures are a representative subset of a broader list of indicators for tracking success. Many of these represent end results that may take up to fifty years to realize. Interim targets, which focus on earlier indications of successional change, will allow assessment of incremental progress.

- Improved status for fourteen federally listed threatened or endangered species, and no declines in status for those additional species listed by the state, by 2020
- A 90 percent recovery of the acreage and number of tree islands existing in 1940, and a health index of 0.90 (where 0 = death is imminent, 1 = completely stress free) (Interim target: A 20 percent improvement in the general health index of the tree islands, and no further loss in the total number of tree islands by 2020)
- Healthy oyster beds in the major estuaries, such as the St. Lucie Estuary and those in Biscayne Bay
- Four thousand nesting pairs of wood storks in the Everglades and Big Cypress basins (Interim target: Fifteen hundred nesting pairs by 2010)
- Water quality within the Everglades ecosystem that meets federal, state, and tribal water quality standards
- A lake-wide average phosphorus concentration of 40 parts per billion (ppb) total in the open-water regions of Lake Okeechobee
- Water provided to all users during droughts up to the level of certainty of a one-in-ten-year frequency of occurrence
- Nesting roseate spoonbills in the coastal zone of the southwestern Gulf Coast between Lostman's River and the Caloosahatchee River; and 1,000 nesting pairs in Florida Bay, including 250 nesting pairs in northeast Florida Bay
- A 65-75 percent coverage of Florida Bay with high-quality seagrass beds
- A long-term commercial harvest of pink shrimp on the Dry Tortugas fishing grounds that equals or exceeds the rate that occurred during the years 1961-1962 to 1982-1983; and an amount of large shrimp in the long-term average catch exceeding 500 pounds per vessel-day
- An average annual loading to the St. Lucie Estuary of no more than 400 pounds of phosphorus per 1,000 acre-feet of discharge
- The capture and storage of most of the excess freshwater currently lost to the ocean and the gulf, and delivery of the water when and where it is needed

Restoration Strategy

The task force provides a forum for consensus building and issue engagement among the entities involved in restoring the South Florida ecosystem. This is a collaborative role, not one in which the task force can dictate to its members. Because on-the-ground restoration is accomplished through the efforts of the individual task force member agencies, they are the ones that are ultimately responsible for their particular programs, projects, and associated funding. This is an important distinction. The task force has no overriding authority to direct its members. Instead, the members are accountable individually to their appropriate authorities and to each other for the success of the restoration.

The task force and its members coordinate and track the restoration effort as follows:

Focus on goals. The document establishes specific goals and measures that define the scope of the restoration initiative and answer these fundamental questions: What will the restoration partners accomplish? When will the restoration effort be done? What key indicators will signal progress and success?

Coordinate projects. To be effective, individual projects should contribute to the vision and goals, be timely, and support rather than duplicate other efforts. The document includes a master list of restoration projects and includes information about goals and objectives, start and finish dates, lead agencies, and funding.

Track and assess progress. The task force will facilitate the implementation of the individual entities' *adaptive assessment* processes to track and assess progress. Adaptive assessment involves constantly monitoring project contributions and indicators of success to determine the actual versus expected results of various actions. This process acknowledges that not all the data needed to restore the South Florida ecosystem are available now. As project managers track incremental progress in achieving objectives they may raise "red flags" alerting the task force members that a project (1) is not on schedule or (2) is not producing the projected outputs or anticipated results. The ability to anticipate problems early helps to minimize their effect on the total restoration effort. Management responses may involve revising the project design, evaluating changing resource needs, or working collaboratively on projects that fall behind. Projects that are not proving effective may be replaced with new projects. Because each participating agency is responsible for its particular programs, projects, and funding, such decisions are made by the entities involved.

Facilitate the resolution of issues and conflicts. Disagreements and conflict are to be expected given the scope, complexity, and large number of sponsors and interests involved in ecosystem restoration. In particular, the ability to resolve existing conflicts is complicated by (1) the large number of governmental entities involved at the federal, state, tribal, and local levels; (2) the differing, and sometimes conflicting, legal mandates and agency missions among the entities involved; and (3) the diverse stakeholder interests represented by the member agencies, which include environmental, agricultural, Native American, urban, and commercial values.

The task force will facilitate the prevention and resolution of conflict to the extent possible by clarifying the issue(s), identifying stakeholder concerns, obtaining and analyzing relevant information, and identifying solutions. The working group will regularly track issues in dispute and report to the task force when there are unresolved issues. Although these efforts are intended to facilitate conflict resolution, opportunities will always exist for parties to pursue conflicts through litigation, although litigation is time consuming, costly, and uncertain. Further, litigation diverts resources from restoration efforts. Unfortunately, judicial resolution of legal claims does not always resolve the underlying conflict to the satisfaction of every party.

For further information, contact: Julio Fanjul, OED—SFERTF, (305) 348-1833.

DANTE B. FASCELL PORT OF MIAMI-DADE 1999 MASTER DEVELOPMENT PLAN

Who did the plan?

The Miami-Dade County Seaport Department prepared the 1999 Port of Miami-Dade Master Development Plan.

When was the plan completed?

The first Port of Miami Master Development Plan was adopted in 1969, the next in 1979, and the last plan in 1988. The 1999 Port Master Development Plan represents the Seaport Department's five and fifteen year planning horizons. The 1999 Plan was drafted in April 1999. Because the plan is adopted as part of Miami-Dade County's overall growth management plan (the Comprehensive Development Master Plan), a predetermined schedule for transmittal, revision and comment was followed, as is required for all comprehensive plan amendments under guiding state law. Text revisions were completed by August 1999, and final policy revisions were completed in February 2000.

What is the status of the plan?

The plan was adopted by the Miami-Dade County Board of County Commissioners on March 28, 2000, and transmitted for final compliance review to the Florida Department of Community Affairs on April 12, 2000.

What entities were involved in the plan?

In addition to being prepared by the Miami-Dade County Seaport Department, the plan received extensive review and comment from other county departments, regional and state agencies, and the county Planning Board and Board of County Commissioners.

What is the geographic area of the plan?

The plan addresses the port facility including on-island facilities, navigational channels and berthing areas, and off-island support facilities. Environmental and transportation issues were reviewed in larger context areas.

What is the scope of the plan?

The Port of Miami Master Development Plan addresses existing and proposed port facilities and operations under the specific requirements of Chapter 163, Florida Statutes, which requires deep water ports to prepare data and analysis and to implement policies.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The Port of Miami is one of the Western Hemisphere's most important commercial ports. Owned and operated by Miami-Dade County's Seaport Department, the Port of Miami is geographically proximate to major international shipping lanes and the largest cruising region in the world. The Port of Miami handled more than 813,000 containers of cargo and almost three million cruise passengers in 1998. As a result of this activity, the Port of Miami is ranked as the eleventh largest container port in the United States and largest cruise homeport in the world.

Combined cargo and cruise operations at the Port of Miami generate large and growing economic benefits for the county and South Florida. The total economic impact of Port of Miami operations is estimated at more than $8 billion per annum. More than 45,000 jobs are directly or indirectly attributable to port operations, most of which are high-value, skilled employment positions.

The goals, objectives and policies of the port master plan guide port operation and expansion. The 1999 plan includes significant new language that provides for the following:

- Maximize existing facilities
    - Encourage user efficiencies
    - Improve on-island resources
    - Secure off-island resources
- Develop new facilities on- and off-island
- Strengthen ties to mainland
- Ensure that off-island expansion is consistent with surrounding communities
- Provide public access/parkland
- Protect environment
- Coordinate more aggressively on transportation issues
- Explore joint-use, mixed-use and joint-venture opportunities to maximize port goals
- Incorporate findings of the U.S. Army Corps of Engineers' 1999 General Reevaluation Report
- Study and improve infrastructure
    - Stormwater
    - Wastewater
    - Potable water

For further information, contact: Charles Towsley, Port Director, (305) 371-7678.

FINAL HABITAT PLAN FOR THE SOUTH ATLANTIC REGION:

Essential Fish Habitat Requirements for Fishery Management Plans of the South Atlantic Fishery Management Council

And

Final Comprehensive Amendment Addressing Essential Fish Habitat in Fishery Management Plans of the South Atlantic Region

Who did the plan?

South Atlantic Fishery Management Council (SAFMC). This is one of eight regional councils in the U.S. created under the Magnuson Fishery Conservation and Management Act of 1976 to manage living marine resources in federal waters. The SAFMC is responsible for the conservation and management of fishery stocks in the South Atlantic Region (see Geographic Area, below). The council operates under NOAA's National Marine Fisheries Service (NMFS), and its membership includes commercial and recreational fishermen, marine scientists, and state and federal fisheries managers, who combine their knowledge to prepare Fishery Management Plans (FMPs).

When was the plan completed?

October 1998.

What is the status of the plan?

The plan was fully approved by NMFS; the announcement confirming approval was issued on June 23, 1999. The SAFMC and NMFS are to review and update the habitat components of FMPs at least every 5 years. This will include preparation of a revised amendment for any FMP if new information becomes available.

What entities were involved in the plan?

South Atlantic Fishery Management Council and its partners on the Habitat Advisory Panel and Coral Advisory Panel. The Habitat Panel is divided into four state subpanels, each with representatives from the state marine fisheries agency, U.S. Fish & Wildlife Service, state coastal zone management agency, a conservation organization, and commercial and recreational fishermen. The panel also includes representatives from the NMFS, EPA, and Atlantic States Marine Fisheries Commission.

What is the geographic area of the plan?

The inshore estuarine habitats and offshore marine habitats out to the 200-mile limit off the coasts of North Carolina, South Carolina, Georgia, and east Florida to Key West.

What is the scope of the plan?

The Magnuson-Stevens Fishery Conservation and Management Act of 1996 sets forth a new mandate to identify and protect marine and anadromous fisheries habitat. It requires the Fishery Management Councils and Secretary of Commerce to identify Essential Fish Habitat (EFH) for species under federal FMPs. EFH is defined as “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” “Fish” includes finfish, crabs, shrimp, and lobsters. Federal agencies, which fund, permit, or carry out activities that may adversely impact EFH, are required to consult with NMFS regarding potential adverse effects of their actions on EFH, and NMFS is directed to comment on any state agency activities that would impact EFH. Habitat Areas of Particular Concern (HAPCs) are also identified by their importance to ecological function, their sensitivity to human-induced degradation, or their rarity.

The Act mandates an effort to integrate fishery management and habitat management by stressing the dependency of healthy fisheries on maintenance of viable and diverse estuarine and marine ecosystems. In its plan, the SAFMC developed a holistic analysis of fishery habitats in the Southeast with information on the requirements for each life history stage of managed species, including habitat variables that control or limit distribution, abundance, reproduction, growth, survival, and productivity. Habitat requirements of prey species and actions that cause reductions in prey populations are to be addressed. FMPs are also to analyze how fishing and non-fishing activities influence habitat function on an ecosystem or watershed scale.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The purpose of the Habitat Plan is to further the national marine resource management goal of maintaining sustainable fisheries. Essential to achieving this goal is the maintenance and protection of suitable marine fishery habitat quality and quantity for managed species. Biscayne Bay is one of the South Atlantic estuarine drainage areas specifically identified in the plan, and it is discussed in relation to occurrence of habitat types such as mangroves and seagrass.

The Comprehensive Amendment contains amendments related to habitat for each of the South Atlantic Fishery Management Plans. Each amendment has two goals: 1) to identify EFH, and 2) to establish EFH-HAPCs. Those FMPs related to Biscayne Bay are:

- Shrimp: Biscayne Bay is mapped as an area of high abundance of juvenile pink shrimp. EFH includes inshore estuarine nursery areas, offshore marine habitats, and interconnecting water bodies. Areas that meet criteria for HAPCs include all coastal inlets, all state-designated nursery habitats of particular importance to shrimp, and state-identified overwintering areas.
- Snapper-grouper complex (includes gray snapper): Biscayne Bay is mapped as an area of high abundance of juvenile gray snapper. For specific life stages of the gray snapper, EFH includes seagrass, tidal creeks, and mangrove fringe. Areas that meet criteria for HAPCs include all coastal inlets, mangrove habitat, seagrass habitat, and all state-designated nursery habitats of particular importance to snapper.
- Coastal migratory pelagic complex (includes Spanish mackerel): Biscayne Bay is mapped as an area where juvenile Spanish mackerel are common. EFH includes all coastal inlets and state-designated nursery habitats of particular importance to coastal pelagic species. HAPCs include Atlantic Coast estuaries with high numbers of Spanish mackerel.
- Red drum: Biscayne Bay is mapped as an area where red drum juveniles are rare, but historically the red drum was a common species in the bay, until it declined rapidly beginning in the 1940s. In 1998, the state ended an 8-year unsuccessful attempt to restock red drum into Biscayne Bay. EFH includes mangrove fringe, sea grasses, oyster reefs, and tidal creeks. Areas that meet criteria for HAPCs include all coastal inlets, all state-designated nursery habitats of particular importance to red drum, and habitats identified for submerged aquatic vegetation.
- Spiny lobster: Biscayne Bay and Card Sound are identified as areas meeting the criteria of HAPC for spiny lobster. EFH includes shallow subtidal bottom, seagrass, soft sediments, coral and live/hard bottom, sponges, algal communities, and mangrove prop roots.
- Coral, coral reefs. and live/hard bottom: Biscayne Bay and Biscayne National Park are identified as areas meeting the criteria of HAPC for coral, coral reefs, and live/hard bottom.

Prepared by Carole Goodyear, formerly with NOAA/NMFS, (305) 361-4255.

FLORIDA KEYS NATIONAL MARINE SANCTUARY

Final Management Plan/Environmental Impact Statement

Who did the plan?

The plan was prepared by the National Oceanic and Atmospheric Administration (NOAA) in the U.S. Department of Commerce. The National Marine Sanctuary Program is administered by the National Ocean Service of NOAA. A wide range of state, federal, and local agency partners assisted in the development of the management plan.

When was the plan completed?

The Final Plan was implemented July 1, 1997. The development of the plan began in the Spring of 1991 and a draft plan was released in April 1995. The Final Plan was released in September of 1996, but was not officially implemented until July 1997.

What is the status of the plan?

The plan was officially implemented in July 1997 and it is extensively in the management of the FKNMS.

What entities were involved in the plan?

Various segments and agencies in state, federal, and local governments were involved in the development of the Final Management Plan. A Sanctuary Advisory Council comprised of 25 stakeholders had an active role in the development of the comprehensive management plan.

What is the geographic area of the plan?

The plan covers the Florida Keys National Marine Sanctuary which is a 2800 square nautical mile area that runs offshore from the northernmost portion of the Biscayne National Park along the 300' depth contour all the way to the west of the Dry Tortugas National Park and back to the Everglades National Park on the Gulf side of the Florida Keys. Card Sound and Barns Sound are both located within the boundary of the Sanctuary. The Sanctuary boundary includes 65% state waters and 35% federal waters. The boundary only included the marine waters and goes to mean high water. Canals and open man-made bodies of water that are included within the Sanctuary.

What is the scope of the plan?

The Final Management Plan for the Florida Keys National Marine Sanctuary contains some of the most innovative tools available for protecting America's coral reef and its surrounding marine communities for the use and enjoyment of future generations. Sanctuary planners are confident that they have achieved the best balanced approach to protecting Sanctuary resources through a management plan based on common sense and practical solutions. The final plan represents the most comprehensive approach ever attempted at protecting a marine community as diverse as that in the Florida Keys and in a socio-economic setting as complex as that in the Keys.

The Sanctuary's final management plan was compiled using the best available science and most current management planning techniques available in this country. Dozens of experts in managing marine resources were consulted in the development of the Sanctuary plan. The final plan provides management tools to solve major problems occurring in the marine environment of the Keys that were identified during the planning process. Those problems are separated into the following major categories: deteriorating water quality; declining health of the living coral reefs; physical damage to coral reefs and seagrass communities; user conflicts, visitor safety, and quality of life issues; and declining marine resources.

The final management plan contains both innovative and practical solutions to solving the problems in the marine environment of the Sanctuary that were identified during the planning process. Most of the solutions in the Sanctuary plan are non-regulatory in nature and serve to provide resource protection through simple management actions. Those solutions are found in the following broad management categories: improvement of water quality; coral reef and seagrass protection; resource enhancement; education and outreach; research and monitoring; volunteerism; and quality of life issues.

The Final Management Plan for the FKNMS can be reviewed on the Sanctuary's webpage at: http://www.fknms.nos.noaa.gov.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The ecosystem approach to management of natural resources, coupled with an integrated and comprehensive approach to management are two key objectives of the FKNMS Final Management Plan that relate to the BBPI. Additionally, the decline in water quality in the Sanctuary is directly attributable to land-base sources coupled with changes linked to global climate change. The impact of water quality degradation in the Florida Keys on the coral reefs and seagrasses is a major concern to resource managers and citizens in the area. These water quality problems directly relate to similar issues in Dade County and the health of Biscayne Bay directly relates to the health of Sanctuary resources.

For further information, contact: Billy Causey, FKNMS, (305) 743-2437.

FLORIDA KEYS NATIONAL MARINE SANCTUARY

Water Quality Protection Program

Who did the plan?

The plan was prepared by the U.S. Environmental Protection Agency, the Florida Department of Environmental Protection, and the National Oceanic and Atmospheric Administration (NOAA). EPA had the lead in the development of the plan, which was authorized by Congress in the Florida Keys National Marine Sanctuary and Protection Act. A high level Water Quality Steering Committee, Chaired by the Regional 4 Administrator for EPA, and Co-Chaired by the Deputy Secretary for DEP, had oversight in the development of the WQPP. The WQSC is comprised of state, federal, county, and municipal representatives along with members of the public and the Sanctuary Advisory Council.

When was the plan completed?

The WQPP was completed and implemented in the Spring of 1993. The development of the plan began in the Spring of 1991 and ran parallel to the development of the FKNMS comprehensive management plan.

What is the status of the plan?

The plan was officially implemented in the Spring of 1993 and it is used extensively to address water quality issues in the FKNMS. A Water Quality Action Plan in the Final Management Plan for the FKNMS integrates Sanctuary water quality activities with those identified in the WQPP. The two plans are comprehensively integrated to address water quality problems within the Sanctuary.

What entities were involved in the plan?

EPA led the development of the WQPP and involved agencies in state, federal, and local governments. The WQPP development included a considerable amount of input from resource managers, scientists, stakeholders, and the general public. The Water Quality Steering Committee had an oversight role in the development of the WQPP.

What is the geographic area of the plan?

The plan covers the Florida Keys National Marine Sanctuary which is a 2800 square nautical mile area that runs offshore from the northernmost portion of the Biscayne National Park along the 300' depth contour all the way to the west of the Dry Tortugas National Park and back to the Everglades National Park on the Gulf side of the Florida Keys. Card Sound and Barns Sound are both located within the boundary of the Sanctuary. The Sanctuary boundary includes 65% state waters and 35% federal waters. The boundary only included the marine waters and goes to mean high water. Canals and open man-made bodies of water that are included within the Sanctuary.

What is the scope of the plan?

The decline in the nearshore water quality of the Florida Keys was recognized by Congress when they designated the Sanctuary and directed the EPA to work with the State and NOAA to develop a Water Quality Protection Program (WQPP). The final plan contains a Water Quality Action Plan that has specific solutions to addressing water quality problems and establishes corrective actions to solve water quality problems. The purpose of the Water Quality Protection Program is to recommend priority corrective actions and compliance schedules addressing point and non point sources of pollution to restore and maintain the living coral reefs and other critical marine life in the Sanctuary. The WQPP consists of four interrelated components: 1) corrective actions that reduce water pollution directly by using engineering methods, prohibiting or restricting certain activities, tightening existing regulations, and/or increasing enforcement; 2) monitoring that includes a comprehensive, long-term water quality monitoring program has been designed to provide information about the status and trends of water quality and biological resources in the Sanctuary; 3) research/special studies that are designed to identify and understand cause and effect relationships involving pollutants, transport pathways, and biological communities of the Sanctuary; and 4) public education and outreach programs that are designed to increase public awareness of the Sanctuary, the WQPP, and pollution sources and impacts on Sanctuary resources.

The final plan also addresses water quality problems ranging from Florida Bay to the nearshore waters of the Keys. The Sanctuary brings National, as well as a State, interests and resources to resolving the water quality problems in the Keys. The final plan provides tools for improving water quality within the Sanctuary and identifies specific projects to determine sources of water quality problems. The plan uses demonstration projects to assess the best available technology for treating wastewater and provides for monitoring to determine what is or is not working. The Water Quality Action Plan outlines research and monitoring programs that will provide the best scientific data for basing management decisions.

The final management plan integrates the Sanctuary into the South Florida ecosystem restoration effort as a major ecological component of the ecosystem. The plan integrates the Sanctuary's water quality protection program with local, State, and other Federal programs that address water quality in the Sanctuary. The National significance of the Sanctuary resources has attracted other Federal and State agency interests in restoring the water quality of the Sanctuary.

More information can be obtained by visiting our website:
http://www.fknms.nos.noaa.gov.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The ecosystem approach to management of natural resources, coupled with an integrated and comprehensive approach to management are two key objectives of the FKNMS Final Management Plan and the Water Quality Protection Program as they relate to the BBPI. Additionally, the decline in water quality in the Sanctuary is directly attributable to land-base sources coupled with changes linked to global climate change. The impact of water quality degradation in the Florida Keys on the coral reefs and seagrasses is a major concern to resource managers and citizens in the area. These water quality problems directly relate to similar issues in Dade County and the health of Biscayne Bay directly relates to the health of Sanctuary resources.

For further information, contact: Billy Causey, FKNMS, (305) 743-2437.

LONG RANGE DREDGED MATERIAL MANAGEMENT PROGRAM

For the Atlantic Intracoastal Waterway in Florida

Who did the plan?

Florida Inland Navigation District (District or FIND).

When was the plan completed?

In 1986 the District initiated a program of long-range dredged material management.

What is the status of the plan?

Work on the program is scheduled to continue through the year 2000, at which time all of the 12 County Plans in the District will have been completed and implemented. The waterways in Dade and Broward Counties have been the last to undergo analysis. This work is being performed, for FIND, by the consulting engineering firm of Taylor Engineering, Inc. of Jacksonville, Florida.

To date this planning effort in the other 10 counties of the District has identified approximately 44.6 million cubic yards (cyds.) of sediment to be maintenance dredged from 342 miles of waterway channel over the next 50 years. Of this dredging volume, 21.5 million cubic yards of sand have been identified as potentially beach quality material and 6 permanent beach placement areas have been identified and designed for these materials. The other 23.1 million cyds. of sediment contains levels of silt that preclude this material from being placed on the beach. These sediments will be temporarily stored in 50 upland containment sites where the material will be selectively excavated and used beneficially. Additionally, at least 3 million cyds. of beach quality materials will be offloaded from existing sites in the vicinity of ocean inlets and transported to ocean beaches thereby returning this sediment to the coastal system.

What entities were involved in the plan?

The District's program is being executed in close cooperation with the Jacksonville District Corps of Engineers. This work is being performed, for FIND, by the consulting engineering firm of Taylor Engineering, Inc., Jacksonville, Florida.

What is the geographic area of the plan?

When fully implemented this program will provide a permanent infrastructure of management facilities for all maintenance material dredged from the 374 miles of Intracoastal Waterway channel connecting Fernandina Harbor in Nassau County with Miami Harbor in Dade County and for 15 miles of the Okeechobee Waterway from its confluence with the Intracoastal Waterway to the first navigation lock (collectively referred to as the waterway).

What is the scope of the plan?

The identification and permitting of suitable dredged material management areas for the Atlantic Intracoastal and Okeechobee Waterways in Florida has become increasingly difficult. This has resulted from the nature of dredging, the requirements of handling and storing dredged material, and the environmentally sensitive and rapidly developing areas in which these operations are performed.

The District's program, executed in close cooperation with the Jacksonville District Corps of Engineers, comprises three main elements: (1) a two-phased plan development and property acquisition element, (2) a facility permitting and construction element, and (3) a facility operation element. Program execution begins with the development of long-range dredged material management plans for the waterway on a county-by-county basis (Phase I of the planning and property acquisition process). Upon finalization of each plan, Phase II of the planning and property acquisition process begins with site boundary surveys. The process continues with detailed environmental site characterizations, soils testing, topographic surveys, preliminary facilities design and site plans, site operation and management plans, and a summary of expected costs for site development and operation. Attachment A provides the details on this two phased plan development process. All of this information is then used for property acquisition and facilities permitting.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Once dredged material management needs have been addressed, resources can be directed to the control of sediment in-flow into waterways such as Biscayne Bay and Miami Harbor. Each long range dredged material management plan includes a general identification of the source of the sediments entering into the waterway channel. This sediment in-flow is being addressed by the District and other government agencies through cooperative projects involving inlet management, stormwater control and shoreline stabilization. If successful, sediment in-flow reductions will save local and federal maintenance dredging funds, increase the length of time to fill the upland sites to capacity, reduce the impact of suspended sediments on the environment of Florida's waterways and increase retainage of these sediments in our beach and upland systems.

Attachment A–Development of a Long Range Dredged Material Management Program for the Atlantlc Intracoastal Waterway In Florlda

Introduction

The identification and permitting of suitable dredged material management areas for the Intracoastal Waterway in Florida have become increasingly difficult. This has resulted from the nature of dredging, the requirements of handling and storing dredged material, and the environmentally sensitive and rapidly developing areas in which these operations are performed. In response to this situation, the Florida Inland Navigation District (FIND) initiated, in 1986, a program of long-range dredged material management. When fully implemented this program will provide a permanent infrastructure of management facilities for all maintenance material dredged from the 374 miles of Intracoastal Waterway channel connecting Fernandina Harbor in Nassau County with Miami Harbor in Dade County.

The FIND's program, executed in close cooperation with the Jacksonville District Corps of Engineers, comprises three main elements: (1) a two-phased plan development and property acquisition element, (2) a facility permitting and construction element, and (3) a facility operation element. Program execution begins with the development of long-range dredged material management plans for the Waterway on a county-by-county basis (Phase I of the planning and property acquisition process). Upon finalization of each plan, Phase II of the planning and property acquisition process begins with site boundary surveys. The process continues with detailed environmental site characterizations, soils testing, topographic surveys, preliminary facilities design and site plans, site operation and management plans, and a summary of expected costs for site development and operation. All of this information is then used for property acquisition and facilities permitting.

Background

Since its formation in 1927, the FIND has served as the state governmental body responsible for maintaining the ICWW channel along Florida's east coast between Fernandina Harbor and Miami. As such, the FIND must provide the U.S. Army Corps of Engineers (COE) with sites suitable for placing material dredged from the authorized federal navigation channel.

Prior to the increased environmental awareness of the 1970's and the recognition by various federal and state regulatory agencies of the value of estuarine wetlands, a short-term economic approach guided management of dredged material. Engineering, cost, and operational considerations determined the design and execution of channel maintenance projects. A majority of the existing easements for the placement of dredged material were located entirely within the sovereign waters of the state and included both open water areas and expanses of pristine salt marsh and mangrove wetlands. Additionally, many landowners with holdings adjoining the Waterway sought to improve the development potential of wetlands by granting disposal easements and allowing the unconfined placement of maintenance material. This approach, combined with the desire of the dredging contractor to maximize operational efficiency, resulted in the proliferation of numerous small spoil mounds and islands lining the Waterway.

As a result of society's increased environmental awareness and the scientific knowledge supporting it, the unconfined placement of dredged material within wetland areas is no longer a responsible approach to the maintenance of the ICWW. Neither is it a realistic approach given present-day agency imposed permitting constraints. Current state and federal legislation mandates that all dredging and dredged material management activities satisfy a spectrum of environmental requirements dealing with water quality, habitat protection, threatened and endangered species, and the filling of wetlands. Specific prohibitions against the unconfined placement of dredged material in wetlands are contained in Sections 301 and 404 of the Clean Water Act (33 U.S.C. 403) administered by the U.S. Environmental Protection Agency, Section 10 of the Rivers and Harbors Act administered by the U.S. Army Corps of Engineers, and Chapters 253, 258, and 403 Florida Statutes and Chapters 17-4, 18-20, and 18-21 of the Florida Administrative Code administered by the Florida Department of Environmental Protection. In addition, local county and municipal governments typically address dredge-and-fill issues in local comprehensive planning documents within guidelines established by the state. The long-range implications of these constraints have become more apparent in the ensuing years as existing sites reach capacity and as the identification and permitting of dredged material management sites become increasingly difficult. Moreover, the intensive development pressure being experienced throughout coastal Florida has made the acquisition of additional sites an ever more expensive proposition.

In order to secure its ability to maintain the ICWW within the existing framework of engineering, operational, and environmental constraints, the FIND initiated a 15-year program of long-term planning and site acquisition to provide a means for accommodating all maintenance material dredged from the Waterway during the next 50 years and beyond.

Program Overview

The varied character of the Atlantic Intracoastal Waterway in Florida, as described above, required that a wide variety of factors and changing circumstance be considered in the development of a comprehensive and realistic dredged material management plan for the 374 miles of channel. The process by which this is being accomplished is addressed in the following sections.

To accomplish the overall program objective, work performed for the Waterway in each County is divided into two phases. The first phase addresses the formulation of a long range dredged material management plan for the entire length of channel within the County, the preparation of a plan document, and the preparation of a set of mylar photo-based plan sheets which show the federal channel right-of-way, cut by cut, and summarize all pertinent information for that sheet regarding historical dredging, shoaling, sediment characteristics, and recommended management sites. The second phase of work in each County finalizes the site selection process by the performance of a detailed site investigation of the primary candidate site within each dredging reach of the County. A detailed documentation package for each site is developed from these investigations to support the property acquisition process and the procurement of the necessary permits for long term maintenance dredging activities.

Phase I - Development of a Long Range Dredged Material Management Plan

Formulation of each County plan begins with a detailed analysis of all available historical data and engineering documents pertaining to previous dredging activity, shoaling, sediment characteristics, and all existing FIND easements or properties available to the Corps for dredged material management. This data allows for the rational development of a characterization of the channel shoaling throughout the County, the spatial variability of these rates, and where possible the physical and chemical characteristics of the material to be dredged. Concurrent with this effort, the existing inventory of FIND easements and sites is evaluated for feasibility of future use within the present day regulatory environment, and the practicality of dike construction and site access. The Waterway channel in the County is then divided into operational dredging reaches by factoring in the overall availability of undeveloped land, and operating pumping distances. A 50 year dredged material management requirement for each reach can then be calculated using the results of the historical data analysis. In arriving at this estimate, the projected 50 year dredged volume is scaled upward using a combined overdredging and bulking factor of 2.15.

Having established the usable inventory of dredged material management sites within the County, as well as the operational dredging reaches of the Waterway and their associated 50 year dredging requirements, work then proceeds on the identification of dredged material management options and candidate sites to meet these requirements. A set of guiding principles are first established to focus the site identification and selection process. These are referred to as the Management Concept, which can and does vary from reach to reach depending upon changing constraints and requirements. In general, however, each management concept attempts to satisfy as closely as possible the following conditions:

- All future dredged material will be confined to upland areas with good road access, except for those reaches where beach disposal is the preferred alternative.
- Sites will be established to provide centralized management in a minimum number of locations per operating reach of the Waterway.
- Management sites will be designed and operated as permanent facilities with the capability of the site being emptied and reused over multiple fifty year periods.

Candidate sites meeting these criteria are then identified using high altitude infrared photography, black and white aerial photography, wetlands inventory maps, soils inventories, and other available documents. Typically, 30 to 40 such sites are identified for a given County by this process. Following this identification process, each site is then subjected to further scrutiny by means of an on-the-ground preliminary inspection. Finally, a bank of primary and secondary sites for each reach is selected using the set of site evaluation listed below:

I. Engineering/Operational Considerations

A. Capacity.

B. Adequate Dike Material on Site.

C. Pumping Distance To Site.

D. Pipeline Access.

E. Upland Vehicular Access.

F. Soil Characteristics.

G. Return Water Access.

II. Environmental Considerations

A. Avoidance of Wetlands.

B. Minimizing Unavoidable Wetland Impacts.

C. Pipeline Access.

D. Quality of On Site Wetlands.

E. Quality of On Site Uplands.

F. Provision of Buffer Zone.

G. Archeological Value of Site.

H. Ground water Conditions.

I. Return Water Access.

III. Socioeconomic Considerations

A. Existing Land Use.

B. Adjacent Land Use.

C. Current Zoning Schemes.

D. Comprehensive Plan

E. County vs. Municipal Boundaries.

F. Property Ownership.

G. Ownership Boundaries

The final Long Range Dredge Material Management Plan for that County is then completed.

Phase II - Implementation of the Long Range Dredged Material Management Plan.

The second phase of work in each County finalizes the site selection process by the performance of a detailed site investigation of the primary candidate site within each dredging reach of the County. A detailed documentation package for each site is developed from these investigations to support the property acquisition process and the procurement of the necessary permits for long term maintenance dredging activities. Each site documentation package consists of the following:

(1) Property Boundary Survey

(2) Environmental Habitat and Vegetation Survey Report

(3) Topographic Survey

(4) Soils Survey and Report

(5) Site Narrative

(6) Permit Drawings

(7) Site Management Plan

(8) Site Cost Report

Normally, the sequencing of work during the plan implementation phase of the program proceeds as follows:

(1) All information available in the public records pertaining to site ownership, assessed value, property boundaries, pending development and permit applications, zoning, land use restrictions, and other potential site encumbrances is gathered and reviewed. Included in this work is a detailed search of the property deed information.

(2) Property owners are notified by FIND of the State's interest in acquiring the site and are requested to sign a written agreement authorizing FIND and Corps of Engineers personnel and agents to enter the property for evaluation and testing purposes.

(3) Property boundary, roadway, and pipeline easement surveys, are performed and monumented. A detailed environmental survey of the property is then completed to document site habitats, plant and animal species, and the existence of threatened and/or endangered species.

(4) Using the access agreements and the boundary surveys, the Jacksonville District Corps of Engineers performs the required topographic and soils surveys of the sites.

(5) Preliminary site plans and design documents for the dredged material management facilities are then prepared. These include dike plans and sections, ramps, excavation depths, dike material requirements, weir sizing and placement, pipeline routing and easements, buffer and vegetation plans, and a hydraulic analysis of the expected settling efficiency of each containment basin. Results of this work are summarized in a 5 to 10 page site narrative for each site and a set of completed site permit drawings which include:

- Site Location Map
- Site Plan
- Pipeline Easement Plan
- Typical Dike Section
- Typical Ramp Section
- Site Vegetation Plan
- Site Wetland Map
- Historical Sediment Time Settlement Curves and Core Boring Logs (if available)

(6) Following the completion of the site plans and containment facility designs, a Management Plan document is then prepared for each site. This document addresses various aspects of the site design and long term operation of the facility. It is divided into three main sections. The first discusses pre-dredging and site design features, including site preparation, site design capacity, interior earthworks, existing easements, ramps, design ponding depths, dike erosion and vegetation, inlet works, and weirs. The second section addresses site operational considerations during dredging, including pipeline placement, inlet operation and monitoring, weir operation and effluent monitoring,

and groundwater monitoring. Finally, the report addresses post-dredging site management operations, such as dewatering, material grading and stormwater control, material handling and reuse, monitoring, mosquito control, and site security.

(7) Each site documentation package is completed with the preparation of a Site Cost Report which summarizes the estimated costs to prepare the site and construct the facility, the costs incurred during dredging operations, and, the costs incurred, between successive dredging operations.

Property Acquisition

Table Two lists the status of the acquisition of dredge material management sites selected through this planning process up to August of 1993. Forty-six (46) sites totaling 2758 acres have been identified to provide management capabilities for 282 miles of channel and approximately 41.5 million cubic yards of dredged material over a 50 year period. Of these sites, 29 are now owned or controlled by the FIND, 5 sites are under purchase agreement, 4 sites are partially purchased and 8 sites are under second phase investigation. To date approximately $18 million has been spent by FIND for site acquisition. It is estimated that it may require up to 65 sites for the permanent infrastructure of dredged material management sites along the entire 374 miles of Atlantic Intracoastal Waterway channel.

Facility Permitting and Construction

The U.S. Army Corps of Engineers has the responsibility, as the Federal sponsor, to permit and construct these dredge material management facilities. This is accomplished using the documents prepared by FIND in the Phase II process. Once a site is permitted the State may issue maintenance dredging permits for that dredging reach of up to 25 years. To date four sites have been permitted and constructed, two sites are in the permitting process and several sites are in a phased development stage where the first development will only include fencing of the site and clearing of the future construction area.

Facility Operation

All sites designed through this program will be operated in perpetuity through a site specific management plan that is developed in the Phase II process. This management and operation plan sets forth procedures to be followed during dredging events, post-dredging and pre-dredging as well as surface water management, material handling and reuse, monitoring and any joint use elements that may be in place.

An important secondary aspect of the long range dredge material management program, that has been developed by the FIND's Board of Commissioners, is to provide beneficial uses of the dredged material and the dredged material management sites. To date, plans have been put in place to renourish approximately 4.2 miles of beach with approximately 19 million cubic yards of beach quality sand. In addition all upland containment sites will be operated to render the dredged material usable for public or private projects at no cost. Finally, sites that are determined to have infrequent use or strong public interest will be have joint public use incorporated in the management plan. To date eleven sites have joint recreation or conservation use plans developed for them and three sites have lease for citrus production in the buffer areas. A site is also being developed at Kennedy Space Center to provide material for the restoration of marshes impacted by barrow operations in the past.

Summary

While the program is not complete, the regulatory agencies are very encouraged and supportive of the approach that has been developed by FIND and the Army Corps of Engineers to provide a long term solution to the proper handling and management of dredged material from the Atlantic Intracoastal Waterway project for the protection of the environment. This cooperative solution to the problem ensures that the waterway will remain a viable navigation corridor along the East Coast of Florida.

For further information, contact: David K. Roach, Florida Inland Navigation District, (561) 627-3386.

THE MIAMI RIVER: A CALL TO ACTION

Miami River Study Commission Report

Who did the plan?

The plan was written by the members of the Miami River Study Commission: Mayor of Miami-Dade County, Mayor of City of Miami, Miami-Dade County State Attorney, Secretary of Community Affairs, Chairperson of the Quality Action Team, Chairperson of the Miami River Coordinating Committee, Chairperson of the Miami River Marine Group, Chairperson of the Marine Council, Chairperson of the Downtown Development Authority, Chairperson of Homeowners Association, Chairperson of the Dade County Legislative Delegation and three community volunteers. This Study Commission was created by the State Legislature to "conduct a comprehensive study and review of the restoration of the Miami River and Biscayne Bay."

When was the plan completed?

January 28, 1998.

What is the status of the plan?

This plan is the basis for all actions of the Miami River Commission. Working groups were defined based on the tasks outlined in the plan.

What entities are involved in the plan?

Entities that are involved in the plan are the same entities that created the plan plus- Greater Miami Chamber of Commerce, South Florida Water Management District, Commissioner from the County and City, U.S. House and Senate representatives, Coast Guard Captain of the Port. The required development of the Working Groups has opened the river improvement process to a variety of experts, agencies and individuals as the Commission operates under the "Sunshine" laws of the State of Florida.

What is the geographic area of the plan?

The geographic area is not clearly defined but in general includes the "Miami River Corridor." The Miami River Commission (MRC) has utilized 2500 feet from the river while designing the Miami River Greenway Action Plan. The stormwater system that drains to the river covers a 69 square mile area and significantly contributes to water quality issues. Our general rule is—if it **IMPACTS** the river —we will get involved.

What is the scope of the plan?

The plan outlines the history and development of the Commission, the importance of the Miami River, general problem statement and conclusions. Next and most importantly the plan makes recommendations on specific areas such as (1) Management, (2) Dredging, (3) Water Quality, (4) Enforcement, (5) Derelict Vessels and (6) Land Use and Development. Under each of the above areas the problems are defined and solutions recommended. The plan breaks down the recommended solutions into tasks and identifies the lead agency/group to accomplish each specific task. In some cases it also recommends the anticipated funding requirements and source.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The management section directly relates to the BBPI. The management or oversight of the Miami River has been a long-standing problem and the River's management problems are very similar to the problems confronting management of Biscayne Bay. The Bay (just like the River) has numerous agencies that have various levels of jurisdiction, but no one agency or group oversees all issues that affect the Bay. There is no clearinghouse agency that can advise or direct citizens to the proper agency for specific issues.

Who is in charge of the Bay?

The law that established the MRC creates a **Policy Committee** consisting of key individuals and stakeholders, which is critical to the success of the Commission. **Working Groups** focused on specific problem areas such as Dredging, Quality of Life, Public Safety, etc. report to the Policy Committee for final decisions and actions. Most critical to the success is the requirement for **fulltime staff** to implement the decisions of the Policy Committee and coordinate the Working Groups.

Water quality issues contained in the MRC plan directly relate to the BBPI.

For further information, contact: David Miller, MRC, (305) 361-4850.

SOUTH DADE AGRICULTURE AREA STUDY

The Agricultural Element of the South Biscayne Bay Watershed Management Plan

Who did the plan?

The study is being compiled and completed by the Institute for Food and Agricultural Sciences (IFAS), University of Florida through a contractual agreement with the Florida Department of Agriculture and Consumer Services (FDACS).

When was the plan completed?

The study will be completed by March 2001, with the GIS/database portions being submitted to Miami-Dade County for their use by the fall of 2000.

What is the status of the plan?

The study has been initiated with a completion date of March 2001.

What entities were involved in the plan?

IFAS, FDACS, Miami-Dade County.

What is the geographic area of the plan?

South Dade agricultural area.

What is the scope of the plan?

It is the Intention of the FDACS in the performance of this study to retain agriculture and rural land uses through the enhancement of the economic viability of commercial agriculture in Miami-Dade County. The main purpose of this study shall be the collection and analysis of data concerning the long-term economic outlook of the agriculture industry and the development of recommendations to enhance the industry's economic viability. It is also the intention of FDACS and the County Commission that this study, and any potential resulting ordinances, shall not have an adverse effect on the value of or use of property in the study area. The purpose of this study is to provide information and recommendations to FDACS and Miami-Dade County government and the citizens of Florida and particularly the citizens of Miami-Dade County to improve current and future planning.

1.a Objective: Provide an overview of the natural and developed environment of the study area and describe the agricultural practices associated with each major crop or commodity group.

1.b Objective: The University of Florida's August 1997 "Economic Impact of Agriculture and Agribusiness in Dade County, Florida", submitted to the Miami-Dade County Farm Bureau in fulfillment of Sponsored Program Agreement 96093-C, shall be updated as appropriate and expanded to include organic agriculture and aquaculture.

1.c Objective: Provide an overview of the current economic environment, and the outlook on the future of the local agricultural industry.

1.d Objective: Identify and describe allied uses which are directly supportive of the local agricultural industry, also those allied uses supported by the local agricultural industry, either of which can or should operate in close proximity to the production areas.

1.e Objective: The University of Florida will provide data from deliverables, as identified in Tasks 1.a. through Tasks 1.d., in a timely manner to assist the County's consultant (Tischler & Associates) in their development of the "Public Sector Fiscal Impact Analysis."

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Objective: Provide an overview of the natural and developed environment of the study area and describe the agricultural practices associated with each major crop or commodity group.

Principal Staffing: The University of Florida and its Tropical Research and Education Center (TREC).

Strategy: This task involves the description and mapping of elements that comprise the natural and developmental environment of the study area. At a minimum, these features shall include soils, land and water elevations, drainage areas, resource policies, land uses, and the use and availability of land for particular crops. The information for all of these elements is expected to exist and will need to be researched, identified, collected and compiled into a format suitable for comparison, analysis and presentation. This task shall require the use of Geographic Information Systems (GIS) technology to efficiently perform these operations.

Data sources for this task are anticipated to include but are not limited to the United States Geological Survey, Miami-Dade County, the South Florida Water Management District, and the University of Florida and the Florida Cooperative Extension Service. It is anticipated that a majority of this data will be available in a digital format that will only require registration and transformation to a common coordinated system.

The University of Florida shall be responsible for collecting and compiling all the land-use and physical GIS databases described in deliverables for Task 1a. into overlayable formats for ARC/INFO which shall be compiled into a map atlas.

The University of Florida shall identify and map in a GIS ARC/INFO database, specific tree crops, row crops, and container and field nurseries to augment Miami-Dade County's map of existing agricultural land use. Identification and GIS mapping of container & field nurseries and specific tree crops shall be a major objective of the University of Florida, TREC faculty because of their relatively high value, sensitivity to environmental conditions, and sometimes intensive cultural practices. GIS mapping of these specific crops shall be expedited to the fullest extent possible, for time is of the essence, utilizing the latest available aerial photography acquired by the University of Florida, the GIS agricultural land use maps from Miami-Dade County, and ground-truthing by University of Florida personnel. Provided sufficient cooperation can be obtained from major growers, the percentage of lime trees categorized as "budded" and the percentage categorized as "marcot" shall be estimated as part of this subtask. A minimum of six copies of the agricultural GIS database(s) collected and compiled by the University of Florida shall be provided on computer diskettes or CD-ROMS in ARC/INFO format to FDACS.

Task l.a.(2) Database Creation

In addition to geographic mapping of specific row and tree crops, and container and field nurseries, the University of Florida, Institute of Food and Agricultural Sciences (IFAS) researchers shall develop databases using voluntarily-obtained information pertinent to all major crops, i.e. those with total commercial production greater than 100 acres or with significant agricultural value. Such data shall include current crop inputs (i.e. general irrigation, fertilization and pesticide requirements) and current crop outputs (i.e. crop yields) for major tree crops, vegetable crops, field nurseries, etc. The University of Florida shall format the data according to an outline mutually agreed to by the County's consultant and the University of Florida. This shall include general descriptions of usage patterns of inputs such as irrigation, fertilizers, and pesticides. University of Florida researchers shall also develop yield databases for these major crops where yields are a function of soil types and water table depths.

GIS maps and associated data of specific crops shall be used in the identification and analysis of geographic areas where agriculture exists. Maps of existing crops that indicate the biodiversity of agricultural production in South Dade County shall be created.

For each major crop, pertinent and significant land-use practices shall be described. These land-use practices shall include generalized descriptions of major land characteristics i.e. salinity, water usage, location requirements, desirable water tables, flood tolerance, on-site operations including pest management and irrigation practices, and estimated operational costs of the crop.

Task l.a.(3) Study Model and Maps

Information from Task l.a. (l) and the maps and information developed in Task 1.a.(2), by the University of Florida, shall be analyzed and synthesized. The University of Florida shall synthesize all applicable information in order to identify, for various types of agricultural production, the requirements for the successful cultivation of specific crops. The University of Florida with review, input and comments from the County and Advisory Committee shall identify criteria that will be used to determine the most suitable lands for the production of specific crops (i.e. soil type, water table depth, etc.) The University of Florida shall review the data, and describe the methods used to collect the data. The suitability criteria and all applicable information will be synthesized in order to delineate: 1) lands suitable for all types of agricultural production; 2) lands suitable for a smaller number of nonetheless important crops 3) areas where natural event flooding or current or proposed groundwater elevations would affect agricultural practices. In addition, a description shall be provided of ongoing major planning studies or projects, which may result in changes to the data and maps already obtained.

Once all of the data has been compiled, the GIS database shall be relied on for the preparation of maps at varying scales and color formats. The database shall also support various analyses, including overlaying different data elements, combining data elements and developing new data sets through the application of algorithms to the existing information. All information, data and analysis shall be presented to the Advisory Committee. Every effort shall be made to reflect the most recent, current data available.

Deliverables:

Maps

1) The University of Florida shall prepare maps delineating the land most suitable for production of various crops considering physical/environmental limitations, and existing land use.

2) The University of Florida shall prepare indices of coverages, and databases with associated descriptive text identifying each of the items listed below. The following information shall be digitally mapped to the extent that the information is digitally available and can be produced from existing Arc/Info compatible GIS data bases and maps, including Florida Power & Light Co. data and maps, which are available and which may be reproduced by the County and/or it's Consultants:

   i) Locations of specific perennial tree crops (groves) in database and map formats based upon the most recent perennial tree crop maps and underlying GIS data as provided by the County. Specific tree crops will be identified through aerial photographs, grower interviews, and ground truthing.

   ii) All commercial crops with aggregate acreage greater than 100 acres or that provide significant agricultural value (including aquaculture).

   iii) Detailed narrative descriptions and characteristics of each major crop and commodity group.

   iv) The University of Florida shall prepare agricultural maps based on the suitability criteria. In addition, a description shall be provided of ongoing major planning studies or projects, which may result in changes to the data and maps already obtained.

Objective: The University of Florida's August 1997 "Economic Impact of Agriculture and Agribusiness in Dade County, Florida", submitted to the Miami-Dade County Farm Bureau in fulfillment of Sponsored Program Agreement 96093-C, shall be updated as appropriate and expanded to include organic agriculture and aquaculture.

Principal Staffing: University of Florida, Florida Agricultural Market Research Center, Food and Resource Economics Department.

Task l.c. Economic Outlook

Objective: Provide an overview of the current economic environment, and the outlook on the future of the local agricultural industry.

Principal Staffing: The University of Florida.

Strategy: This task will occur in three major subtasks, as set forth below. The University of Florida shall provide: (1) an examination of qualitative information and quantitative data to estimate the impact of changes in the regulatory environment and trade practices; and (2) a quantitative analysis (using appropriate analytical techniques) to estimate trends in production acreage, yields, crop values, and costs of production and to make appropriate projections. The University of Florida, in consultation with the Advisory Committee, shall establish the appropriate sectors or commodity groups to be separately projected in this work activity. In addition, (3) the University of Florida shall organize a " future technology and practices workshop bringing together key researchers and industry representatives. The workshop shall be conducted as a research activity to stimulate a creative, yet realistic assessment of emerging technologies that are likely to impact the economic future of agriculture in Miami-Dade County.

For further information, contact: John C. Folks, FDACS, Office of Agricultural Water Policy, (850) 414-9928.

OLETA RIVER STATE RECREATION AREA

Unit Management Plan

Who did the plan?

Florida Department of Environmental Protection.

When was the plan completed?

The draft of the plan was completed September 23, 1996. The Land Management Advisory Council (LMAC) review Draft was completed on January 31, 1997.

What is the status of the plan?

The plan was adopted and has been partially implemented, within the constraints of staffing and funding.

What entities were involved in the plan?

The following entities are listed in the plan as having "major or direct role in the management of the park":

Department of Agriculture and Consumer Services, Division of Forestry

Florida Game and Fresh Water Fish Commission

Department of State, Division of Historical Resources

Department of Environmental Protection, Division of Marine Resources

The following entities were offered an opportunity to review and comment on the plan:

Miami-Dade County Commission

South Florida Water Management District

South Florida Regional Planning Council

What is the geographic area of the plan?

The geographic area of the plan is for the property known as Oleta River State Recreation Area. This property is located in Miami-Dade County within the City of North Miami. It is approximately 11 miles northeast of central Miami. Access is from State Road 826. The property includes approximately 1,033 acres.

What is the scope of the plan?

The plan serves as the basic statement of policy and direction for the management of Oleta River State Recreation Area as a unit of Florida's state park system. It identifies the objectives, criteria and standards that guide each aspect of park administration, and sets forth specific measures that will be implemented to meet management objectives.

The plan consists of two interrelated components. Each component corresponds to a particular aspect of the park's administration. The resource management component provides a detailed inventory and assessment of the park's natural and cultural resources. Resource management problems and needs are identified, and specific management objectives are established for each resource type. This component provides guidance on the application of such measures as prescribed burning, exotic species removal, and restoration of natural conditions.

The land use component is the recreational allocation plan for the unit. Based in considerations such as access, population and adjacent land uses, and optimum allocation of the park's physical space is made, locating use areas and proposing types of facilities and volume of use to be provided.

What are the key goals that directly relate to the Biscayne Bay Partnership Initiative?

- Restore and enhance fringe mangrove communities by improving tidal connections and reconstructing the shoreline adjacent to existing fringe mangroves
- Re-vegetate ruderal uplands with native species to create functional maritime hammock
- Pursue and support enforcement measures through the Florida Park Patrol, Florida Marine Patrol, and local law enforcement, which help maintain slow and idle speed zones in the river and bay to protect manatees and prevent shoreline erosion.
- Restrict use of motorized vehicles in the lagoon and river for the protection of manatees and the public recreating in the park waters.
- Encourage the county to replace existing sewer line adjacent to the park to minimize sewage contamination in park waters.
- Continue to advise EPA regarding cleanup of the Munisport landfill to minimize impacts to the park's water quality, wetlands, submerged communities.
- Pursue an increase in water quality testing by DERM at the mangrove preserve and in nearby bay water waters to assess the impacts of the Munisport landfill.
- Coordinate with SFWMD and DERM regarding management of the Snake Creek Canal, which is upstream of Oleta River.
- Develop new interpretive programs and enhance existing programs, seek funding for fishing platforms, seek funding for canoe launch and docks.

For further information, contact George Jones, FDEP, (561) 546-0900.

BILL BAGGS CAPE FLORIDA STATE RECREATION AREA

Unit Management Plan

Who did the plan?

Florida Department of Environmental Protection, Division of Recreation and Parks. Staff from the Park, from the Recreation and Parks District 5 Office and from the Office of Park Planning participated.

When was the plan completed?

The park's unit management plan is updated every five years. The latest update is currently being drafted. The last fully revised plan was approved on October 10, 1991; Addendum 9 was approved on July 21, 1993 and subsequently re-approved administratively.

What is the status of the plan?

Approved by the Governor and Cabinet in the summer of 2000 and implemented thereafter.

What entities were involved in the plan?

Primarily the Division of Recreation and Parks; Park staff, District staff and administration and the Office of Park Planning, with public input.

What is the geographic area of the plan?

The plan applies to the park's lands at the southern end of Key Biscayne, as well as to a management zone that extends outward 400 feet from the Park's Biscayne Bay border and Atlantic Ocean shoreline and approximately halfway across Pines Canal to the North.

What is the scope of the plan?

The plan is the basic statement of policy direction for the management of the park as a unit of Florida's state park system. It identifies the objectives, criteria and standards that guide each aspect of the park administration, and sets forth the specific measures that will be implemented to meet management objectives. The plan is intended to meet the requirements of Sections 253.034 and 259.032, F.S., chapter 18-2, F.A.C., and intended to be consistent with the State Lands Management Plan. All development and resource alteration encompassed in this plan is subject to the granting of appropriate permits, easements, licenses, and other required legal instruments. Approval of the management plan does not constitute any compliance with the appropriate local, state, or federal agencies. This plan is also intended to meet the requirements for beach and shore preservation, as defined in Ch. 161, F.S., and Chapters 62B-33, 62B-36 and 62R-49, F.A.C.

The plan consists of two interrelated components. The resource management component provides an inventory and assessment of the natural and cultural resources of the park, identifies management problems and needs, and establishes specific management objectives for each resource. The land use component is the recreational resource allocation plan for the park. It locates use areas and proposes types of facilities and volume of use to be provided.

What are the key goals of objectives that directly relate to the Biscayne Bay Partnership Initiative?

The plan includes the goal of preserving, restoring and protecting the park's native flora and fauna from human-related impacts. Objectives are the continuation of the restoration of the park's plant communities; the continuation of the monitoring and protection of sea turtle nests; better protection of marine life through increased enforcement of existing regulations and increased informational and regulatory signage; better protection of the park's seagrass beds and other marine substrate communities through the placement of boundary buoys and restrictions on anchoring and swimming along the western seawall; and the monitoring of water quality in the park's harbor, Pines Canal and the newly restored tidal wetlands. As such proper instrumental of activities and resources along Biscayne Bay, including No Name Harbor, are instrumental in enhancing the viability of this water of critical concern.

For further information, contact George Jones, FDEP, (561) 546-0900.

JOHN PENNEKAMP STATE PARK - KEY LARGO

Unit Management Plan

Who did the plan?

District 5 Biologists; Park Management; Planners and Biologists with the Office of Park Planning.

When was the plan completed?

March 20, 1998.

What is the status of the plan?

Adopted and implementation begun.

What entities were involved in the plan?

Division of Recreation and Parks; Division of State Lands; the public during open public meetings.

What is the geographic area of the plan?

Upper Keys (Key Largo)

What is the scope of the plan?

Management Program Overview

- Management Authority and Responsibility
  - Park Goals and Objectives
  - Management Coordination
- Resource Management Component
  - Resource Description and Assessment
    - Natural Resources
    - Cultural Resources
- Resource Management Program
    - Management Needs and Problems
    - Management Objectives
    - Management Measures for Natural Resources
    - Management Measures for Cultural Resources
    - Research Needs
    - Resource management Schedule

Land Use Component

External Conditions

Existing Use of Adjacent Lands

Planned Use of Adjacent Lands

Property Analysis

Recreation Resource Elements

Assessment of Use

Conceptual Land Use Plan

Potential Uses and Proposed Facilities

Existing Use and Optimum Carrying Capacity

Optimum Boundary

Table - Existing Use and Optimum Carrying Capacity

Addendums: Trust Fund Lease Agreement - References Cites - Soil Descriptions - Natural Community Descriptions - Plant and Animal – Designated Species - Maps - Location - Vicinity - Soils - Natural Communities - Cultural Resources - Exotics – Base – Conceptual Land Use Plan Optimum Boundary

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

- Protect and preserve park waters with emphasis on the reefs and shallow flats
- Acquisition of additional undeveloped uplands bordering park waters
- Monitor visitor use impacts
- Water quality monitoring
- Evaluate permit applications that may affect park waters
- Protect marine tidal swamps
- Protect water resources form dredge and fill impacts
- Educate residents, visitors and recreational boat operators, dive boats operators and fisherman.

For further information, contact George Jones, FDEP, (561) 546-0900.

BARNACLE STATE HISTORIC SITE

Unit Management Plan

Who did the plan?

Department of Environmental Protection; Division of State Lands.

When was the plan completed?

February 6, 1998.

What is the status of the plan?

On-going implementation.

What entities were involved in the plan?

Division of Recreation & Parks; Division of State Lands; Division of Historical Resources.

What is the geographic area of the plan?

5 Upland acres & 5 submerged acres.

What is the scope of the plan?

This plan serves as the basic statement of policy and direction for the management of The Barnacle State Historic Site as a unit of Florida's state park system. It identifies the objectives, criteria and standards that guide each aspect of park administration, and sets forth the specific measures that will be implemented to meet management objectives. The plan is intended to meet the requirements of Section 253.034, F.S., Chapter 18-2, F.A.C., and is intended to be consistent with the State Lands Management Plan. All development and resource alterations encompassed in this plan are subject to the granting of appropriate permits, easements, licenses, and other required legal instruments. Approval of the management plan does not constitute an exemption from complying with the appropriate local, state, or federal agencies. This plan is also intended to meet the requirements for beach and shore preservation, as defined in Chapter 161, F.S., and Chapter 62B-33, F.A.C.

The plan consists of two interrelated components. Each component corresponds to a particular aspect of the park's administration. The resource management component provides a detailed inventory and assessment of the park's natural and cultural resources. Resource management problems and needs are identified, and specific management objectives are established for each resource type. This component provides guidance on the application of such measures as prescribed burning, exotic species removal, and restoration of natural conditions.

The land use component is the recreational resource allocation plan for the unit. Based on considerations such as access, population and adjacent land uses, an optimum allocation of the park's physical space is made, locating use areas and proposing types of facilities and volume of use to be provided.

During the planning process, all potential outdoor recreation uses are considered. Those found appropriate are discussed within this plan. Uses of property for mining, silviculture, range management, or other consumptive purposes, where not prohibited by legal restrictions, are considered inappropriate. Exceptions are evaluated on a case-by-case basis for compatibility with the unit's outdoor recreation and resource preservation purposes.

In the development of this plan, the multiple-use management potential of the property was analyzed. It was determined that the current single-use management designation is the most appropriate for this property as a unit of the state park system. However, compatible secondary uses of the property may be approved if they do not conflict with the outdoor recreation and conservation purposes, which the property is intended to serve.

The potential for generating revenue to enhance management was also analyzed. It was determined that multiple-use management activities would not be appropriate as a mean of generating revenues for land management. Instead, techniques such as entrance fees, concessions and similar measures will be employed on a case-by-case basis as a means of supplementing park management funding.

The use of private land managers to facilitate restoration and management of this unit was also analyzed. Decisions regarding this type of management (such as mitigation projects, removal of timber for resource protection or restoration, etc.) will be made on a case-by-case basis as necessity dictates.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

Preservation of remaining natural coastal hammock community.

For further information, contact George Jones, FDEP, (561) 546-0900.

SOUTH DADE WATERSHED PLAN

Who did the plan?

In 1998, the Florida Legislature appropriated $500,000 to initiate development of the South Dade Watershed Plan. These funds were directed to Miami-Dade County through the Florida Department of Environmental Protection (FDEP). On December 7, 1999, the Miami-Dade County Board of County Commissioners (BCC) approved a resolution authorizing the County Manager to execute an Agreement with FDEP to utilize these funds. The 1999 Legislature appropriated an additional $1,000,000 for this initiative, stipulating that $500,000 was to be earmarked for the agricultural component of the Watershed Plan. The County's approved 2000 State Legislative Package also contains a $1,000,000 appropriations request for the Watershed Plan. In March of 2000 this project was approved by the Water Advisory Panel established by Governor's Executive Order 99-288, and included in a list of projects submitted to the Senate for funding consideration.

One of the first tasks identified in the FDEP Funding Agreement is establishment of an Advisory Committee charged with reviewing and making recommendations regarding the draft Scope of Work prepared by the Biscayne National Park (BNP) Buffer "Land Bank Trust" Working Group (Working Group) for the Watershed Plan. This Advisory Committee was established via Ordinance 00-37, adopted by the BCC on March 21, 2000.

The language developed by the Working Group was ultimately incorporated into the CDMP as Land Use Element Policy 3E, adopted by the BCC in October of 1996. The Working Group then spearheaded development of a draft Scope of Study for the Watershed Plan, which was completed in December of 1997. The originally adopted target date for completion of the Watershed Plan was January 1, 2000. Policy 3E stipulates that this date may be extended by amendment to the CDMP. The Department of Planning and Zoning filed an application to amend Policy 3E by extending the deadline to January 1, 2002, as part of the April 1999 CDMP Amendment Application Cycle. The BCC approved transmittal of the proposed amendment to the Department of Community Affairs and other state agencies for review and comment on November 4, 1999. An ordinance providing for final disposition of the April 1999 amendment applications, including approval of the deadline extension for Policy 3E, was adopted by the BCC on March 28, 2000.

When was the plan completed?

The impetus for the Plan was an application filed by Biscayne National Park in 1995 to amend Miami-Dade County's Comprehensive Development Master Plan (CDMP). The Florida Department of Environmental Protection Agreement (see above) provides that Miami-Dade County, the South Florida Water Management District, and the South Florida Regional Planning Council (RPC) jointly develop and implement the Watershed Plan through a Memorandum of Understanding (MOU). A resolution authorizing the County Manager to execute an MOU between these agencies that outlines the timing of planning activities and respective responsibilities of the parties was approved by the RPC in May 2000 and by (BCC) in July 2000.

What is the status of the plan?

The plan will have two time horizons: a short-term component extending through the year 2015 and a long-term component extending through the year 2050.

What entities were involved in the plan?

The Florida Department of Environmental Protection, Miami-Dade County, the South Florida Water Management District, and the South Florida Regional Planning Council, among others.

What is the geographic area of the plan?

The South Dade Watershed is located in the southeastern portion of Miami-Dade County, between Everglades and Biscayne National Parks (BNP). The eastern boundary of the watershed begins at the eastern edge of the C-3 Canal Basin where it intersects Tamiami Trail, and proceeds southward along the shoreline of Biscayne Bay to the point at which the shoreline intersects with U.S. 1. The northern boundary is formed by the Tamiami Trail, excluding that portion of the C-4 Basin extending south of the Trail and including those portions of the C-1 and C-3 Basins extending north of the Trail. The western boundary begins at the western edge of the C-1 Basin where it intersects the Trail, and proceeds southward from the C-1 Basin in an irregular fashion along the Krome Avenue (SW 177th Avenue) corridor to the intersection of U.S. 1, and then follows U.S. 1 to land's end. The watershed is divided into a primary area, south of and including the C-2 Basin, and a secondary area consisting of the C-3 Basin.

What is the scope of the plan?

The South Dade Watershed Plan is designed to integrate land use and water management decisions. As originally proposed, a moratorium would have been placed on development in the southeast portion of the County. Local landowners and economic development interests objected strenuously to the proposed amendments, while environmental interests argued that they were needed in order to protect BNP. In an effort to reach community consensus, the Miami-Dade County Board of County Commissioners created the BNP Buffer "Land Bank Trust" Working Group. The Group was charged with balancing the environmental health of BNP with property rights of area landowners. The Working Group crafted consensus language addressing the issues of concern, which called for development of an integrated land use and water management plan for south Miami-Dade County (the Watershed Plan).

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiaitve?

Policy 3E stipulates that the Watershed Plan be based on a comprehensive study that analyzes and projects surface and ground water uses and corresponding land uses. Required components of the study include an analysis of all relevant studies pertaining to the watershed area, existing and needed numeric standards for the quality, quantity, timing and distribution of waters into and of Biscayne National Park, existing and needed water supply studies, best management practices for sources of stormwater runoff, and methods for integrating the Plan into the Restudy. The nexus between the Watershed Plan and the Restudy will most likely occur though the Restudy's Biscayne Bay Coastal Wetlands component, which is designed to rehydrate coastal wetlands, reduce point source discharges and develop management criteria for freshwater flows to southern and central Biscayne Bay.

Policy 3E states that the Watershed Plan must fulfill the following specific objectives:

- Identify and protect lands, including their uses and functions, that are essential for preserving the environmental, economic, and community values of BNP.
- Identify and establish mechanisms for protecting constitutional private property rights of owners of land identified above.
- Support a viable, balanced economy including agriculture, recreation, tourism, and urban development in the Plan area.
- Assure compatible land uses and zoning decisions in the Study Area consistent with long-term objectives for a sustainable South Miami-Dade.

It is anticipated that the total cost of the watershed planning project will be on the order of $3.5 million. The Advisory Committee includes representatives from agriculture, tourism, business, development, environmental interests, and civic organizations active in South Miami-Dade County, as well as local, state and federal government agencies. Because the Watershed Plan must address land use and water issues that cross jurisdictional boundaries, extensive interagency cooperation will be required. Accordingly, the FDEP Agreement provides that Miami-Dade County, the South Florida Water Management District, and the South Florida Regional Planning Council jointly develop and implement the Watershed Plan through a Memorandum of Understanding.

For further information, contact: Cindy Dwyer, Miami-Dade County P & Z, (305) 375-2835.

THE SOUTH DADE WATERSHED PROJECT

Who did the plan?

South Florida Water Management District.

When was the plan completed?

July 1995.

What is the status of the plan?

"Put on the shelf," but the plan won an American Institute of Architects national honor award in 1999 for urban and regional planning.

What entities were involved in the plan?

Wide local participation in a steering committee. Work accomplished primarily by University of Miami Center for Urban and Community Design, University of Florida Center for Wetlands and South Florida Water Management District.

What is the geographic area of the plan?

Cross section of southern Miami-Dade County.

What is the scope of the plan?

Land use, hydrology, drainage, water quality, climate and interconnectedness.

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The purpose of the plan was to create a vision and conceptual land use plan that would mitigate water quality and hydrologic impacts to Biscayne Bay while increasing the quality of life for residents.

For further information, contact: Rick Alleman, SFWMD, (561) 682-6716.

SOUTH FLORIDA MULTI-SPECIES RECOVERY PLAN

Who did the Plan?

United States Fish and Wildlife Service, Southeast Region

When was the plan completed?

May 1999

What is the status of the plan?

The plan provides a framework for the conservation of selected wildlife species in southern Florida, and serves as a guide in project planning, research, etc. The United States Fish and Wildlife Service will develop an implementation plan as part of the overall South Florida Ecosystem Restoration Initiative.

What entities were involved in the plan?

The plan was organized and written primarily by the staff of the United States Fish and Wildlife Service, with extensive input and contributions from individuals representing themselves, universities, other local, state, and federal agencies, and private conservation organizations.

What is the geographic area of the plan?

South Florida

What is the scope of the plan?

The plan includes two major sections: *The Ecological Communities*; and *The Species*. Eighteen communities are summarized along with federally listed species of birds, reptiles, mammals, invertebrates, and plants. Each community account includes information on synonymy, distribution, a description of the ecosystem and distinct community types, wildlife, ecology, status and trend, and management.

Ecological communities related to Biscayne Bay include:

Beach Dune/Coastal Strand/Maritime Hammock

Tropical Hardwood Hammock

Mangroves

Coastal Salt Marsh

Seagrasses

Nearshore and Midshelf Reefs

Species accounts include descriptions, distribution, habitat requirements, behavior, relationship to other species, status and trend, and management.

Examples of species relevant to Biscayne Bay include (but are not limited to):

American crocodile

loggerhead sea turtle

West Indian manatee

wood stork

Schaus swallowtail butterfly

What are the key goals or objectives that directly relate to the Biscayne Bay Partnership Initiative?

The primary objective of the document is to provide a baseline reference of information regarding selected listed species in southern Florida and their relationship to each other and the region's ecosystems. The sections on ecological communities provide useful background and some management recommendations that related to the BBPI. This is likewise the case for the species accounts, although additional species may be of concern for the BBPI that are not addressed in the plan.

For further information, contact: Mark Robson, Florida Fish and Wildlife Conservation Commission, (561) 625-5131.

REGULATION SURVEY TEAM

FINAL REPORT

BISCAYNE BAY PARTNERSHIP INITIATIVE

CONTENTS

INTRODUCTION

OVERVIEW

Biscayne Bay is perhaps our most important resource, and as such has over the years been the focus of any number of laws, acts, and regulations. These many regulations are administered by over three dozen governmental agencies, and well over a dozen municipalities have Bay-related ordinances.

One component of the Biscayne Bay Partnership Initiative is the regulatory environment of the Bay: which of these regulations have a critical impact, how effective they are in preserving the Bay for future generations, and what recommendations could provide better protection of Biscayne Bay in the new millennium.

ORGANIZATION AND STRUCTURE

The Regulation Survey Team was originally organized with the following Categories of Affiliation:

1. Federal
2. State
3. County/City
4. University
5. Non-Governmental Organizations
6. Private Sector

After identifying and categorizing the bay issues to be addressed by the team, members divided up into smaller "Issue" subcommittees. The three issue teams were: Education, Enforcement and Regulation.

A list of active team members, their affiliation and issue subcommittee assignment is in Appendix D to this report.

BACKGROUND

History of Regulation in the Bay

Biscayne Bay is a shallow 428 square mile subtropical lagoon which is approximately 40 miles long and extends the length of Miami-Dade County, Florida. Early activities such as dredge and fill operations, mangrove destruction, disposal of raw or poorly treated sewage, storm water outfalls, flood control projects, and shoreline development have substantially altered the character and quality of Biscayne Bay. Through a number of Management Plans, Biscayne Bay is in better condition today than it was 30 years ago. Some of the enacted plans and regulations that are enforced by Miami-Dade County, the State of Florida, and various federal agencies are:

Plan	Enacted
Biscayne Bay Aquatic Preserve	1974
Biscayne Bay "Aquatic Park and Conservation Area"	1976
Bay Management Committee	1981
Biscayne Bay Surface Water Improvement and Management (SWIM) Plan	1995
Federal Clean Water Act	1972
County Code, Ordinance 20-58, amended	1980
Dade Biscayne Bay Management Plan	1981

The Regulatory Environment

Work and activities in Biscayne Bay are regulated by any number of acts, plans and regulations. Those that the team used in developing this report include:

a. Surface Water Improvement and Management (SWIM) Plan
b. Biscayne Bay Management Plan
c. Biscayne Bay Aquatic Preserve Act and Rules
d. Shoreline Review Development Ordinance
e. Manatee Protection Plan
f. Miami-Dade Comprehensive Plan
g. Florida Forever Act
h. Chapter 24-Code of Metro-Dade County
i. Existing Submerged Lands and Environmental Resource Permitting Program (SLERP)
j. Federal Endangered Species Act
k. Federal Clean Water Act
l. Federal Coastal Zone Management Act
m. Marine Mammals Protection Act
n. Federal Rivers and Harbors Act
o. Various municipal regulations

Jurisdictions

Along with the plethora of regulations indicated above, Biscayne Bay also has many agencies and municipalities that have some degree of jurisdiction over it. In fact, there are at least 30 agencies (federal, state, local) and 17 municipalities that have some jurisdiction over the bay. A listing of these is contained in Appendix A.

Current Status of Biscayne Bay

a. Introduction

In the opinion of most people, Biscayne Bay today is in better "ecological shape" than it was 30 years ago. Many good things have happened in that time to create the improved Biscayne Bay we know today. However, many challenges still remain. Many of these assets and challenges are listed below.

b. Assets of, or related to, Biscayne Bay

1. The overall condition of the bay is better than it was 30 years ago.
2. In general, there are adequate regulations and agency structures in place to manage activities within the Bay.
3. The establishment of the Biscayne Bay Aquatic Preserve Act and Rules.
4. The establishment of the Water Pollution Control Act and other federal laws governing water pollution.
5. Prohibitions in the county code for non-water dependent activities on or adjacent to Biscayne Bay.
6. No variance allowed to specific policies of the Comprehensive Development Management Plan.
7. More accuracy in the federal decision-making process resulting in additional safeguards being integrated into the regulatory review process.
8. At the state level, regulatory time frames are specifically identified.
9. There are ongoing efforts to streamline state, local, and federal programs for projects on the bay.
10. Cooperative efforts of state and county agencies have greatly assisted the U. S. Coast Guard in identifying polluters.
11. The Florida Fish and Wildlife Conservation Commission has been responsive and effective.
12. The introduction of a "Task Force" approach (i.e., an organized coordination effort among law enforcement agencies) that helps maximize the enforcement effort.
13. Some required boater education has been established.

c. Challenges
   1. Current regulations are inadequate to protect against impacts to Biscayne Bay from development on lands within the watershed. This is of particular concern for the large undeveloped areas in southern Miami-Dade County.
   2. Maintain and improve bay access including preservation and management of remaining open spaces adjacent to Biscayne Bay such as Bicentennial Park.
   3. Staffing within regulatory and enforcement agencies at county, state, and federal levels continues to be insufficient.
   4. Budget constraints bring reduced compliance/enforcement resources to all agencies.
   5. There is no 24 hour law enforcement patrol for Biscayne Bay.
   6. The effects of population increases and resulting increase in use of the bay is exacerbated by the decrease in enforcement and regulatory assets.
   7. Although improved, there needs to be better coordination among governments.
   8. There are overlapping agency and local governmental jurisdictions.
   9. Water quality levels are, at times, below acceptable standards.
   10. There is a need for additional water quality test sites that properly document test results.
   11. There is a lack of consistency in federal, state and county water quality standards.
   12. There is insufficient maintenance and replacement of signage.
   13. There is an increased number of registered vessels in Miami-Dade County with access to Biscayne Bay.
   14. There is an identified need for both additional funding and a more expedient process for the removal of derelict vessels.
   15. There are potential impacts from unregulated boat anchorages such as Dinner Key.
   16. There has been no definitive study of the impacts by recreational, commercial, and other users on Biscayne Bay.
   17. Up to 1000 vehicles per year are being dumped in Miami-Dade County canals which are part of the Biscayne Bay watershed and thus affect overall water quality.
   18. There is no comprehensive list of bay resources for potential user groups.
   19. Boater education needs to be expanded.
   20. There is little coordinated effort toward public education of Biscayne Bay and its resources.

OBJECTIVES OF THE REGULATION SURVEY TEAM

Overall Team Objectives

a. Identify agencies with jurisdiction over Biscayne Bay.
b. Identify problem areas, determine how effectively current or conventional regulations address these areas, and whether innovative regulatory solutions from other locations would be appropriate.
c. Assess whether the current regulatory regime is
   1. current;
   2. comprehensive;
   3. balanced;
   4. compatible between and among jurisdictional entities;
   5. compatible with current management principles/models;
   6. effective;
   7. capable of enforcement; and
   8. has adequate resources to ensure satisfactory results.
d. Develop recommendations with regard to the above objectives.

Issue Subcommittee Objectives

a. Enforcement
The objective of the Enforcement Issue Subcommittee is to identify issues regarding enforcement of current marine regulations as they relate to Biscayne Bay and to recommend possible solutions to remedy identified problems.

b. Education
The objective of the Educational Issue Subcommittee is to identify the educational resources currently available from all entities involved in regulatory activities relating to the bay, and to make these resources readily available and easily accessible to all interested parties through a centralized information repository.

c. Regulation
The objective of the Regulation Issue Subcommittee is to identify issues involving the existing regulatory structure and to recommend possible solutions.

ISSUES IDENTIFIED

Enforcement

a. Increase the number of enforcement personnel
b. Address the need for more effective inter-agency coordination.
c. Address the need for maintenance of existing marine regulatory signage, as well as a provision for additional signage.
d. Increase the collection of data pertaining to user populations.

Education

a. Determining the target audiences and how they can best be identified.
b. Insufficient interaction in the regulatory process between educators and regulatory proponents.
c. Inadequate system of feedback from affected user groups to the regulators and legislators to improve the decision making process.
d. Lack of a centralized clearinghouse to collect available information and disseminate it efficiently to interested parties.
e. Identification of formal education programs that currently exist, and determination whether these programs are sufficient to represent all of the identified concerns.
f. Develop new initiatives.

Regulation

a. Areas of extraordinary significance such as, but not limited to, Biscayne National Park, Virginia Key Critical Wildlife Area and Oleta River State Mangrove Preserve have to be afforded a higher level of protection.
b. The need to determine if all individual governmental entities (county, municipalities, etc.) are aware of and comply with the existing regulations for bay shoreline development. If not, make them aware or encourage compliance.
c. Shorten the time frame for responding to the application for, and issuance of, permits.
d. Local and federal regulations have no mandated time frames.
e. State and local agencies need regulatory tools to enforce preservation of natural features violations.
f. Develop better inter-agency coordination between federal, state and local regulatory agencies to implement permitting decisions and mitigation recommendations, as well as take enforcement actions.
g. Though improved, water quality levels in Biscayne Bay need to be monitored and maintained.

SURVEY SECTION

INTRODUCTION

Once the subcommittees had identified the key issues in their area of study, they developed possible ways to deal with the various issues. In order to do so, they had to first examine existing conditions and activities, then access data available, and finally develop the subcommittees recommendations.

ACTIVITIES, CONDITIONS AND SOURCE MATERIAL

Enforcement

a. Conditions and Activities
    1. Miami-Dade County is ranked number one in fatal boating accidents in the State of Florida (per the Florida Fish and Wildlife Conservation Commission, 1999 Florida Boating Accident Statistical Report).
    2. Enforcement and support of the Miami-Dade County Manatee Protection Plan
    3. Violation of manatee speed zones by boaters.
    4. Mooring scars caused by anchorages. A good example is at Dinner Key.
    5. Recurring problems with solid waste/littering in the bay.
    6. Recurring problems with derelict vessels.
    7. Lack of 24 hour law enforcement patrols.
    8. The current positive working relationship between marine regulatory agencies in Miami-Dade County is considered an important asset.
    9. Current public outreach by Miami-Dade Police Marine Patrol and Marine Advisory Support Team (MAST).
    10. Overlapping jurisdictions of existing agencies.
    11. Propeller damage to bay bottom caused by: boaters not following channel markers, not being able to find a channel marker, uneducated boaters, or inadequately marked channels.
    12. Lack of maintenance of existing marine regulatory signage.

b. Source Material
    1. Personal/group knowledge
    2. Responses from Government Survey (See Appendix B)
    3. Responses from other Survey Teams regarding issues of Biscayne Bay.

Education

a. Activities and Conditions
    1. Most of the entities represented within the Biscayne Bay Partnership Iniatiative (Initiative) have educational programs and resources, but there is little or no coordination, information retrieval, or dissemination.
    2. Educational efforts are currently underway on the local, regional, national, and international level.
    3. Educational efforts seem to be focused on traditional user groups but need to diversify to reflect the complexion of the current community.
    4. Print medium seems to be the most prevalent form of educational outreach. Efforts should be made to incorporate new technology (video/internet access) in order to reach greater audience.
    5. Bay issues affect the entire watershed area, but educational efforts seemed to be focused primarily on active user groups.

6. Publicity/public education campaigns have been successfully used nationwide to heighten public interest and support for marine environmental protection and responsible use of resources (e.g., Save the Chesapeake Bay).
7. Greater emphasis needs to be focused on school children in grades K through 12 to impart a bay protection and environmental educational ethic early on.

b. Source Material
   1. Information supplied by other survey team members about educational programs.
   2. Personal knowledge of education subcommittee members.

Regulation

a. Activities and Conditions
   Using the groups understanding of past project reviews and existing regulations.
b. Source Materials
   Acts, plans, and regulations previously identified in this report, and group members knowledge of these and other existing rules, ordinances, and laws.

ASSESSMENT AND FINDINGS

Enforcement

a. Need for increased enforcement:

Existing local, state and federal laws and regulations were found to be adequate. However, existing resources (personnel, boats, equipment, etc.) necessary to enforce these laws and regulations are not sufficient to meet the enforcement demands presented by Biscayne Bay. In addition, there is a need for an increase in staffing of enforcement officers. Major marine enforcement agencies (including local, state and federal), have existing personnel vacancies that should be filled. Specific examples of three local enforcement agencies personnel needs are detailed in Appendix B to this report.

Another shortcoming in existing enforcement presence on the bay is the lack of a 24 hour, 7 days per week, marine patrol because of a shortage of marine officers. There is no enforcement of the Shoreline Development Review Committees recommendations regarding development fronting Biscayne Bay. Finally, there is no law, similar to that used in Biscayne National Park, to address vessel grounding damage to bay bottom resources (sea grasses, hard bottom communities, etc.).

b. Need for Increased Inter-agency Coordination:

Various local, state and federal agencies have jurisdiction over Biscayne Bay and, in some instances, these jurisdictions overlap. The agencies are aware of their jurisdictions and their responsibilities, but, there is a lack of information on the part of the public about which agency responds to various situations. The present working relationship among the marine regulatory agencies (local, state and federal) is considered to be one of the best in the state; nevertheless, communication between the agencies could be improved.

The response to the government survey was limited. Of the 17 municipalities surveyed, only six responses were received. Based on those responses and group knowledge, there is definitely a need for 24 hour, 7 days per week marine coverage. The majority of the responding agencies would be interested in participating in a Biscayne Bay-wide task force approach and/or interagency agreements for mutual aid to provide a marine law enforcement response that would both identify issues and share intelligence about crime trends and boating violations.

Examples of current interagency cooperative efforts that were found to be effective are the Miami River Enforcement Group, the Quality Action Team, the Marine Advisory Support Team, “Operation Sea Cow“ (manatee enforcement) and the Columbus Day Regatta Task Force. These efforts all provide examples of marine regulatory agencies working together and deploying scarce resources to best address concerns prioritized by the public.

c. Need for maintenance of and additional marine regulatory signage

Current marine signage on the bay was found to be inadequate and not well maintained. There are many markers and signs in disrepair and therefore not informing the public about current laws and regulations. This, in turn, prevents proper enforcement due to legality issues (for example, a boat speeding in a manatee zone where zone designation sign is missing). In addition, there is a need for more signage to address issues such as illegal mooring and better mark existing channels and speed zones.

One of the problems is that there is no single agency responsible for the maintenance and posting of marine regulatory signage. In 1998, there was a complete inventory of marine regulatory signage for Biscayne Bay which was deposited with the Florida Fish and Wildlife Conservation Commission (FWC), the agency currently coordinating the installation of the manatee zone signs.

One of the main findings of this inventory was that the manatee zone signs were conflicting, missing, or in poor repair. Contracts for new signage is delegated to the Florida Inland Navigation District (FIND) in coordination with FWC. There is neither a current mandate to conduct an inventory of marine signage during a set time frame nor a centralized repository for marine signage information. Last, but not least, there is no dedicated funding source for the maintenance and posting of marine signage.

d. Lack of data pertaining to user populations:

There is no data source that quantifies impacts to Biscayne Bay caused by the current user population. This population includes recreational and commercial users, tourists, etc.

This impact on Biscayne Bay requires a marine regulatory infrastructure that provides a wide range of services including protection of parks, law enforcement, fire and emergency services, derelict vessel and trash removal, and other services. Without this information, there is no data source for agencies responsible for providing these services to help justify a funding request for support resources such as personnel, equipment, etc.

Examples of missing data:

- How many boaters use the bay on a given weekend?
- How many public, private, and commercial boat launch ramps with access to the bay currently exist?
- How many marina boat slips and moorings are available?
- How many live-aboards are currently in Miami-Dade County?

Education

a. Determine the target audiences that need to be reached, and how they can best be identified.

While most would agree the scope of the audience encompasses those who live in the entire surrounding watershed, paring this group down to a manageable, effective level is quite another feat. Most existing educational programs focus primarily on the users groups that directly interface with the bays resources and environment. Rarely taken into account are the groups or influences whose connection to the bay resource is indirect, but whose cumulative impact could be as great as that of active user groups.

b. Insufficient interaction in the regulatory process between educators and regulatory proponents.

There seems to be a major gap in communication between educators and regulators. This gap occurs at every step of the regulatory process, but is perhaps most pronounced in the regulatory development stage. Input from educators could alleviate shortfalls in regulatory enactment prior to the finalization of any new proposal. Most agencies have educational initiatives that are collateral functions of a greater area of program responsibility, and that do not afford sufficient time to actively interface with all phases of the regulatory function.

c. Inadequate system of feedback from affected user groups back to the regulators and legislators that would enhance the decision making process

The educational process could not only be enhanced to provide information and guidance to affected users groups, but modified to gather feedback and forward findings to legislators and regulators about current and future proposals. It is often expressed by user groups that regulators and legislators operate in a vacuum, and that regulations fail to reflect current user group assessments or input.

d. Lack of a centralized clearinghouse to collect available information and disseminate it efficiently to interested parties.

While it is quite obvious that there is an abundance of educational material currently available on bay regulatory matters and current affairs, there is no central repository or database to access to enhance the level of understanding. Even regulators have often commented on this recognized deficiency and noted reliance on their own informal networking system with colleagues to stay abreast of changing requirements. While these informal systems appear moderately functional, there are instances where a general lack of knowledge lead to duplicated efforts.

e. Identification of formal education programs that currently exist and determination if these are sufficient to represent all of the identified concerns.

The majority of current, local educational programs are fairly well known in the regulatory community, but it is necessary to insure that information on these assets remains current and easily accessible. Educators and regulators must also be open to regional, national, and international programs that have been successful in connecting with target audiences.

The rich cultural diversity of the communities surrounding the bay must be recognized, and all existing and new educational initiatives must take these demographics into consideration. Educators and regulators must remain flexible and poised to immediately retool any program or initiative as outside influences and global political forces impact our local immigration status.

f. New initiatives

Assessment of local educational efforts by the subcommittee has determined that sufficient resources are currently available, but that the single agency-specific approach to this process is making for a disjointed and less than efficient vehicle for reaching target audiences. Subcommittee efforts have uncovered other national and international programs that may be used locally to unite educational initiatives for greater distribution.

Any new effort must include demographic and cultural considerations. New proposals or initiatives must be packaged to reflect contemporary trends in marketing and management strategies. Advances in technology should be considered in the way information is distributed and feedback is collected.

Regulation

a. Impacts caused by existing regulations and agency structure are generally adequate to protect the bay resources from projects built within the bay, but not necessarily for projects built adjacent to the bay or within its watershed.
b. Inter-agency coordination works well but could be improved.
c .Implementation of the Shoreline Development Review Ordinance has not been completed in a manner that fully realizes the protections it provides.
d. There is a need to improve agencies permit processing times and overall resource assessment capabilities.
e. Direct, secondary and accumulative impacts to environmentally significant areas such as Biscayne National Park, and the Virginia Key Critical Wildlife Area should be addressed for both in-water, wetland and upland projects.
f. Staffing at the county, state & Army Corps regulatory offices should be increased to improve inter-agency coordination, permit processing time and overall resource assessment capabilities.
g. There is a need to gather data on endangered species, water quality, and both boater impacts & distribution; in addition, resource inventory should be improved to refine management.

RECOMMENDATIONS

INCREASED FUNDING FOR BISCAYNE BAY RESOURCE MANAGEMENT AND PRESERVATION

1. Existing local, state, and federal agencies, as well as citizen groups involved in bay issues should join to create a formal arrangement to coordinate funding requests and strengthen inter-agency cooperation. This "Task Force" should have one full time staff person and include the following agencies: Biscayne National Park, Everglades National Park, U.S. Army Corps of Engineers, Florida Department of Environmental Protection, Florida Fish and Wildlife Conservation Commission, South Florida Water Management District, Miami-Dade County Department of Environmental Resource Management, Miami-Dade County Department of Planning and Zoning, and representation from the private sector. A Memorandum of Agreement should be drawn up and adopted after consultation by all participants.
2. One of the initial assignments of this "Task Force" should be to identify existing user fees (such as vessel registrations and fishing licenses) and determine how and to what extent they are used, and make recommendations about how they can be better used.

LAND ACQUISITION

1. Existing land acquisition programs should focus their efforts on acquiring lands within the Biscayne Bay watershed.
2. Develop additional efforts to acquire lands within the Biscayne Bay watershed that are not targeted by existing land acquisition programs.

COUNTY ORDINANCES

Revise existing county ordinances and/or county or local comprehensive plans to include direct, secondary and commutative impacts to environmentally significant areas. These include, but are not limited to, Biscayne National Park and the Virginia Key Critical Wildlife Area for in-water, wetland, and upland projects, to insure the extraordinary values of these areas are preserved.

NEED FOR INCREASED ENFORCEMENT

1. Establish a centralized grant location to fund multi-agency enforcement initiatives. Costs (personnel, overtime and fuel) associated with inter-agency efforts, such as the Columbus Day Regatta Task Force, "Operation Sea Cow" and other cooperative ventures, would be paid from these funds.
2. Marine law enforcement agency directors should be educated about the need for, and urged to provide, a 24 hour, 7 days per week enforcement presence.
3. Require that Miami-Dade County and/or the municipalities use zoning inspectors to inspect all new shoreline developments for compliance with the recommendations of the Shoreline Development Review Committee, as adopted by the applicable zoning authority.
4. Mandate that all government agencies fill existing marine enforcement vacancies.
5. Increase staffing at the county, state and federal regulatory agencies to improve permit processing times and overall resource assessment capabilities.
6. State law should be revised to include a vessel grounding damage violation to protect bay bottom resources. (Recommended language is shown in Appendix C to this report.)
7. Encourage the judiciary and marine law enforcement policy makers to require that Florida Litter Law violators do cleanup along shorelines as part of penalty.

8. Increase fines for marine citations by $20.00 (currently $50.00), with the additional money going to increase enforcement (such as multi-agency enforcement initiatives previously described) and marine regulatory signage.
9. Require an additional cost to register a vessel if the owner does not have proof of successful completion of an accredited boating education course.
10. Give first time offenders the option to take a boater safety course instead of paying fine, unless mandatory by statute.
11. Review present funding received by Miami-Dade County under Florida Statutes 328.66 and 328.27, to insure monies are used for enforcement and other boating related activities. Funds are available for these projects from the Florida Inland Navigation District, and under Florida Statute 328.66 County and municipality optional registration fee, and 328.72 (15) Distribution of fees.
12. Perform annual manpower needs assessments (See Appendix B).

NEED FOR IMPROVED DATA

Information Clearinghouse:

a. Create a central clearinghouse, through the use of an existing and recognized organization for regulatory and all other types of information, pertinent to bay and watershed issues.
b. Network with existing public information organizations to make pertinent bay and marine information available to them.
c. Hold an annual conference for educators and regulators to ensure that all interested parties actively network, and that new initiatives and current educational techniques are explored in depth.
d. Contact other partnership/preservation/regulatory initiatives, conducted in other locations, for an exchange of information and ideas.

Other Related Recommendations:

a. To provide adequate data pertaining to Biscayne Bay, a comprehensive study, funded by matching funds form local, state, and federal governments, should be one of the following:
   - user population impacts on the bay;
   - endangered species;
   - water quality;
   - resource inventory; and
   - boater impacts and distribution.
b. Determine the target audiences that need to be reached and the best way to reach them. Using existing user survey data from local governmental sources and existing databases, such as boat registrations, fishing licenses, marine dredge and fill permits, marine insurance companies, and other associated marine industry and related services to identify possible target audiences.
   1. Review violations data from regulatory agencies to establish profiles about what entities are more prone to experience the adverse effects of non-regulatory compliance, and tailor educational efforts to reduce these occurrences.
   2. Conduct a partnership-directed user group survey with input from all bay regulatory agencies to insure that all areas of interest and focus are covered.
   3. Explore similar regional, national, and international efforts to identify contemporary survey and census-gathering methods.

c. Identify formal education programs that currently exist and determine if they are sufficient.
    1. Almost every agency involved in the Initiative has some type of public education program or campaign in place. Program complexity ranges from rudimentary to those employing the most technological advances currently available. Great strides in public education about regulations can be made by having agencies share their current educational approaches with others. Advances in computer technology, and an increase in internet exploration, provide opportunities to correct some communication deficiencies experienced in the past.
    2. Some of the agencies are currently focusing educational efforts for school children in grades K through 12 with the belief that this particular groups early involvement is essential to gaining future understanding and support for bay initiatives. This focus appears to have universal appeal and acceptance, but to keep the initiative headed in the right direction, additional agency involvement is needed.
    3. The importance of public support is so essential to the success of any portion of these initiatives, that all entities should be required to elevate their public education campaigns to a position of prominence within their overall goal setting strategy.

INTERAGENCY ACTIVITIES

Coordination Between Agencies:

a. Expand the Marine Advisory Support Team (MAST) to include an inter-agency marine regulatory task force to address enforcement issues baywide. MAST already provides for public input for concerns in the marine community, and enforcement coordination is addressed informally through this venue. This MAST task force would provide a community policing aspect to the marine environment.

   The MAST task force would coordinate “hits“ where agencies could go together to inspect areas along the shoreline of the bay, employing similar tactics to those used by the Miami River Enforcement Group. This approach would more efficiently coordinate agency resources and provide better 'customer service' to the regulated public. Finally, this task force would need a baywide mutual aid agreement (a Memorandum of Understanding) to give marine agencies cross-jurisdiction when operating under the auspices of the MAST task force.

b. A common marine law enforcement radio frequency for Miami-Dade County must be designated to conduct interagency operations. All agencies engaged in marine enforcement within the geographical areas of Miami-Dade County should be mandated to install this communication capability on their vessels.

Interaction With General Population:

a. Create interaction in the regulatory process between the general public and the education community.
    1. Take advantage of new advances in technology to insure the maximum amount of participation and feedback. Employ teleconferencing capabilities to maximize participation and satisfy Sunshine Law requirements. Establish a centralized web site to post current and proposed regulations, along with capabilities for user input and comment.
    2. Establish requirements for all new proposed regulations to include an educational initiative plan to maximize information dissemination to produce better user group understanding and compliance.
    3. Regulators and educators should be encouraged to meet frequently throughout the entire regulatory process to insure the focus of initiatives remains on track and that educational principles are maintained.
    4. Encourage the creation of a special alliance, or a professional association of educators, associated with bay educational efforts.
    5. Establish a centralized advisory panel to serve as the informational clearinghouse for all initiatives of this nature.
b. Establish system of feedback from user groups to regulators and legislators.
    1. Actively pursue consistent coordination between trade groups, boating clubs, and environmental support organizations to enhance feedback from their constituents.

2. Increase efforts to ensure that regulatory issues and proposed planning sessions receive the greatest possible exposure and advertising to attract as much external involvement as possible.
3. Expand efforts to enhance public involvement in regulatory processes such as the Miami-Dade Police Departments Marine Advisory Support Team (MAST). Encourage other agencies to initiate similar support teams.
4. Identify leaders from the non-governmental organizations not previously included in dialogue for proposed rule making.

MARINE REGULATORY SIGNAGE

1. Require all agencies with jurisdiction over the bay to review and inventory existing marine signage annually and submit a comprehensive report to the Florida Fish and Wildlife Conservation Commission (FWC) that would include the condition and location of signage.
2. Create a Florida Boating Safety Section. Among this sections initiatives would be annual reports from agencies with bay jurisdiction about their bay-related activities, plus recommendations of necessary actions, including locations of regulatory signs needing maintenance and where additional signs are needed. The FWC should be designated as the central repository for these annual reports.
3. Request additional funding from the legislature and Florida Inland Navigational District for maintenance of existing signs and installation of new signs including, Manatee Speed Zones, channelmarkers (Intracoastal waterway, private channel markers), bridge signs (No wake/marine traffic), and storm drain signs.

DEFICIENCIES OF THE PROCESS

The team has experienced some difficulties during the process leading up to this report which it feels should be acknowledged. First, the structure of the Initiative was complete without input from co-chairs and participants, and the selection process of team members was not as responsive to input from the team co-chairs as it could have been. This may have led to the second difficulty of having many named members who did not attend meetings, making it hard to complete team work efficiently. Lastly, it proved extremely difficult to get most of the team members who were from the private sector to participate in the development of this report.

APPENDIX A

ENTITIES WITH JURISDICTION OVER BISCAYNE BAY

Federal Agencies:

1. United States Coast Guard
2. United States Customs Service
3. Immigration and Naturalization Service
4. United States Border Patrol
5. United States Army Corps of Engineers
6. United States Department of Agriculture
7. Drug Enforcement Agency
8. Federal Bureau of Investigation
9. United States Marshalls Office
10. United States Occupational Safety and Health Administration
11. United States National Park Service
12. United States Environmental Protection Agency
13. United States Alcohol, Tobacco, and Firearms
14. United States Department of Transportation
15. United States Department of Maritime Administration

State Agencies:

1. Florida Fish and Wildlife Conservation Commission
2. South Florida Water Management District
3. Florida Department of Transportation
4. Florida Department of Environmental Protection
5. Florida Inland Navigation District
6. Florida Department of Community Affairs
7. Public Health Department

County Agencies:

1. Miami-Dade Department of Environmental Resources Management
2. Miami-Dade County Water and Sewer Department
3. Miami-Dade County Fire Department
4. Miami-Dade County Public Works
5. Miami-Dade County Building Department
6. Miami-Dade County Solid Waste
7. Miami-Dade Police Department
8. Miami-Dade County Planning Department and Zoning Department
9. Miami-Dade County Seaport Department

Cities/Municipalities:

1. Miami
2. Coral Gables
3. Biscayne Park
4. North Miami
5. Miami Shores
6. North Miami Beach
7. Aventura
8. Village of Key Biscayne
9. Golden Beach
10. Bal Harbor
11. Bay Harbor
12. Surfside
13. Indian Creek
14. Miami Beach
15. Sunny Isles Beach
16. El Portal
17. North Bay Village

APPENDIX B

STAFFING WITHIN REGULATORY & ENFORCEMENT AGENCIES

Miami-Dade County Police Marine Patrol Unit

Miami-Dade County is a popular boating destination. Numerous islands and inlets characterize its coastline. The area is home to the Port of Miami, the Port of Miami River, Cape Florida and Oleta State Parks, Biscayne National Park, and six major marinas. Marine policing issues range from those associated with the inner city to those of undeveloped areas. The population of Miami-Dade County continues to grow, increasing recreational boating and criminal activity on the bay. The countys close proximity to the Bahamas, Haiti, and Cuba make it a high smuggling area.

According to the 1999 Florida Fish and Wildlife Conservation Commission statistics, Miami-Dade County is ranked first in the state with the most registered vessels (53,000), fourth in boating accidents, first in fatal boating accidents, and number one in registered personal watercraft (8,111). Miami-Dade County is bordered by Broward County, which is ranked third in the state with 45,041 registered vessels and number two in registered personal watercraft (6,931).

The Miami-Dade Police Marine Patrol Unit provides marine patrol and underwater recovery services to unincorporated areas of Miami-Dade County. Daily coverage is provided from 7 a.m. to 5 p. m. Specialized patrol deployments are developed in response to major marine events, holidays, and during the summer.

Miami-Dade Police Department Marine Patrol Unit Staffing

Staffing Level 1993	Current Staffing 2000-2001	New MilleniumStaffing
Offices 3	Offices 3	Offices 3
Supervisors 5	Supervisors 5	Supervisors 5
Officers 15	Officers 14	Officers 18
Administrative Support 1	Administrative Support 1	Administrative Support 1

City of Miami Marine Patrol Detail

The City of Miami Marine Patrol Detail is currently located at Watson Island, on the second floor of the Miami Yacht Club, 1001 MacArthur Causeway. The detail has seven members; one supervisor and six officers, and nine police vessels to patrol the waterways within the City of Miamis jurisdiction. These officers primarily work day shift hours, changing their hours during the summer months to cover the early evening hours.

The detail has jurisdiction over one of the busiest body of waters in Miami-Dade County, if not in the entire state of Florida. The Intracoastal Waterway runs from the City of Miamis northern boundary at NE 87 Street through Biscayne Bay to its southern boundary near the Coral Gables waterway. The Port of Miami, one of the busiest ports in the state, is in the middle of City of Miamis jurisdiction. The Miami River, with its many vessels and waterfront facilities, runs right through downtown Miami to NW 27 Avenue. The City of Miami has six public boat ramps located within its jurisdiction, all of which serve the needs of many south Florida boaters. The public uses these boat ramps for free, and boaters come from the all around Miami-Dade County.

Two supervisors and fourteen officers working two shifts previously manned the City of Miamis Marine Patrol Detail. The calls for service, the number of vessels, and the emergence of personal watercrafts using the waters within the City of Miami have increased significantly since then. The detail is now staffed with less than half of the personnel that it reached at its maximum staffing levels. The significant increase in the amount of engine horsepower, causing the increase in speeds of the vessels using this area, has also caused a considerable number of new violations to occur in these waterways.

The Miami-Dade County Manatee Ordinance affects all the waters within the City of Miamis jurisdiction. Manatees are a precious and endangered species in serious trouble in the State of Florida. Their very survival is in jeopardy due to the enormous amount of boat traffic they encounter. Greater awareness and care on the part of all bay user groups is necessary. An annual grant from the state of Florida to Miami-Dade County to hire more marine enforcement officers to assist with manatee and other enforcement efforts would be welcomed by all the agencies involved.

City Of Miami Marine Patrol Detail

Staffing Level 1990	Current Staffing 2000-2001	"New Millennium" Staffing
Sworn 16	Sworn 6	Sworn 16
Supervisors: 2	Supervisors: 1	Supervisors: 2
Officers: 14	Officers: 5	Officers: 14

Biscayne National Park

Biscayne National Park compromises 240 square miles (172,000 acres) of Biscayne Bay, 40 island keys, and coral reef formations out to the sixty-foot depth contour. Biscayne is one of the largest marine protected areas within the National Park System, and is an area of state and federal concurrent jurisdiction. Currently there are seven (7) fully-commissioned law enforcement park rangers, with three (3) of these commissions in supervisory or support roles. This number is exactly half of the commissions that were active in the park in 1990. The primary reason for this decline was the professionalization of the Park Ranger series that elevated law enforcement, and other disciplines, from collateral assignments to full time responsibilities. The current ranger staff performs full law enforcement duties, emergency medical, search and rescue, structural and wildland fire fighting, cultural and natural resources protection, fee collection, as well as serving in other park collateral functions. Patrol activities are relegated primarily to daytime hours, with additional emphasis placed on weekend and holiday periods. Ordinarily there are no routine enforcement/protection patrols on the water after 7:00 P.M. To adequately protect park visitors and resources, and to manage new protection initiatives that have been proposed for the future, we would at least need to re-establish staffing levels that existed in 1990. As the population of Miami-Dade County continues to grow, we will need to increase the protection of the resources to avoid further resource degradation and adverse visitor use impacts.

Biscayne National Park

Staffing Level 1990-1991	Current Staffing 2000-2001	"New Millennium Staffing"
14 Sworn	7 Sworn	14 Sworn
Supervisors: 2	Supervisors: 2	Supervisors: 2
Officers: 11	Officers: 6	Officers: 11
Support: 1	Support: 1	Support: 1

Florida Fish and Wildlife Conservation Commission, Bureau of Marine Enforcement

With nearly 54,000 recreational boats registered in Miami-Dade County in 1999 and marine industry estimates of more than 26,000 transient visitor vessels for the year, it is obvious that the Florida Fish and Wildlife Conservation Commission (FWC) Marine Patrols allocated staffing of twenty positions for the county (including supervisors) is inadequate. The current breakdown is nearly 5,000 boats per officer position in a county of some two point two million residents. The Florida Legislature recognized that more officers were needed ten years ago (when staffing was a third greater than at present) and ordered the Florida Marine Patrol (FMP) to develop a five-year plan to provide an adequate number of officers for the old District Six (Dade and Broward Counties), now District 2A. The five-year plan submitted to the Legislature called for a total of 97 positions in the District, apportioned between the two counties, by the end of fiscal year 1995. Although the plan was approved, the additional patrol positions never materialized, and the net result was actually a reduction due to deletion of positions, transfer of positions to other locations within the agency and legislative cuts. As the lead agency in conservation, boating and marine environmental law enforcement, the Florida Marine Patrol maintained the only scheduled and ongoing 24-hour patrol, and today no law enforcement agency in this area provides a comparable level of service in the bay. The restoration of eight lost positions would return todays FWC Marine Patrol in Miami-Dade County to the FMP staffing of ten years ago. This would not, however, make an allowance for the decades increases in population, registered boats, fisheries industry, or duties and responsibilities of our officers. The "best case" scenario would provide for a staffing increase proportionate to the needs of the new millennium and reflect the states commitment to properly managing the human and environmental resource that is Biscayne Bay.

FMP/FWC Marine Patrol Positions For Miami-Dade County

Staffing Level 1990-1991	Current Staffing 2000-2001	"New Millennium" Staffing
28 sworn	20 sworn	40 sworn
Supervisor: 4	Supervisors: 4	Supervisors: 5
Officers: 24	Officers: 16	Officers: 35
Admin. Support: 1	Admin. Support: 2	Admin. Support: 4

APPENDIX C

CODE OF FEDERAL REGULATIONS

Damage to Reefs, Sea Grasses and Sea Bottom by Boat Propellers

The suggested wording for state law to protect bay bottom resources from vessel grounding violations comes from the Code of Federal Regulations, Title 36 (Parks, Forests, and Public Property), Volume I, Part 2 (Resource Protection, Public Use and Recreation) Section 2.1 (Preservation of Natural, Cultural and Archeological Resources), (a)(1)(ii):

"Except as otherwise provided in this chapter, the following is prohibited:

(1) Possessing, Destroying, Injuring, Defacing, Digging, or Disturbing from its natural state:

(ii) Plants or the parts or products thereof."

APPENDIX D

ACTIVE REGULATION TEAM MEMBERS BY SUBCOMMITTEE

Chairs

Major Kenneth B. Clark, District Commander, Florida Fish and Wildlife Conservation Commission
Phil Everingham, President, Miami Marine Council

Educational

Wayne C. Elliott, Chief, Law Enforcement, Biscayne National Park
Fernando Moreno, Academic Chair, University of Miami, Rosenstiel School of Marine AS
Constantine Hadjilambrinos, Asst. Professor, Florida International University

Regulatory

Edward A. Swakon, President, EAS Engineering Inc.
Charles A. Schnepel, U.S. Army Corps of Engineers, Miami Office
Craig Grossenbacher, Chief, Coastal Resources, Miami-Dade DERM
Maureen Brody Harwitz, Executive Director, Munisport Dump Coalition
Mike Miles, Commander, Marine Safety Office, U.S. Coast Guard
Patti Thompson, Biologist, Save the Manatee
Robert Weinreb, South Florida Board Sailing Association
Mary Murphy, Administrator, Florida Department of Environmental Protection Regulatory Programs

Enforcement

Milton Brelsford, Lieutenant, Marine Patrol Unit, Miami-Dade Police
Ruth Ellis Myers, Developmental Impact Committee Coordinator, Miami-Dade County Dept of Planning and Zoning
Kristine Serbesoff, Environmental Analyst, South Florida Water Management District
Arthur Serig, Sergeant, Marine Patrol Detail, Miami Police Department

MINORITY REPORT
OF THE BISCAYNE BAY PARTNERSHIP INITIATIVE
FINAL REPORT

BISCAYNE BAY PARTNERSHIP INITIATIVE

BISCAYNE BAY PARTNERSHIP INITIATIVE

The Marine Council
269 Giralda Avenue, Suite 302
Coral Gables, FL 33134
305.856.0206

February 2, 2001

Dear Chairman Ruvin:

Please accept this letter as a Minority Report submitted on behalf of The Marine Council.
Using the Biscayne Bay Partnership Initiative as a genesis, we look forward to taking a proactive role in the ongoing efforts to protect Biscayne Bay and to maximize its benefits to the entire South Florida community.

Sincerely,

Philip B. Everingham
President
The Marine Council

MINORITY REPORT

First of all, let us state our full support for the BBPI's goal of procuring significantly more public funding to "protect, improve, and enhance the bay's resources." Adequate funding is necessary for any effort to produce meaningful results, and the long term protection of Biscayne Bay is certainly no exception.

As representative of the boating public in Miami-Dade County, we applaud many of the recommendations contained in the Policy Development Committee's Final Report, especially the recommendations for:

- Funding to mark channels, seagrass beds, and coral areas, and to provide maintenance for markers and signage;
- Improve coordinated public education and outreach;
- Increase access to the bay to those who will use it in a manner that will preserve it for future generations;
- Management strategies for Biscayne Bay must include coordinated public education and outreach among various groups, *including direct users of the bay with an emphasis on boaters* (emphasis ours);
- Develop economically sound methods to restore and maintain freshwater wetland, coastal mangrove, benthic seagrass, and coral communities;
- Preserve water-dependent uses and facilities along the bay shoreline;
- Encourage the use of waterfront property along the bay and the Miami River where appropriate for job-producing, water-dependent commercial activity (emphasis ours) that provides adequate protection to the environment;
- Increase funding for enforcement, public information, signage and regulatory efforts to increase compliance rate;
- Expand the Marine Advisory Support Team to include an interagency marine regulatory task force to address bayside enforcement issues;
- Designate a common marine law enforcement radio frequency

We take issue, however, with a number of recommendations which will create new committees and/or "action plans" that we believe will have regulatory impact, despite claims to the contrary. It was our understanding that the existing regulatory framework was determined to be sufficient to protect the bay, and that improvements should focus more on enforcement and compliance rather than on promulgating new regulations. Unfortunately, it is our experience that regulatory agencies have a tendency to treat goals and policy recommendations of quasi-regulatory committees with the same level of zeal as they do statutory mandates. In many instances, these plans become "legislation" by reference, often without public input.

For this reason, we object very strongly to the following recommendations:

- Funding a Science Committee to coordinate scientific research, monitoring and restoration activities; while we support scientific research and recognize its value, we are convinced this group will not be balanced in its opinions;
- the establishment of a Biscayne Bay Project Coordination Team and a Biscayne Bay Action Plan; we are concerned that such a team, if not made up of all bay stakeholders equally, could become a "loose cannon" that could come up with objectionable recommendations without sufficient public input or adequate controls; In sum, we are concerned that environmental protection would override any concern for economic or social considerations.
- Refine water quality standards used to indicate the presence of sewage; we believe this proposal is too vague and are concerned that the new standards will target boats without sufficient background data;
- Develop water quality targets necessary to prevent water quality degradation; same concern as above;
- Pursue the goal of identifying and eliminating all sources of degradation; same concern as above;
- Carrying capacity of Biscayne Bay should be determined and not exceeded; we object very strongly to this proposal. However noble the concept, who will determine how "capacity" is measured, and how this will be enforced? We truly believe this can't be done. Also, as with other attempts at growth management, this would most likely be challenged in the courts.
- "The Biscayne Bay Aquatic Preserve Act is inviolate and should never be weakened." However beneficial it may be, no law should ever be "cast in stone." In fact, the Act has unintentionally produced a huge focus on marina development

on non-State-owned submerged land due to the Act's "extreme hardship" requirement and in turn new marinas can't be built. This denies new points of access to the bay to boaters.

We also have concerns with several aspects of the BBPI process:

- the structure, which was set prior to any volunteers being asked to participate, should have been developed with input from at least the Co-Chairs;
- the interests of the primary users of Biscayne Bay—boaters—were not well represented on the survey teams and the Policy Development Committee, and little effort was made to seek their perspective;
- makeup of and attendance by the various survey teams was very often unbalanced, particularly in terms of lack of participation by the private sector, due to meetings being scheduled during the work week, and often for the entire day;
- this same problem affected the Policy Development committee, which was responsible for approving the content of the final report;
- this lack of balance by definition skewed the efforts for consensus, and most important in our view, has produced a report that favors the views of regulatory agencies and environmental groups.

We strongly believe the report's tone clearly emphasizes environmental considerations and recommendations far more than economic ones. However, the final report makes a very important statement that is unfortunately buried in the text of the section on "Population and Economic Growth:"

"Taken altogether, bay-related commercial and recreational activities may account for approximately *15 – 20 percent of the local economy*." (Emphasis ours)

If even close to being accurate, this clearly shows the need for a balanced approach to bay management that fives economic considerations equal weight to environmental ones.

A glaring omission from the report's educational sections is the critical importance of boater education and support for the value of responsible boating. This is one of the primary goals of The Marine Council, and should be a key recommendation in the report.

Perhaps an even more glaring omission form the report is any mention of fishing and fishermen, both recreational and commercial, beyond three references that are very negative in tone, specifically:

- "Finally, commercial and recreation fishing are thought to have contributed substantially to resource change in Biscayne Bay." (Emphasis ours)
- "The combined effects of the commercial and recreational fleets have contributed to increased fishing pressure."
- "Only a well-informed public and its representatives can protect the bay from the increasing pressures of…" (several things, including) "… damage related to fishing techniques."

The fact is that many fishermen, both commercial and recreational, are as concerned with species population and habitat as anyone, and are making concerted efforts to help through groups such as the Coastal Conservation Association of Florida, The Billfish Foundation, the American Sprotfishing Association, and the Center for Sustainable Fisheries at the University of Miami's Rosentstiel School. The vast majority of fishermen fully respect the bay and its resources, and are totally supportive of any efforts to help maintain and grow fishing stocks in the bay.

Last but not least, we have grave misgivings that the great majority of any funding that might come from this Partnership Initiative would, according the recommendations the final report, go *not* to the Coordination Team of bay stakeholders but to various regulatory agencies. In our opinion, this removes a critical element of control by those most concerned with the bay, and makes any input to and monitoring of results much more difficult.

Despite these concerns, we believe passionately in the importance of Biscayne Bay and its long term health, and we fully support a balanced effort to both protect the Bay and at the same time maximize its benefits to the South Florida community.

Respectfully submitted,

Philip B. Everingham
President, The Marine Council

Miami River Marine Group
480 S.W. 1st Court
Miami, FL 33130

February 2, 2001

Dear Mr. Ruvin:

The Miami River Marine Group would like to lend its name in support of the Minority Report submitted by The Marine Council responding to the Biscayne Bay Partnership Initiative's Final Report. While we wish we could fully support the BBPI Report, we are unable to do so because of concerns already articulated by The Marine Council, and because of additional concerns that result from our observations of the process.

First, members of the river's marine industry find the bias of the report to be reflective of a partnership between agencies, academia and environmental organizations, but not of the many commercial interests that use the Bay. True, the names of some commercial enterprises are included on each of the BBPI committee lists, but in reality, participation from the private sector was curtailed by the frequent day long meetings which were most prohibitive to that group of people.

The marine industry is particularly demanding, and I know of few companies that can spare a key individual for an entire day on a monthly, sometimes twice-monthly, basis. Our representative on the Management Team, Dr. Fran Bohnsack, expressed this concern to her Team, to the Co-chairs, and in a letter to the BBPI organizers, all to no avail.

Second, when members of the private sector were able to attend meetings, even if not for the entire day, their views were often discounted since they were much fewer in number. As a result, there were few successful efforts on the part of commercial enterprises to correct errors of fact, negative impression, or biases against the private sector. These, and a variety of assertions unsupported by fact, were subjected to committee votes; their validity was determined by the will of the majority. Most disappointing was the fact that "consensus" was articulated as a goal and a value of the process, but in reality, there was no real effort to achieve consensus.

Third, committee members with dissenting views were urged to devote precious time to providing written comments which were never discussed by the group. This absence of acknowledgment did not serve as an incentive to the private sector for increased participation or further commentary since it left the undermining impression that comments were selectively disregarded.

Finally, an overall reading of the document does not reflect the balance we would wish to see when evaluating the environmental ***and*** economic importance of Biscayne Bay. Terms which refer to boats and ships are too often pejorative, loaded with assumptions which undermine the economic values of Biscayne Bay.

It is my hope that further efforts by the BBPI's organization will be more inclusive of the Bay's true diversity, and not injurious to the many benefits offered by the marine industry which relies upon the bay. I would welcome the opportunity to educate members of the Partnership as to the modern practices and concerns of the marine industry.

Sincerely,

James W. Brown
President

Fran Bohnsack, Ph.D.
Executive Director