



**LAKE WORTH LAGOON
MANAGEMENT PLAN REVISION**

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EXECUTIVE SUMMARY

Considerable progress has been made since the LWL Management Plan (LWLMP) was adopted in 1998. Tasks and projects originally defined in the plan were and are currently being implemented by various groups and agencies. This first revision of the LWLMP encompasses the 1998-2007 timeframe. It provides a look back at the progress made in implementing the original goals and priorities, and a look ahead at strategies and restoration projects. A current status of the lagoon is included, along with Action Plans for future projects.

The most prominent change to the plan is the format. While still organized by Program, the information has been synthesized with visual aids and specific Action Plans scheduled for the next 5 years. Each Plan summarizes the topic, presents management objectives, and suggests a series of actions with strategies to address those objectives. Anticipated costs and schedules are included, along with the expected benefits. These specific and attainable targets will allow governmental agencies, municipalities, businesses and industry, non-profit groups and concerned citizens to get involved by committing to specific Action Plans. References in the Action Plan to local governments/agencies under the headline "Responsible parties", attempt to identify the leading partner with the best technical knowledge, skill set, or jurisdiction for the implementation of that specific plan.

In the nine years since its completion, many tangible components of the original LWLMP have been implemented under the leadership of the Palm Beach County Department of Environmental Resources Management (PBCERM). Significant progress has been made by construction of stormwater treatment and habitat restoration projects. Through the Lake Worth Lagoon Partnership Grant Program (LWLPG), developed in cooperation with 15 agencies and municipal partners, a total of \$14 million in State funding has been leveraged against \$33 million in local funding to successfully complete 37 projects at a total cost of \$ 47million.

Projects using a variety of non-LWLPG funding sources were also implemented by Palm Beach County in cooperation with the Florida Inland Navigation District (FIND), the Port of Palm Beach, the United States Army Corps of Engineers (USACE), the Florida Department of Environmental Protection (FDEP), the LWLPG, Florida Fish and Wildlife Conservation Commission (FWC), South Florida Water Management District (SFWMD), the Palm Beach County School Board and municipalities including Lake Park, West Palm Beach, Palm Beach, Lantana, Hypoluxo, Boynton Beach and Ocean Ridge.

Combined with the LWLPG projects, approximately 184 acres of habitat have been created or restored: 67 acres of mangroves, 64 acres of potential submerged aquatic vegetation (SAV), 14 acres of artificial reef, and 39 acres of maritime hammock. More than 1,700 acres of runoff that previously discharged directly to the LWL are now being

treated.

Despite the success of these endeavors, there are many challenges still facing the lagoon. The challenge to improve or maintain water quality while accommodating future growth will have to be balanced with competing social and economic needs of local communities. Another challenge is altered hydrology and the large-scale freshwater releases from regional canals. Although changes to water management strategies for the LWL are included in the Comprehensive Everglades Restoration Plan (CERP), their direct or indirect affect to the health of the ecosystem is yet to be studied. The input of contaminants and toxins from urban and agricultural runoff, along with elevated loads of nutrients and suspended and dissolved organic matter, are all contributing factors to the environmental distress of this estuary.

PROGRAMS AND GOALS

Five broad areas within the system are used in this revised management plan to identify specific goals and objectives for restoring the lagoon. Goals identified in the original 1998 LWLMP have been revised according to this new effort and are summarized below.

Water and Sediment Quality Program

Improving water and sediment quality will require continuous effort to compensate for the increased pollution associated with the growth of our community. Recent water quality gains have been attributed in part to wastewater treatment technologies, which have significantly reduced municipal sewage discharges in the lagoon. Action Plans targeted specifically to improve and monitor Water Quality, and to reduce Wastewater, Stormwater and Sediments are outlined in Chapter 4. Goals for this program are:

- Expand and implement a long term water quality ambient monitoring program in the LWL for baseline purposes and trend analysis.
- Increase focus on decreasing inputs of suspended materials, nutrients, and toxic substances from point and nonpoint sources.
- Identify and reduce anthropogenic loadings of fecal contaminants in the LWL.

Habitat Restoration and Enhancement and Restoration Program

The restoration and protection of the diverse habitats within the LWL is crucial to the lagoon's health. The overall targets within the next five years are to restore approximately 125 acres of tidal marsh habitat, add a minimum of 16 acres of oyster reef habitat, continue development of artificial reefs, protection of land through acquisition, protect and enhance the lagoon's existing mangrove and seagrass areas. These goals will be accomplished through 29 specific capital projects (Appendix C) and monitored as outlined in a series of specific Action Plans. Goals for this program are:

- Restore, enhance, and create seagrass beds, oyster habitat, emergent mangrove wetlands, coastal hammock habitat, and protective upland buffer zones.
- Add riprap to vertical seawalls to reduce wave-generated sediment resuspension and provide additional hardbottom habitat.
- Construct artificial reefs that provide juvenile, intermediate and adult habitats required by the life cycle of estuarine and marine dependent fish and invertebrate species.
- Evaluate the status and protect sea turtles, manatees, and other endangered, threatened, and rare species, and species of special concern using the LWL.

Public Use and Outreach Program

Interested, informed citizens are the lagoon's best hope for the future. The *Public Outreach Program* is committed to creating an engaged constituency of citizens who understand both the environmental, recreational and economic value of the LWL, and actively participate in restoring and protecting it. Though approximately 16 of the 26 outreach projects originally identified in the 1998 LWLMP have been implemented, more needs to be done to raise public awareness. Goals for this program are:

- Develop a Lake Worth Lagoon Initiative (LWLI) to facilitate stakeholder partnerships and to seek funding assistance for projects that would improve and protect the natural resources within the LWL and its watershed.
- Develop public awareness programs to involve and inform the residents, visitors, and decision makers about the LWL ecosystem.
- Develop new school education programs within the PBC science curriculum that emphasize the ecology of LWL ecosystem and ways to help to preserve it.
- Identify and construct areas around the LWL for public access features.

Interagency Planning and Coordination

When the 1998 LWLMP was initiated, key policy leaders representing state, local and federal government, members of the scientific community, businesses and other stakeholders actively participated in the development of the plan. It is both a goal and a necessity that the revised management plan and its programmatic activities coordinate with other agency and local government plans or programs. Goals are:

- Build partnerships with government agencies, municipalities and stakeholders for the implementation of the management plan.

Funding

Based on very preliminary estimates, the cost to implement all of the Action Plans is estimated to be in excess of \$37 million over the next five years. Since 1989, the partners have provided over \$47 million for projects that benefit the lagoon. Since funding is limited, recommended actions will have to focus on cost-effective use of existing

resources and a clear return on investment. The following approach for funding the management plan for LWL should be considered:

- Aggressively pursue state and federal partnerships for lagoon improvement, including efforts to secure funding in State agencies' budget through the establishment of a Lake Worth Lagoon Initiative;
- Maintain existing levels of expenditures for cost-effective projects contributing to the lagoon restoration goals;
- Evaluate programs and investigate opportunities to redirect resources to accomplish more with public dollars;
- Promote public-private partnerships with the potential for bottom-line benefits for the LWL and businesses;
- Evaluate the feasibility of a local option sales tax, when deemed essential for the implementation of action plans.

The key strategy for the successful implementation of the LWLMP is partnerships. The restoration efforts should include consideration for best current and future uses of the lagoon, and must be supported by clearly defined funding and sound management strategies to implement the Action Plans. To achieve that, local governments and agency partners are encouraged to adopt by Resolution a commitment to undertake specific Action Plans outlined within this document, and to support and promote the LWLMP. This commitment will confirm that partners are willing to work together cooperatively and commit funding and resources to the Plan. Broad community support and a united effort by environmental managers in government and industry will assure attainable and realistic goals within the next five years.

A call to action:

The LWL has been drastically altered and degraded throughout the years. By the 1970's, water quality and resources had become severely impacted, which got public and governmental attention. Interagency action in the form of a management plan, changes in stormwater/sewering practices and successful restoration projects have resulted in improved conditions within the lagoon. The LWL has important resources that need to be protected and restored. With the implementation of the proposed projects and Action Plans we will have an estuarine system that is nationally recognized, regionally significant, and on the road toward restoration and protection for future generations.

Project Priority List for the next five years

High

Habitat Restoration and Enhancement

Singer Island Seagrass Sanctuary
South Cove Waterfront Restoration
Palm Beach Atlantic Univ.
Bingham/ Audubon Islands
John's Island
Palm Beach Ibis Isle Restoration
Bryant Park Islands
Mangrove Preserves Palm Beach County/ Ocean Ridge & Boynton Beach

Studies and Monitoring Projects

Implement Sea Turtle Monitoring Goals for LWL
Develop a SAV Monitoring Program
Monitor Oyster Reef Habitat in LWL
Post Construction Project Monitoring
Implement Water Quality Monitoring Goals for LWL
Reduce Delivery of Freshwater and Total Suspended Solids through the C-51 Canal
Implement Landscaping Best Management Practices
Increase stormwater retrofit projects to benefit water quality in the LWL
C-51 Basin and complete the LWL Sourcing Study

Public Outreach

Promote Public Outreach in Lagoon Restoration and protection through education and citizens' involvement
Identify and construct public access features around the LWL

Funding

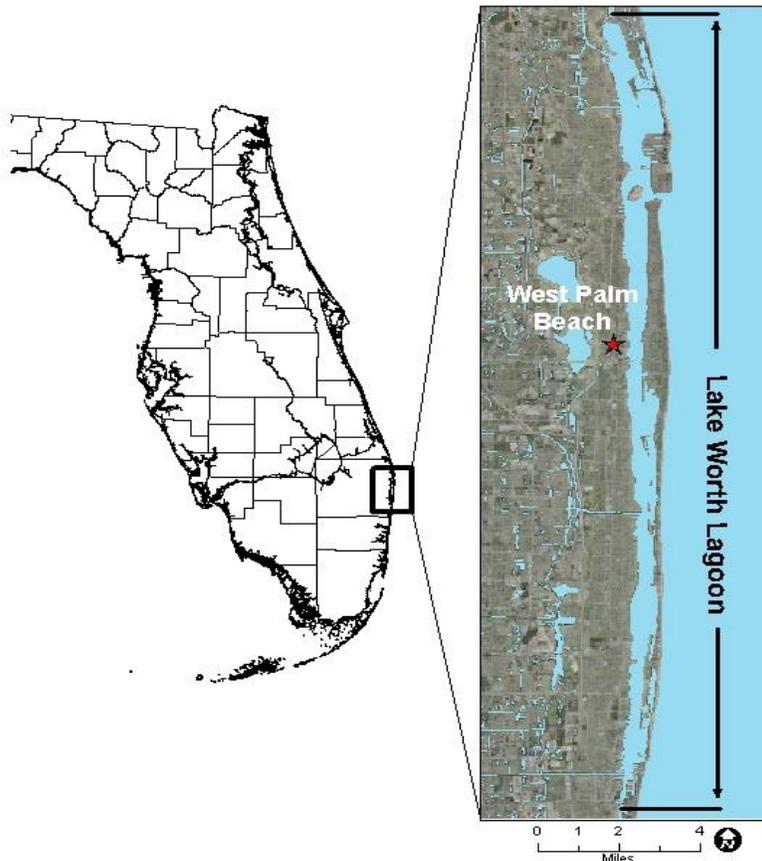
Increase Funding and Partnerships for the Lake Worth Lagoon Partnership Grant Program
Increase funding directed toward LWL management through Federal, State and local government grants and partnerships

Note: See Appendix C for project details.

1. INTRODUCTION

The Lake Worth Lagoon (LWL) is located in Palm Beach County along the southeast coast of Florida (**Figure 1**). Although the lagoon is heavily urbanized, it has been recognized as one of the most important estuarine lagoon systems in Florida. Significant regionally important natural resources remaining in this lagoonal ecosystem need to be protected. Since 1994, there has been heightened awareness and communication concerning the need for water quality improvements and habitat restoration and enhancement within the LWL. Recognizing the need for a comprehensive management plan, the Florida Department of Environmental Protection (FDEP) and Palm Beach County (PBC) formed the LWL Ecosystem Management Area (EMA) team in January 1997. The team gathered input from numerous governmental agencies, municipalities, businesses and industry, non-profit groups and concerned citizens. In August 1998, the team's steering committee voted to accept the LWL Management Plan (LWLMP). Individual tasks and projects originally defined in the plan, were and are currently implemented by various groups and agencies. The following management plan is an update on the progress and accomplishments since 1998, and the future needs for restoring the lagoon. A discussion of the current status of the lagoon is included in this update, along with specific Action Plans for future projects and tasks to be completed within the next five years. The reader should refer to the 1998 management plan for the specifics of each Program conceived in the original plan.

Figure 1. Location of Lake Worth Lagoon, Palm Beach County, Florida



WHAT IS NEW ABOUT THE MANAGEMENT PLAN REVISION

This first revision of the LWLMP encompasses the 1998-2006 timeframe. It provides a look back at progress made in implementing the original goals and priorities, and a look ahead at updated strategies and restoration projects. The most prominent change to the plan is the format. While still organized by Program, the information has been synthesized with visual aids such as pictures, graphs and tables. A current baseline (Chapter 2) about the state of the LWL, along with specific Action Plans for the next 5 years, has been added. Another change is the removal of the former Chapter 6 Program from the plan. This specific chapter dealt with Regulatory Review and Pollution Prevention Program and is now referenced as part of the interagency coordination effort (Chapter 7). Within each of the remaining Programs (Chapters 4 to 8), a general overview is presented with some of the original goals, plus several new ones. These new goals are the reflection of changed environmental conditions, scientific and economic assessments, and new data collected within the past eight years. The introduction of Action Plans for the main programs (*Water and Sediment Quality, Habitat Restoration Enhancement and Monitoring, Public Use and Outreach, Funding*), is also a new approach proposed in this revision. Each action plan begins with an introduction that summarizes the topic, presents management objectives, and includes a list of actions with strategies to address those objectives. Each action plan is intended to be a flexible framework that can be adapted to the changing needs of both, the lagoon and the responsible parties involved.

The last two chapters (Chapters 7 and 8), emphasize the need for interagency coordination and cooperation as well as a stable funding source for continuing restoration efforts. Since the adoption of the management plan in 1998, the Florida Legislature has supported the restoration and enhancement of the LWL through the Lake Worth Lagoon Partnership Grant Program (LWLPG). The Program provides funds for construction projects that benefit water quality and habitat in the lagoon. Despite the success of the grant program, the consensus, input and involvement of numerous governmental agencies, municipalities, and various stakeholders has diminished over time. One of the purposes of this update is to highlight the need for a renewed commitment to the lagoon, and to invite old and new partners to join in the restoration effort. The update also provides a framework where directions and priorities are established for the accomplishment of the restoration goals.

MAJOR ACCOMPLISHMENTS AND CHALLENGES

In the nine years since its completion, many tangible components of the LWLMP have been implemented under the leadership of Palm Beach County Department of Environmental Resources Management (PBCERM). Significant progress has been made through stormwater treatment and habitat restoration projects. Through the LWLPG a total of 37 projects have been funded. Among those projects, 27 have been completed and the remaining projects are in various stage of implementation. Twenty-two

stormwater treatment projects have been implemented within the LWL watershed treating more than 1,700 acres of runoff that previously discharged directly to the LWL. The use of pollution control devices, stormwater ponds, wetland treatment, and treatment swales has significantly reduced the amount of nutrients, sediments, and heavy metals entering the lagoon. A pollutant loading reduction study (PBCERM 2004a) was performed on six representative stormwater and septic retrofit projects in LWL. Based on these data, loading reductions were extrapolated to all stormwater and septic retrofit projects. It appears that substantial amounts of suspended solids and nutrients are being removed through innovative treatment technologies as follow:

- 1.6M lbs of Total Suspended Solids Per Year
- 36,000 lbs of Nitrogen Per Year
- 6,000 lbs of Phosphorus Per Year

Since 14 projects have yet to be analyzed, the results should be considered as preliminary estimates.

In addition to these stormwater projects, 12 Habitat Enhancement and Restoration Projects have been implemented with LWLPG funds. Two septic to sewer projects have been completed to reduce septic loading to the LWL. The grant program has also funded 1 marina pump-out station. This project benefits the lagoon by reducing the occurrence of overboard discharges from vessel holding tanks. A summarized description of these projects is discussed in Appendix B and Chapter 8.

Although the aforementioned projects have been developed through the LWLPG in cooperation with 15 agencies and municipal partners, several projects were also implemented by PBCERM using other funding sources. Combined with the grant funded projects, approximately 184 acres of habitat has been created or restored in the LWL: 67 acres of mangroves, 64 acres of potential submerged aquatic vegetation (SAV), 14 acres of artificial reef, and 39 acres of maritime hammock. Some of the most successful restoration projects are listed below:

- The **Munyon Island** restoration project removed 35 acres of exotic vegetation, created 20 acres of mangrove habitat and restored 25 acres of maritime hammock.
- The **Peanut Island** enhancement project removed over 60 acres of exotic vegetation, and excavated the sand spoils to create/restore upland and wetland habitats: 4.5 acres of tidal channels and ponds, 1.3 acres shallow-water reef and 3.0 acres of mangroves. Created upland habitats include 7.1 acres of maritime hammock, 8 acres of beach dune and 4 acres of coastal strand habitat. Over 125,000 native plants have been planted to enhance the island.
- The **Ocean Ridge Natural Area** restoration project removed 5.0 acres of exotic vegetation, restored and created 7.0 acres of mangrove wetlands, 0.6 acres of tidal

ditches/ponds for SAV habitat, and 0.8 acres of transitional/coastal strand uplands.

- The **Snook Island** project added good quality wetland habitat (mangroves, oyster reefs, and seagrass recruitment areas) to the central part of the LWL. Four mangrove islands and three shoreline mangrove planters were constructed resulting in 10.1 acres of red mangrove habitat, 2.8 acres of spartina marsh, and 2.3 acres of oyster reefs. Approximately 57 acres of submerged habitat suitable for seagrass recruitment has been created.
- The **John's Island** restoration project included the restoration of approximately 1.7 acres of existing mangroves, the creation of approximately 3.3 acres of red mangroves, and the enhancement of approximately 1.4 acres of maritime hammock.
- The **C-51 Sediment Management** project removed over 101,000 cubic yards of muck deposits up to 20' thick from the bottom of the C-51 canal before it reached the lagoon. An estimated 480 tons of nitrogen and 52 tons of phosphorus were removed from the system. The project included the creation of a sediment trap upstream of the S-155 structure to reduce future sediment loads to the LWL.

These environmental enhancement projects have been accomplished in many instances through the efforts and cooperation with many funding partners: PBCERM and PBC Parks, the Florida Inland Navigation District (FIND), the Port of Palm Beach, the United States Army Corps of Engineers (USACE), the Florida Department of Environmental Protection (FDEP), LWLPG, Florida Fish and Wildlife Conservation Commission (FWC), and South Florida Water Management District (SFWMD), the Palm Beach County School Board and municipalities including Lake Park, West Palm Beach, Palm Beach, Lantana, Hypoluxo, Boynton Beach and Ocean Ridge. A summarized description of these projects and partnering efforts is discussed in greater details in Appendix B.

Another successful restoration project within the LWL has been accomplished by the Bird Island Trust with the restoration of Beer Can spoil island, near the South Lake Worth Inlet. The Bird Island Restoration project removed 5.4 acres of exotic vegetation and created 2.1 acres of tidal channels and interior estuarine lagoons. In addition, 4.6 acres of native coastal hammock with over 60 native species were created. This island has increased the habitat for many shore birds, juvenile fish and other marine species.

PROBLEMS AND ISSUES AFFECTING THE LAKE WORTH LAGOON

Even with the success of the projects discussed above, there are many challenges still facing the lagoon. Population in Palm Beach County (PBC) has climbed approximately 30% since 1990 and is expected to reach 1.8 million by 2030 (Smith 2002). The population increases will likely further habitat loss, fishing and boating pressure from both recreational and commercial demands. Efforts to improve water quality in the LWL while accommodating future growth will have to be balanced with the competing social

and economic needs of local communities. Another challenge facing the lagoon is its altered hydrology and the large-scale freshwater releases from regional canals. Although changes to the water management strategies for the LWL are planned as a result of the Comprehensive Everglades Restoration Plan (CERP), their direct or indirect affect to the health of the ecosystem is yet to be studied. The input of contaminants and toxins from urban and agricultural runoff, elevated loads of nutrients and suspended and dissolved organic matter, are all contributing factors to the environmental distress of this estuary. A new approach is required in the LWL. The restoration efforts should include consideration for best current and future uses of the lagoon, and must be supported by clearly defined funding and sound management strategies to implement the Action Plans. Broad community support and a united effort by environmental managers in government and industry will assure attainable and realistic goals within the next five years.

2. STATE OF THE LAKE WORTH LAGOON

DESCRIPTION

The LWL is approximately 20 miles in length and averages ½ mile in width, with an average depth of 6 feet and some dredged areas reaching up to 35 feet in depth. The lagoon is the largest estuarine system in PBC and an important estuarine lagoon system in Florida. It is connected to the Atlantic Ocean by two maintained inlets, the Lake Worth Inlet and the South Lake Worth Inlet. A barrier island separates the lagoon from the Atlantic Ocean. The Atlantic Intracoastal Waterway (ICW) runs the entire length of this estuary, with eight bridges and causeways connecting the barrier island to the mainland. The watershed of the lagoon includes the communities of North Palm Beach, Lake Park, Riviera Beach, Palm Beach Shores, West Palm Beach, Palm Beach, South Palm Beach, Lake Worth, Lantana, Hypoluxo, Manalapan, Boynton Beach, Ocean Ridge and unincorporated Palm Beach County. Currently the lagoon receives the drainage from approximately 450 square miles. Major fresh water inflows from the watershed are discharged to the estuary from regional canals: the Earman River (C-17) canal, which discharges to the north or upper segment of the lagoon; the West Palm Beach Canal (C-51) which discharges to the central segment; and the Boynton Beach Canal (C-16) which discharges to the southern segment. These discharges carry large influxes of nutrients, suspended and dissolved organic matter, contaminants, and toxins, affecting the flora and fauna (Crigger et al. 2005). Altered hydrology, fishing and boating pressure, and loss of natural habitat have all contributed to the environmental degradation of this body of water. The following sections will provide a summary of the water quality and habitat conditions in the lagoon, along with challenges and unresolved issues. Baseline conditions will be used in evaluating the effects of the restoration projects within the next five years.

MANAGEMENT UNITS

The LWL can be divided into three segments (north, central, and south) based on hydrological factors including water quality, circulation, and physical characteristics (**Figure 2**). The boundaries of these segments have been slightly modified from the 1998 LWLMP. These new management units reflect the currently adopted segments of the Palm Beach County Manatee Protection Plan (PBCMPP).

Lake Worth Lagoon North (LWN):

This segment includes waters north of the Flagler Memorial Bridge in West Palm Beach. Lake Worth Inlet (also referred to as the Palm Beach Inlet) is the largest inlet and primary source of ocean water in the LWN and it is also the primary outlet for freshwater. The flushing provided by the inlet results in generally good water quality that supports seagrass beds and a marine population of fish and shellfish. The C-17 canal serves as the primary freshwater source in this segment of the lagoon, just south of Munyon Island, on

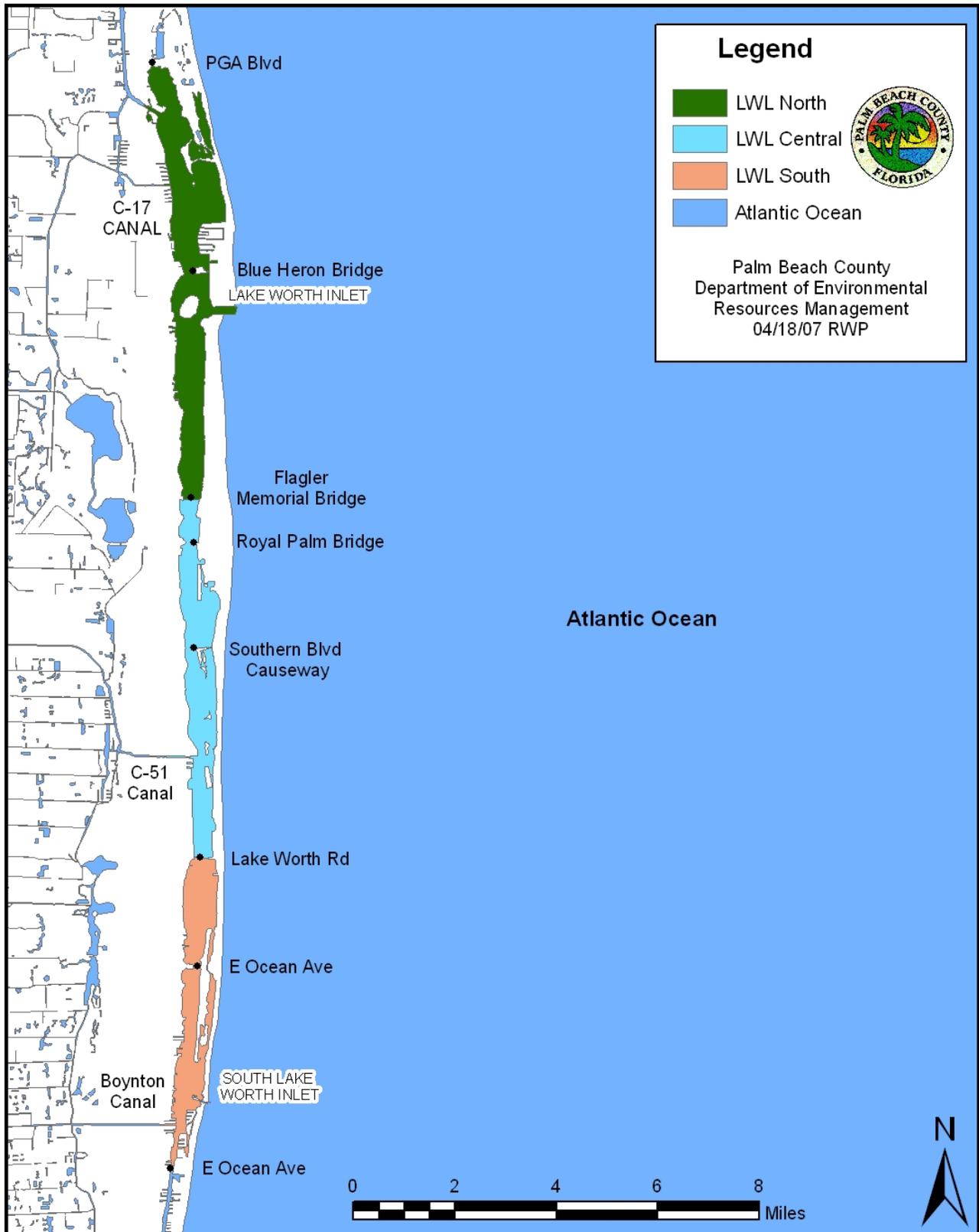
the west side of the ICW in North Palm Beach. The largest amount of mangroves in the LWL is located here. There are also extensive seagrass beds in this area of the lagoon located in and around John D. MacArthur Beach State Park, Peanut Island, and south of Peanut Island, primarily along the western shores of the ICW (PBCERM 2006).

Located within this section of the LWN is the Port of Palm Beach (PPB) District, the 4th busiest port in Florida. The Port is an independent special taxing district established in 1915. Entrance and access to the port is gained through the Lake Worth Inlet, where a channel 300 feet wide and 33 to 35 feet deep at mean low water (MLW) is maintained for vessel access. Submerged areas immediately adjacent to the Port have been similarly developed; deep water berths, channels and turning basins are located adjacent to Port areas. The ICW runs north and south along the Port, a deepwater channel is located adjacent to the filled shoreline of the Town of Palm Beach, and historic dredged materials disposal has resulted in the creation of Peanut Island (PPB 2006).

Lake Worth Lagoon Central (LWC):

This segment includes waters from the Flagler Memorial Bridge to Lake Worth Bridge. This section can range anywhere from a few hundred feet to nearly three-quarters of a mile across with depths up to 25 feet. The central lagoon is characterized primarily by single-family residences with armored shorelines, a sand and muck bottom with less seagrass coverage and scattered mangrove islands. The C-51 Canal is the major source of fresh water, as well as pollutants, to the lagoon. To address these concerns, Everglades' restoration projects are expected to result in a reduction of freshwater discharges thereby providing flood damage reduction benefits, improvements in water quality and an increased water supply for the Everglades and other uses (PBCERM 2006).

Lake Worth Lagoon South (LWS) – The south segment includes waters between Lake Worth Bridge and the Boynton Beach Bridge at Ocean Avenue. The South Lake Worth Inlet (otherwise known as Boynton Inlet) is 130 feet wide by 9 to 12 feet deep. It was initially opened in 1927 to increase circulation and improve water quality. In addition to abundant seagrass beds and mangroves, LWS also contains the Boynton (C-16) Canal which is the primary source of freshwater discharges in this segment. There are also 14 wastewater treatment package plants that operate in Ocean Ridge (FDEP 2007). Two package plants have direct surface water discharges to the LWL. The remaining 12 domestic wastewater facilities dispose of secondary-treated wastewater via land application (ponds, drainfields, injection wells, etc).



Legend

- LWL North
- LWL Central
- LWL South
- Atlantic Ocean


 Palm Beach County
 Department of Environmental
 Resources Management
 04/18/07 RWP

Figure 2. Lake Worth Lagoon segments

HISTORY

Anthropogenic disturbances and altered hydrology over the past 100 years have significantly impacted and reshaped the LWL. This body of water was originally a freshwater lake isolated from the ocean and bordered by wetlands on its western boundary, from which it received drainage. By the 1850's the area had been settled by native Seminoles. Lake Worth was known by the natives as "Hypoluxo" or Long Water (AHC 1994). In the late 1800's, new settlers arrived on the banks of Lake Worth and immediately began making changes. Extreme high tides, waves, high lake water levels, and storms occasionally formed temporary inlets, but it was not until 1877 that the first stable inlet from the ocean was excavated. Subsequent dredging of a navigation canal from the north end of the LWL to the Jupiter Inlet resulted in increased freshwater discharges from the Loxahatchee River. It was during this time that developers began filling the wetland edges of the lagoon, an activity that continued into the 1970's. In the early 1900's the ICW was completed, along with the creation of the Lake Worth Inlet and the South Lake Worth Inlet to improve navigation, tidal circulation, and flushing to the southern end of the lagoon.

Perhaps the most significant impact to the lagoon itself was the completion in 1925 of the West Palm Beach Canal (C-51). The canal was dredged with the intent of draining the western shore of the lagoon (northern Everglades), to allow development and provide flood protection. Today this canal is the major contributor of freshwater discharges from an extensive tributary basin, encompassing large areas of central Palm Beach County. It receives inputs from Lake Okeechobee, numerous smaller freshwater lakes, and canals within the surrounding residential neighborhoods. According to recently published data from 1998 to 2003 (SFWMD Hydrological Database 2004), an average of 360 million gallons per day (MGD) discharged through the C-51 spillway control structure (S-155) into the LWL during the summer months (April-November). Discharges during the winter (December-March) are 43 percent lower, with an average rate of 205 MGD (PBCERM 2006). Some additional activities that transformed the lake into an urbanized lagoon include extensive channel dredging, shoreline hardening, dredging and filling, causeway and bridge construction, dock and marina construction, canal development, industrial and sewage waste disposal, stormwater runoff, port development, mosquito control, and power plant construction and operation. Today over the 86 miles of shoreline, more than 81% has been bulkheaded, and only 278 acres of mangroves remain (PBCERM 2007).

HABITAT CHARACTERIZATION

The quality of life and the economy of coastal communities in Florida are intrinsically related to marine and coastal resources. Florida coastal lagoons and estuaries are extremely important ecosystems, as they support unique and important fish and wildlife populations. More than seventy percent of all commercial and recreational fish species depend on coastal estuaries at some stage of their life cycle (Harris et al. 1983). To better

manage and protect these important assets, it is necessary to identify and characterize the types and extent of habitats that exist in the LWL. An extensive survey, inventory and analysis of existing natural resources, literature and data, were compiled in the *Lake Worth Lagoon Natural Resources Inventory and Enhancement Study* (PBCERM 1990). Since the completion of this inventory, additional knowledge have been gained about the lagoon. The following sections will provide updated information on seagrass beds, oyster reefs, sea turtles, mangrove communities, and water quality.

Seagrass Background and Current Status

Seagrass beds are highly productive and ecologically important habitats within South Florida's estuaries and coastal lagoons. They are also nursery grounds for the juveniles of a variety of finfish and shellfish of commercial and recreational fishing value. Their roots and rhizomes stabilize the sediments, promote sedimentation of particles, inhibit resuspension of sediments, and maintain an active environment for nutrient recycling. Seagrass blades provide a substrate on which epiphytes can attach, providing a valuable food source for aquatic herbivores. Seagrasses may be more important to the food web as detritus than as a source for direct herbivory. Detritus is an important food source for deposit feeders, providing polychaetes, amphipods, isopods, ophiuroids, some gastropods, and mullet with much of their nutrition. Seagrasses are also important because they are the primary food source for the Florida manatee and sea green turtles (PBCERM & FDEP 1998).

Losses of seagrasses have been documented worldwide and have been correlated with anthropogenic eutrophication and alteration of shorelines and habitats. Declines have been correlated with a reduction in available light due to an increase in phytoplankton, epiphytic or macroalgal growth (Bortone 2000). This limits the depth at which seagrass can grow, thereby reducing the overall areal extent of seagrass beds. The mandate for the protection of seagrass comes from several sources including the 1998 LWL Management Plan, PBC Comprehensive Plan – Coastal Management Element, Florida Statute 376.121 - Liability for Damage to Natural Resources, and the Federal Endangered Species Act protecting listed species of seagrass. Historical seagrass surveys from 1940, 1975, 1990 and 2001, are presented in this report to provide a baseline and a benchmark for the development of a seagrass restoration model (Braun 2006).

The earliest survey for LWL in 1940 found that 4,271 acres of seagrass were present (PBCERM & FDEP 1998). In 1975, a resource inventory found that only 161 acres of seagrass remained in LWL. While there is uncertainty about accuracy of the methods used, this indicates a substantial loss of seagrass from 1940. The loss of seagrass was hypothesized to be linked to extensive dredging and filling activity, sewage disposal outfalls that directly discharged to LWL, degraded water quality and changes in salinity (PBCERM 1998). This was inevitable due to the rapidly expanding population surrounding the estuary and the limited technology associated with wastewater treatment plants. During the 1950s, an estimated ten million gallons per day (MGD) of raw sewage

was discharged in the lagoon resulting in extensive bacterial and nutrient pollution. By 1970, seven major waste water treatment plants had been constructed, discharging 18.49 MGD of secondarily treated sewage effluent. The volume was reduced to 2.98 MGD by 1984, largely as a result of the NPDES program administered by the U.S. Environmental Protection Agency (USEPA) (PBCERM & FDEP 1998).

In 1990, the natural resource inventory performed by Dames & Moore and PBCERM included detailed in-water surveys which provided the most complete information to date. The survey indicated that there were 2,110 acres of seagrass or approximately half of the extent of seagrass in 1940. However, there was a substantial increase of 1,949 acres when compared to results of the 1975 survey (Braun 2006). The most recent assessment of seagrass beds was conducted in 2001 using true color aerial photographs. The total seagrass beds coverage was determined to be 1,626 acres or approximately 22% of the lagoon (PBCERM 2002). The coverage varies throughout the three segments of the lagoon. Specifically, 69.7% of the seagrass in LWL are in the northern segment of the lagoon, 11.8% are in the central segment, and 18.5% are in the southern segment. The overall seagrass coverage within each of the segments is 33.5% in the north, 9% in the central, and 17% in the south segment of the lagoon (Braun 2006). The north segment was determined to have the majority of seagrass, 1,134 acres followed by the south segment with 300 acres; and the central segment with 192 acres. Although the methods of analysis were markedly different for the 1990 and 2001 surveys, there appears to be a loss of seagrass coverage over an 11-year period. The apparent loss may be due increased development in the watershed, causing upland disturbance and hydrological alteration. This development might have led to increased eutrophication and increased loading of sediments, thereby affecting water quality, clarity, and the overall health of seagrass communities. This assessment did not include extensive in-water ground truthing, therefore sparse seagrass beds, or those located in areas with poor water visibility, were not mapped. **Table 1** presents a summary of seagrass coverage in LWL found in the four studies.

Table 1. Historical Seagrass Coverage in Lake Worth Lagoon

Year	Seagrass (Acres)	% Change ³
1940 ¹	4,271 ²	-
1975	161	(96%)
1990	2,110	1,210%
2001	1,626	23%

¹Arbitrary date reflects conditions prior to intense urbanization; conditions allow for maximum coverage of seagrass.

²Acres is the maximum allowable area of seagrass given pre-WWII conditions.

³Due to gross differences in survey methods, these values should only be used to indicate an order of magnitude change.

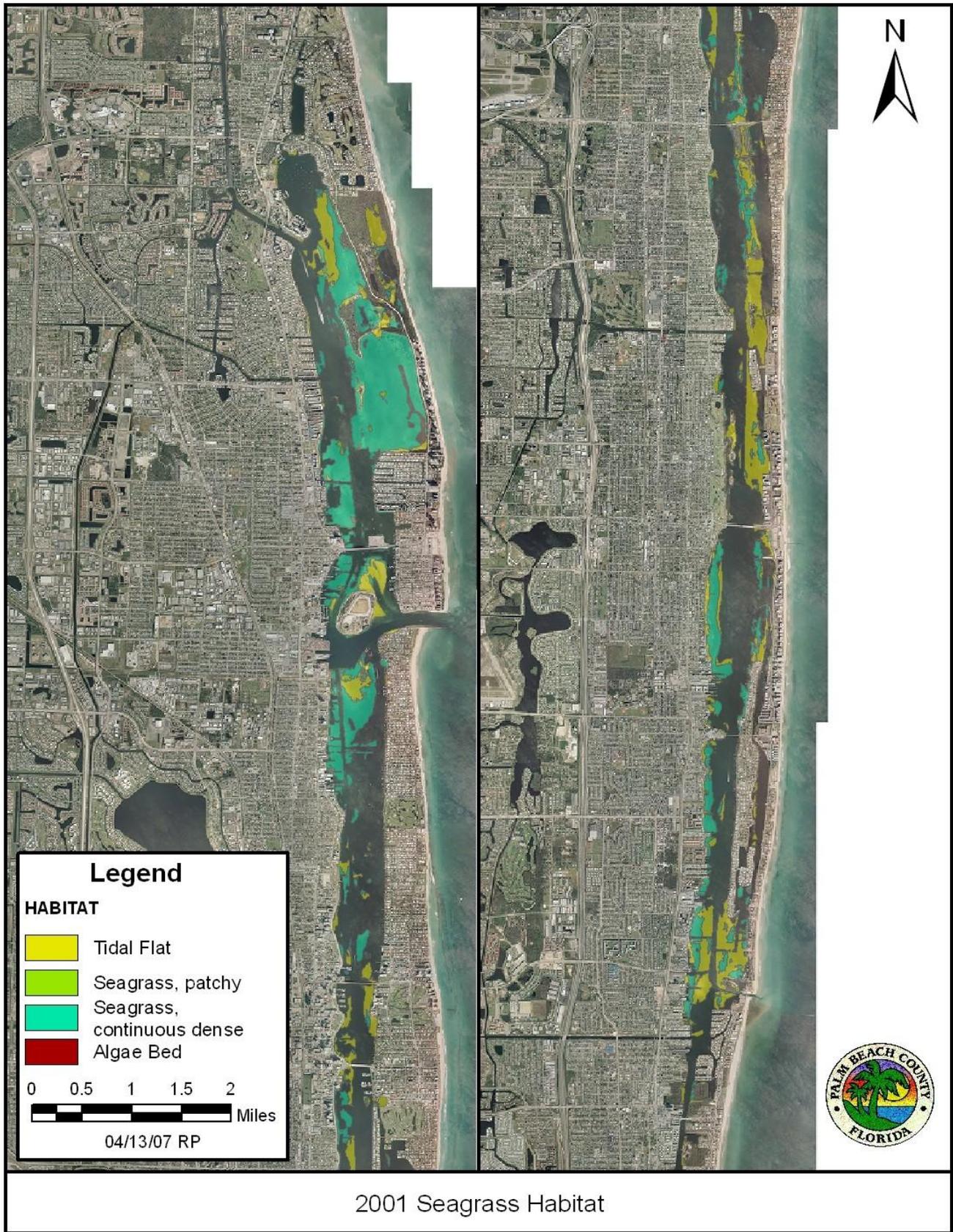


Figure 3. Seagrass Coverage from 2001 Seagrass Mapping Project

Table 2 presents the current distribution of seagrass in LWL by segment.

LWL Segment	2001 Seagrass (Acres)	Segment Area (Acres)	% Seagrass Cover
North	1,134	3,386	33.5%
Central	192	2,102	9%
South	300	1,747	17%
Totals	1,626	7,235	22%

Table 2. Current Seagrass in Lake Worth Lagoon

One of the requirements for seagrass growth is availability of light, which limits the depths at which they occur. PBCERM staff assembled existing data sets to determine the distribution of seagrass by depth using seagrass coverage from 2001, and bathymetry data from 2003 (PBCERM 2003a). **Figure 4** presents the intersection of bathymetry point data and seagrass data in a selected area of LWL.



Figure 4. Intersection of Bathymetry Transect Data and Seagrass Data for Determination of Seagrass distribution by Depth.

Approximately 92% of the seagrass in the north segment is present at depths of -2.0 to -6.0 feet NGVD. The average depth of seagrass in the north segment is -5.0 feet NGVD.

Figure 5 presents the distribution of existing seagrass by depth.

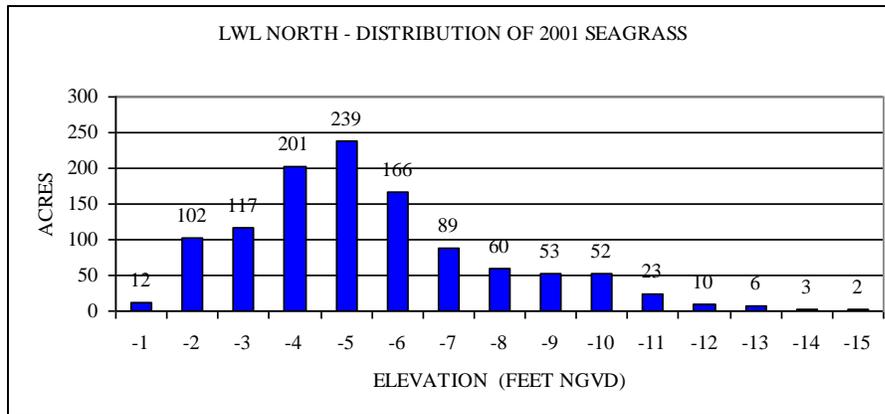


Figure 5. Distribution of Existing Seagrass by Depth in Lake Worth Lagoon North Based on Analysis of Aerial Photographs and Bathymetry.

The central segment of the LWL is the most severely impacted with respect to water quality and the presence of muck. As water quality and light attenuation decrease, seagrasses have been known to retreat to shallow depths (Bortone 2000). The central segment of the Lagoon typifies this phenomenon. In contrast to the north segment, there are only 192 acres of seagrass in the central segment. The majority of seagrass is found at depths between -3.0 to -5.0 feet NGVD. The average depth of seagrass in the central segment is -4.4 feet NGVD. **Figure 6** presents the distribution of existing seagrass in the central segment.

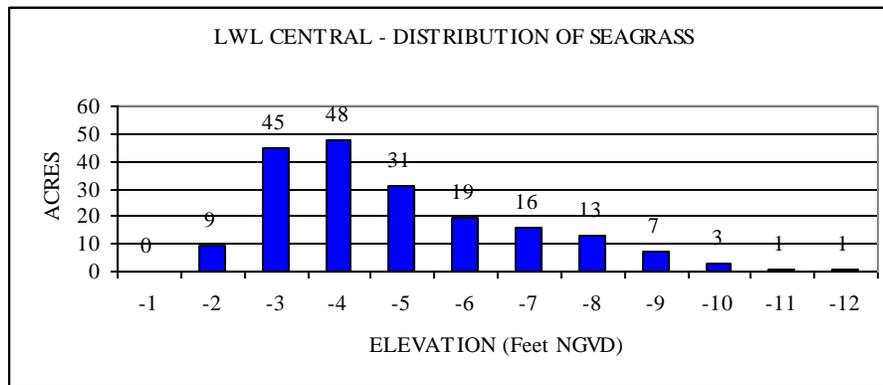


Figure 6. Distribution of Existing Seagrass by Depth in Lake Worth Lagoon Central Based on Analysis of Aerial Photographs and Bathymetry.

The south segment of the LWL is also stressed due to poor water quality and is typified by the retreat of seagrass to shallow depths where light requirements can be met. Presently, there are only 300 acres of seagrass in this segment. The average depth of seagrass in the south segment is -3.4 feet NGVD. **Figure 7** presents the distribution of existing seagrass in the south segment.

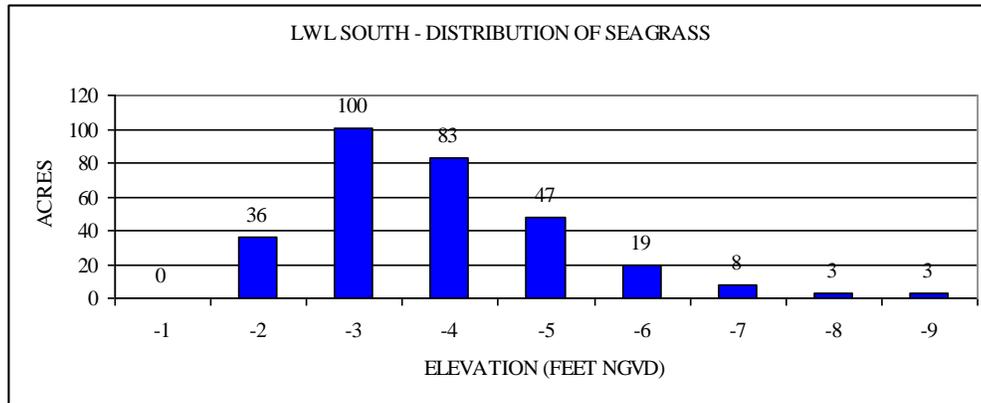


Figure 7. Distribution of Existing Seagrass by Depth in Lake Worth Lagoon South Based on Analysis of Aerial Photographs and Bathymetry.

While seagrass recruitment is dependent upon a complex set of factors and dynamics, there are basic building blocks which are important to the colonization of seagrass. One of the building blocks is suitable substrate (Braun 2006). For the purpose of calculating the extent of potential suitable habitat for seagrasses, substrate characteristics were modeled for the LWL. Historical data from the late 1960's collected by the USEPA, were digitized and combined with a muck survey performed during a bathymetric data collection event in 2003. In this case, muck deposits greater than 1 foot were mapped principally in the central and southern segments of LWL using a dual frequency fathometer. These data sets were integrated into a single shapefile. Once integrated, a Triangulated Irregular Network (TIN) was created to interpolate unmapped areas of the LWL. The TIN was then converted to raster and reclassified. **Figure 8** presents the raw data and reclassified substrate map. For the purpose of this discussion, muck is defined by grain-size analysis and includes the combination of sandy silt, silt and peat substrate classes shown in Figures 8, 9, 10.



Figure 8. Digitized Substrate Characteristics from Sediment Cores and Muck Survey (A) and Substrate Contour Map (B)

The same methodology used to analyze the seagrass distribution by depth is applied in establishing a seagrass distribution by substrate (**Figure 9**).

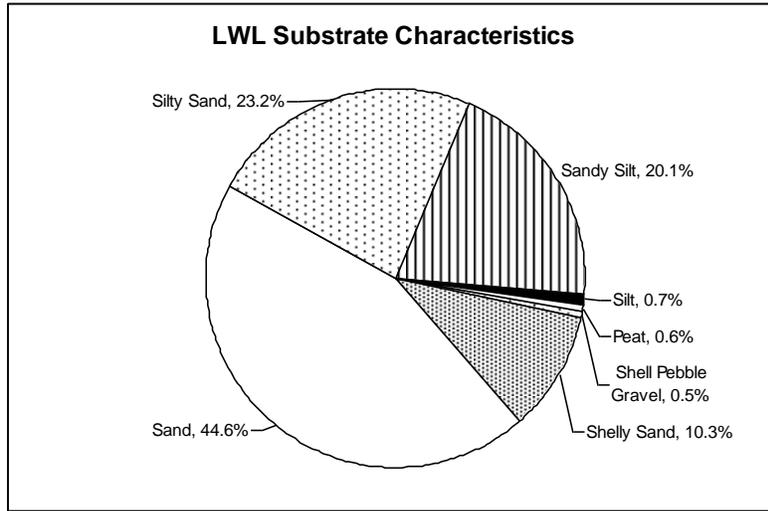


Figure 9. Lake Worth Lagoon Modeled Substrate Characteristics Distribution

Note: LWL Substrate Characteristics based on 1990 Lake Worth Lagoon Natural Resource Inventory and PBCERM 2003a Bathymetry/Muck Survey.

Figure 10 presents LWL 2001 seagrass data distribution by modeled substrate characteristics. An analysis of the results indicates that seagrass is predominantly found in sandy environments and does not colonize well in silty environments. Seagrass colonized substrates, from most dense to least dense, in sand, shelly sand, silty sand, silt, peat, sandy silt and shell pebble gravel. Seagrass is colonizing silty environments within the central and southern segments of LWL. These seagrass beds, found in impacted areas of LWL are not typical of healthy beds. Although seagrass may be found in these environments, seagrass is not expected to successfully recruit in areas with high silt content (Braun 2006).

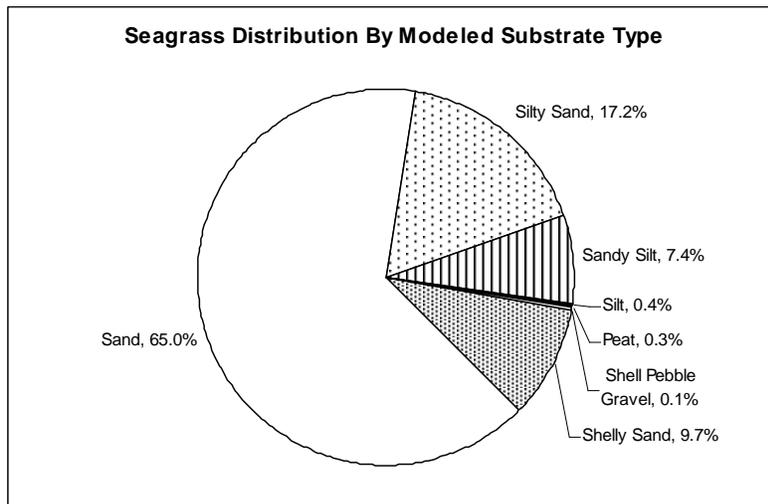


Figure 10. Lake Worth Lagoon Seagrass Distribution by Modeled Substrate Characteristics

While establishing a suitable target for seagrass restoration was beyond the scope of this baseline, the utilization of current seagrass distribution, along with examining historical trends to predict future seagrass distribution would be discussed further in the development of future Action Plans.

Fixed Transect Seagrass Surveys

Since 2000, PBCERM has conducted annual monitoring along nine transects located across the length of the LWL (except in 2006). These transects were located in areas where the lagoon bottom increased in depth by one to two feet within 50 to 100 feet of the edge of an existing seagrass bed. The areas selected were chosen by their proximity to construction projects funded by the LWLPG Program or some other water or habitat improvement project. As water quality in the lagoon improves, seagrass beds are expected to expand to greater depths and increase in density and diversity. Five years of surveys have shown fluctuation in seagrass cover with no obvious pattern of increase or decrease – until the hurricanes of 2004. The survey conducted in June 2005 showed a major decrease in seagrass cover in most areas of the lagoon. This loss is believed to be due to increased turbidity caused by runoff from the hurricanes, discharges from Lake Okeechobee, as well as burial and scour from wave action. Areas suffering the least impact were shallow sites and sites closer to inlets where water quality was least impacted (PBCERM 2005a).

Oyster Reefs

Oysters form an important part of a healthy estuarine ecosystem, but their ecological function and significance remains under-appreciated and under-studied (Coen et al. 1999a). Individual oysters filter 4-34 liters of water per hour, removing phytoplankton, particulate organic carbon, sediments, pollutants, and microorganisms from the water column. This process results in greater light penetration immediately downstream, thus promoting the growth of submerged aquatic vegetation. Although oysters assimilate the bulk of the organic matter that they filter, the remainder is deposited on the bottom where it provides food for benthic organisms. Furthermore, the oyster's ability to form large biogenic reefs (Coen et al. 1999b) qualifies it as a keystone species. Oysters and the complex three-dimensional reef structure they form, attract numerous species of fish and invertebrates (RECOVER 2007). However, excessive freshwater discharges from drainage canals adversely impact estuarine biological communities. Pre-drainage estuarine systems received freshwater inflow primarily from direct rainfall and basin runoff that resulted in low nutrient inputs. These natural patterns of freshwater inflow sustained an ecologically appropriate range of salinity conditions with much fewer salinity extremes that are experienced currently. Water management and dredging practices have major impacts on the presence of oysters and SAV within these estuaries (RECOVER 2006).

A current monitoring program conducted by FWC found several natural oyster reefs in the LWL, which for the most part appear to be in a relatively healthy state (**Figure 11**). Despite their apparent health, the areal extent of natural oyster reefs in the lagoon is very limited (~ 5 acres). FWC also found oysters on dock pilings and seawalls throughout the area, as well as on limestone riprap at the Snook Islands Natural Area. These findings imply that the population in the lagoon is not recruitment-limited, but instead limited by the availability of suitable substrate. Distribution of oysters in the LWL is confined primarily to the intertidal zone with their densest concentrations found in the central zone. In this area there is a rocky “spine” east of the ICW channel connecting several islands, most of which is intertidal. The majority of natural oyster reefs in the lagoon are located on this rocky spine, however much of the area is impacted by sediment deposits inhibiting oyster colonization. The accumulation of muck on available substrate or nearby areas makes the substrate unsuitable for oyster larval settlement and thus recruitment and growth of larval oysters (RECOVER 2007a). In addition, accumulation of muck may also impact the dissolved oxygen content making the area/substrate unsuitable for larval settlement and growth (RECOVER 2007a). Expanding the areal extent of oyster reefs in the LWL is an objective of CERP/Restoration Coordination & Verification (RECOVER). While projects implemented in the C-51 Basin as part of CERP will have an impact on freshwater discharges and consequently sedimentation and salinity, the estimation of increased oyster colonization resulting from these projects is very difficult to predict. Adding suitable material to provide additional substrate on the other hand, provides direct and measurable results. Over 185 acres of potentially suitable habitat for oyster reef enhancement have been identified by PBCERM in the central zone of the lagoon. Other areas in the estuary might also be suitable for reef creation; however those areas have not yet been identified.

CESI Oyster reef location within Lake Worth



Mark Gambordella
FWC Fish and Wildlife Research Institute
November 7, 2006
Unpublished data



Figure 11. Currently Mapped Natural Oyster Reefs in Lake Worth Lagoon. Courtesy of Mark Gambordella, Critical Ecosystem Studies Initiative (CESI), FWC.

Mangrove Communities and Shoreline Characteristics

Mangroves serve very important functions in the ecology of South Florida. Mangroves have a key ecological role as nursery grounds and as a physical habitat for a wide variety of vertebrates and invertebrates. They recycle nutrients and contribute to the nutrient mass balance of estuarine ecosystems. Mangrove leaves, wood, roots, and detrital material provide essential food chain resources, and provide habitat for many wildlife including mammals, birds, reptiles, amphibians, and arthropods. Mangroves have a special ecological function for endangered species, threatened species, and species of special concern. They also serve as storm buffers as their roots stabilize shorelines and fine substrates, reducing potential turbidity and enhancing water clarity. Another important value of mangrove swamps in Florida is their aesthetic appeal.

In 2003 PBCERM initiated a study (PBCERM 2004b) to expand the 1990 resource baseline inventory by PBC and Dames and Moore by including the entire ICW, and updating the data. One of the goals of this new study was to map and inventory mangrove communities and shoreline characteristics County-wide, and provide trend analyses between 1985 and 2001. The inventory data were categorized by the following shoreline characteristics: seawall, seawall with riprap, riprap revetment, exotic woody vegetation, mangrove swamp, and developed unarmored. True color aerial photographs of the LWL, Loxahatchee River, and the entire ICW were acquired in 2001 for these mapping purposes. The overall shoreline trend showed a conversion from natural shorelines to armoring during the period from 1985 to 2001. In Palm Beach County, 168 miles were armored in 1985 compared to 200 miles in 2001, a 19% increase. LWL showed an increase in armoring from 79% in 1985, to 87% in 2001. Countywide, mangroves showed a slight increase from 1985 (657 acres) to 2001 (669 acres), a 2% increase. In the LWL, mangrove stands also increased ~2%, from 273 acres in 1985, to 278 acres in 2001.

It should be noted that the 1985 aerial photographs were taken at a resolution of 1:58,000 compared to the scale of 1:10,000 for the 2001 aerial photographs. In addition, two different types of photography were used for those maps. The larger scale for the older maps made data interpretation more difficult combined with the inability to “groundtruth” them. Also, the larger scale necessitated a larger minimum mapping unit of 2 acres compared to 0.25 acres for the 2001 aeriels. Therefore, these results should be used with caution and with the recognition that they are appropriate for depicting gross changes only. Several conclusions and recommendations were drawn from this study:

- The results show a substantial shift in shoreline characteristics toward greater armoring as a result of development. This is expected to negatively affect fisheries and wildlife, such as fish, birds, and benthic invertebrates that utilize shallow, natural estuarine shorelines and beaches.

- Although the amount of armoring increased 19% countywide, the increase in riprap facing the armoring that provides some habitat value and benefit to the lagoon showed a 267% increase, which should provide benefits to the system.
- Shorelines with just riprap (no seawall) increased 44%; a stabilization method that provides more habitat value than a vertical bulkhead.
- There appears to have been a slight increase in mangrove acreage which is most likely attributable to large-scale restoration projects and some mitigation projects.
- Northern Palm Beach County has the most significant coastal resources compared to the rest of the County.
- Greater emphasis should be placed on preserving and enhancing the few remaining coastal resources in southern PBC.

Many habitat enhancement projects have been completed since the 2001 aerials were taken and this County-wide study was performed. Approximately 184 acres of habitat have been restored (see comparison from **Figure 12 and 13**). Updated mapping of mangrove communities and shoreline characteristics has been initiated in summer 2007. The results will be interpreted and compared to the previous study.

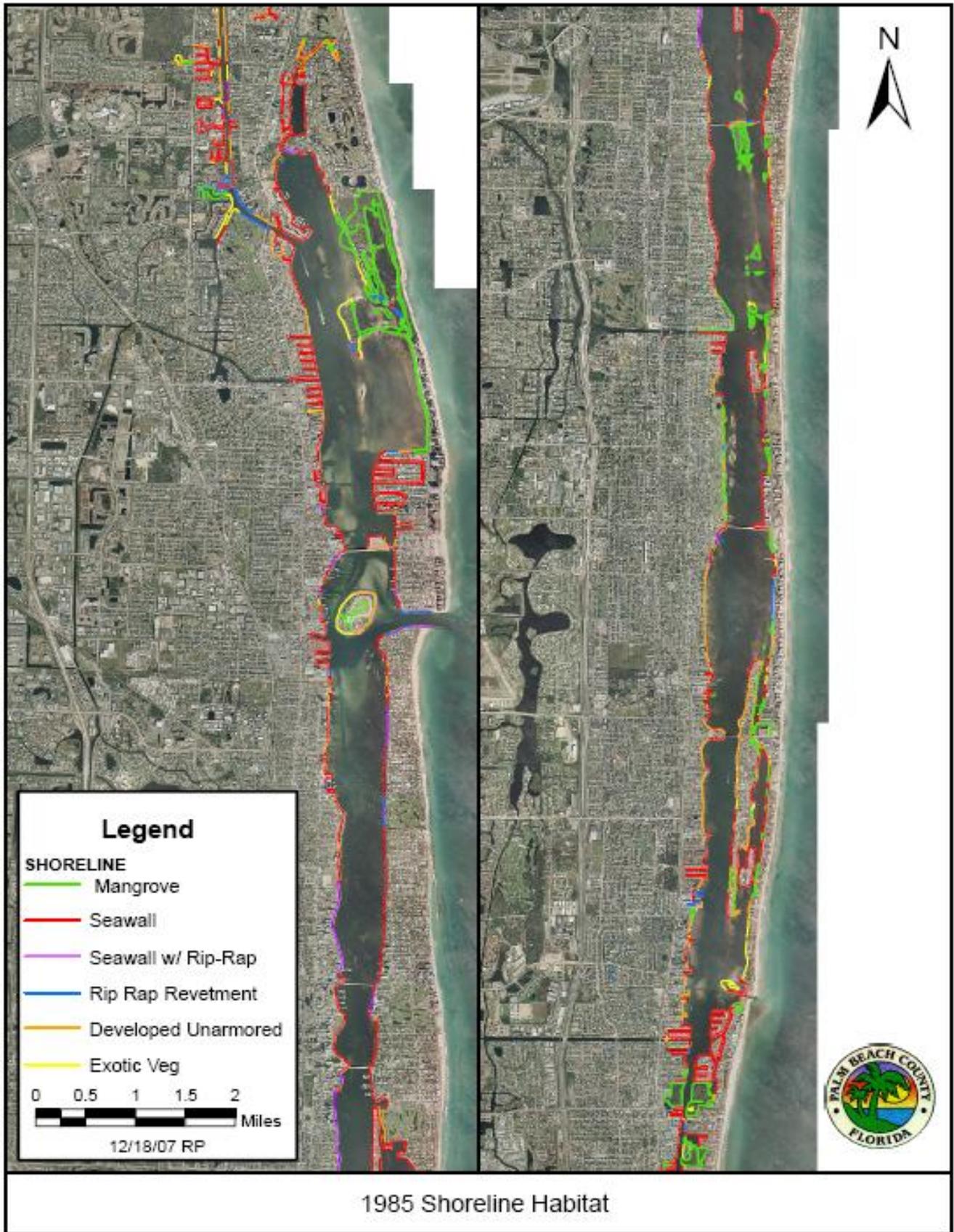


Figure 12. Map of Shoreline Habitat in 1985

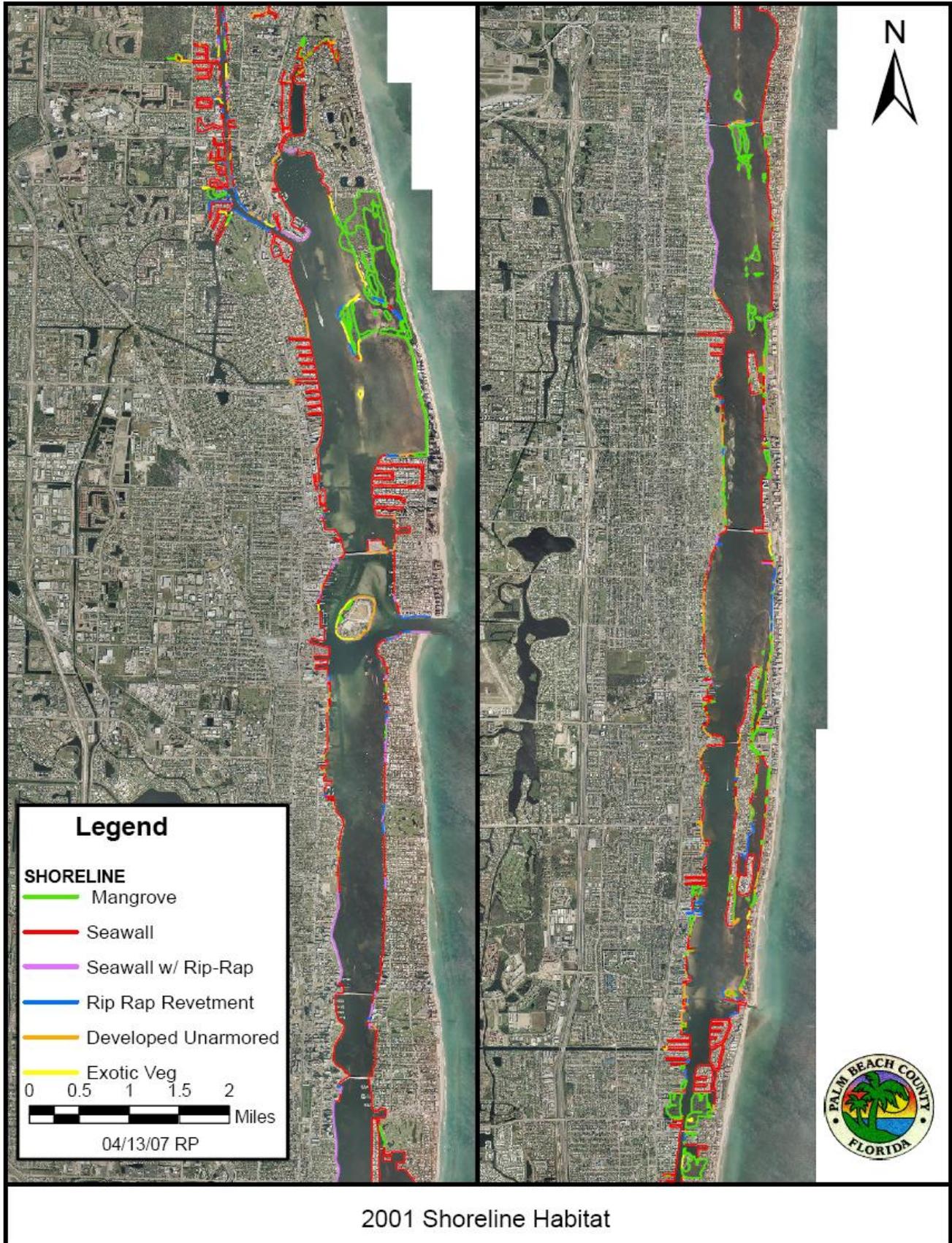


Figure 13. Map of Shoreline Habitat in 2001

Sea Turtles

Sea turtles have been swimming the oceans for more than 100 million years and have been using our beaches, reefs and estuaries long before man settled in Florida. Sea turtle populations have declined, however in recent years because of man's activities, they are now "endangered" and "threatened" species. Palm Beach County's beaches are some of the most densely nested in the United States. Sea turtles can be found in our waters year round, but in the spring and summer, large numbers of adults congregate off our beaches and along the reefs. Nesting on our beaches begins as early as March. The early nesters are usually leatherback sea turtles with the more numerous loggerhead sea turtles arriving in significant numbers in May. Nesting continues into August and tapers off in early September. Loggerhead sea turtles lay the vast majority of nests in PBC, with the green and leatherback sea turtles accounting for the remainder of the nests. The hawksbill and the very rare Kemp's ridley sea turtles can be also found in PBC waters. The U.S. Fish and Wildlife Service (USFWS) has listed the leatherback, green, hawksbill and Kemp's ridley sea turtles as "endangered" species, and the loggerhead sea turtle as a "threatened" species.

A recent analysis of Florida's long-term loggerhead sea turtle nesting data, collected as part of the FWC Index Nesting Beach Survey, revealed a significant decline in nesting numbers around the state. The analysis indicates nest counts have declined 22.3% from 1989 to 2005, and 39.5% since 1998. An average of 14,423 loggerhead sea turtles nested on Florida beaches between 2001 and 2005. Florida accounts for more than 90% of the loggerhead nesting in the U.S., with a nesting aggregation considered to be one of the two largest remaining in the world (www.myfwc.com).

Estuaries can be important development habitat for subadult sea turtle population. Though much is known about the sea turtles utilizing Palm Beach County's nesting beaches, little is known about the sea turtle population in the LWL. Because sea turtles can function as indicator species as to habitat health, it is, therefore, important to know if sea turtles are utilizing the LWL and to characterize that sea turtle population. Fibropapillomatosis (FP), a potentially deadly disease affecting primarily green sea turtles in polluted estuarine waters, has been documented at a high frequency in the Indian River Lagoon (IRL) and Mosquito Lagoon sea turtle populations, and is likely to occur at similar frequency in the LWL, though more data is necessary for adequate comparison.

For this purpose, in March 2005 PBCERM contracted Inwater Research Group, Inc. (IRG) - a non-profit organization - to conduct a survey of sea turtles in LWL. Possible study sites in LWL were originally identified by analyzing stranding records and sighting data provided by PBCERM. The primary objectives of this on-going study are to:

- Obtain baseline data on species abundance, size frequencies and sex ratios.
- Determine the Catch per Unit Effort (CPUE) at specific sites in LWL.

- Document the prevalence of FP
- Collect gut contents to evaluate feeding preferences between algal or seagrass species
- Obtain blood samples for genetic, sex ratio and disease analysis.
- Determine habitat preference of sea turtles within LWL by collecting GPS waypoints for sighting and captures.

Data collected from March 2005 to June 2006 showed 150 sea turtles have been spotted on ~175 km of visual transects in the LWL. During netting activities, 29 sea turtles were captured for a CPUE of 2.61 turtles per kilometer net hour. The majority of turtles observed and caught have been juvenile green turtles. Overall, FP was observed in 57% of the green sea turtles captured (**Figure 14**). In addition, 3 of the captures have required transfer to a rehabilitation facility for monofilament or boat-related injuries. FP appears to be more prevalent and severe during the winter months, similar to the IRL.

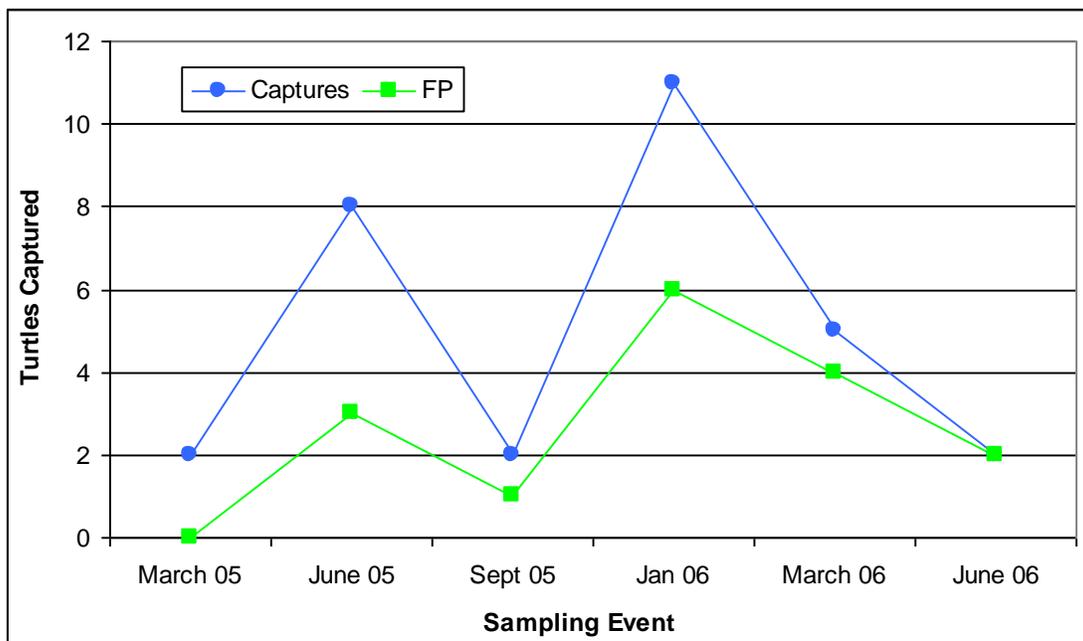


Figure 14. FP Rate in Sea Turtles Captured from 2005 to 2006

Additional observations from this study showed that sea turtles in LWL are frequenting areas that support high amounts of seagrass and algae and eating both, different from IRL turtles which tend to feed on one or the other. Results from this on-going monitoring are summarized below:

- Sea turtle captures and sightings are more prevalent during winter and spring months
- FP rate and severity is highest in winter and spring
- Sea turtles are frequenting areas that support high amounts of seagrass and algae

- LWL sea turtles are eating both seagrass and algal species, different from IRL sea turtles which tend to feed on one or the other
- CPUE is similar to study sites in the IRL
- FP rate and severity is also similar to study sites in the IRL
- Growth rates are similar to those recorded in the IRL

In summary, LWL is being used as developmental habitat by subadult green sea turtles to a much greater extent than expected. Sea turtles are found regularly in areas with the best seagrass beds and nearly 2/3 of the turtles captured have tumors. As previously mentioned, because sea turtles can function as an indicator species to habitat health and water quality, the high FP rate could have important implications and inferences about the water quality in the lagoon.

PBCERM, in cooperation with the SFWMD, is in the process of expanding its water quality monitoring program. Within the next year, additional monitoring stations will be established, frequency of monitoring will increase, and additional constituents will be analyzed, specifically those thought to be linked to FP incidence. Promoting community participation in maintaining LWL health and protection of sea turtles, similar to beach programs, is vital to sea turtles' survival. An educational campaign focused on LWL water quality and the health of its sea turtle population has been planned as part of the Sea Turtles Action Plan.

Manatees

Many habitat restoration projects planned within the next five years are designed to benefit one of the most valuable natural resource in the lagoon: the endangered Florida subspecies of the West Indian Manatee (*Trichechus manatus latirostris*). The lagoon attracts as many as 300 manatees during the winter months. A recent synoptic survey performed by FWC in February 2007 confirmed that 237 manatees were gathered at the FPL Riviera power plant. Although manatees are observed year-round within the lagoon, the majority of these gentle marine mammals congregate near the warm-water discharges of the Riviera Power plant from December through March. The northern segment of the lagoon appears to provide a particularly important habitat. Approximately 37% of all manatees sighted during past aerial survey were in the LWN segment, where the most expansive seagrass beds are located (PBCERM 2006). More details about manatees' status and trends, and the Palm Beach County Manatee Protection Plan can be found at: <http://www.co.palm-beach.fl.us/erm/enhancement/manatees.asp>.

Water Quality

At present, water quality within the estuarine coastal areas of PBC is highly variable. Generally, water quality is best in the vicinity of the four tidal inlets, where the water bodies are subjected to diurnal flushing and enhanced circulation. This section provides a summary of the information available on the current state of, factors affecting, and initiatives to monitor and improve water quality within the LWL.

In Rule 62-302.400, FAC, the State designates all surface waters in Florida into one of the following classes:

- Class I Potable Water Supplies;
- Class II Shellfish Propagation or Harvesting;
- Class III Recreation, Propagation and Maintenance of a Healthy, Well-Balanced Population of Fish and Wildlife;
- Class IV Agricultural Water Supplies; and
- Class V Navigation, Utility and Industrial Use.

There are separate State water quality standards for each class of surface water. These standards identify acceptable levels for a variety of constituents (e.g., nutrients, suspended solids, turbidity, dissolved oxygen, etc.). All surface waters in PBC, including LWL, are classified as Class III waters with few exceptions. Since World War II, water quality within the lagoon has been significantly degraded by various drainage, dredging, and development projects. These projects have caused significant alterations in the timing, distribution, quality and quantity of fresh water that enters the coastal waterways. Water quality within the coastal waters, canals, and freshwater lakes of PBC are mainly affected today by nonpoint sources of pollution including stormwater runoff. Water quality issues associated with runoff in the lagoon include those related to low levels of dissolved oxygen (DO) from two tributaries (C-51 and C-17), excessive nutrients, metals (copper, zinc, and lead), elevated bacterial levels, and turbidity (FDEP 2003a).

According to the LWLMP (1998), the major issues affecting surface water quality within the lagoon include:

- Undesirable salinity fluctuations;
- Increased sediment loading and sedimentation;
- Increased nutrient loading;
- Increased input of toxic substances;
- Increased levels of pathogens;
- Loss of emergent wetlands;
- Loss of submerged natural resources.

Large volumes of freshwater discharges into the lagoon, primarily through the C-17, C-51, and C-16 canals, cause extreme salinity fluctuations. Many aquatic organisms, such

as oysters and seagrasses, are unable to tolerate excessive freshwater inflows, which sometimes occur over relatively short time periods following large rainfall events. Adult oysters typically occur between 10 and 30 parts per thousand (ppt) but they tolerate a salinity range of 2 to 40 ppt (Gunter and Geyer 1995). Excessive freshwater inflows over a short period of time causes a sudden drop in salinity that can lead to a significant mortality in the oyster population, and decreased growth, reproduction, and spat recruitment (RECOVER 2007a). Seagrasses are also affected by salinity fluctuations. Montague and Ley (1993) found that SAV biomass, including seagrasses, was directly proportional to salinity, with biomass decreasing as salinity variation increased (RECOVER 2007b). In addition to altering salinity regimes, freshwater discharges also introduce nutrients and suspended materials. The water quality in many areas of the LWL has been affected by the increased discharges from residential and commercial development, industry, agriculture and other human land-use activities. The removal of natural shoreline vegetation (mangroves) and expansion of shoreline's armoring, also contributed to further the decline on water quality, since mangroves enhance water quality by acting as natural filters (Crigger et al. 2005).

A major threat to the recovery of the LWL is excess suspended sediment loading. Suspended sediments, fertilizers, pesticides and other pollutants find their way into estuaries via freshwater tributaries, canals, and upland run-off. While suspended sediments increase turbidity and thereby decrease the amount of sunlight that reaches the bottom, nutrients cause proliferation of phytoplankton in the water column further deteriorating water clarity. As sediments fall out of suspension, they accumulate on the bottom, sometimes forming a silty layer over previously natural sediments. Seagrasses have difficulty growing on this layer, and cannot survive when covered by it. Thus, changes in drainage basin characteristics have significantly impacted the water column and sediments causing the loss of oysters and submerged aquatic vegetation from large portions of their historic range.

Water Quality Baseline

The LWL monitoring network has undergone several revisions since 1991, with stations added or discontinued, with few site locations possessing relatively long datasets. Originally, the LWL Water Quality Monitoring Program consisted of 10 sampling stations in the three segments of the lagoon (north, central, and south) sampled on a monthly basis. Eight fixed stations are located within LWL proper and two fixed stations are located at SFWMD control structures or within tidally influenced canal confluences. Twelve (12) new stations have been added to the monitoring network (implemented in October 2007), for a total of twenty-two (22) sites (**Figure 15**). Several parameters will be analyzed on a monthly basis including: dissolved oxygen (DO), pH, salinity; Kjeldahl nitrogen (TKN), ammonia nitrogen (NH₄), nitrite-nitrate nitrogen (NO_x), total phosphorus (TP) and orthophosphorus (OPO₄), turbidity, and chlorophyll-a. Metals such as arsenic (As), copper (Cu), cadmium (Cd), and lead (Pb) will also be collected. Additionally, 5 high-frequency in-situ sondes (multi-parameter sampling units) will be

deployed to augment the monitoring network.

The new proposed Water Quality Monitoring Network is coordinated with the SFWMD. It will provide an estuary-wide assessment of the chemical and physical conditions of LWL. The proposed network will also provide policy-makers and the public with estimates of the status of the County's inshore coastal resources with statistical confidence. It will be used in an effort to describe the relationships between indicators of natural and anthropogenic stress and marine resource. The impacts on biological resources, such as seagrasses and oyster beds, will be assessed as well.

Water Quality Data Sources and Sampling Stations

This section provides an overview of the status of water quality in LWL relative to Class III criteria collected from January 1994, through January 2007. Water quality data collected during this period of record will accomplish the following objectives:

- Summarize water quality data in LWL and indicate spatial and temporal trends
- Summarize areas and times where water quality criteria are not being met and discuss factors contributing to excursions
- Provide an evaluation of natural background conditions and possible effects of hydrologic, climatic, and human-induced perturbations

The water quality data was analyzed by SFWMD using data retrieved from STORET, the hydrometeorologic database maintained by the FDEP, and the PBCERM database. Sample collection was accomplished through a grab-sample collection program. At each station, near-surface samples were collected on a monthly basis, including water quality physical parameters measured in-situ. Physical parameters measured included water temperature, dissolved oxygen, turbidity, salinity, conductivity, and pH. Water samples were collected by ERM and FDEP, preserved and stored according to FDEP Standard Operating procedures. Quality assurance/quality control measures include pre-cleaned equipment blanks, field cleaned equipment blanks, field spikes, and the collection of duplicate sample.

For the purpose of this baseline, few parameters were analyzed due to the limited long-term consistency of the data. Prior to 1994, the samples were collected irrespective of tidal cycle and consequently were excluded from the analysis. There is a fairly high quality dataset extending back to 2001, thus data from 2001 to 2006 period of record (POR) have also been also analyzed and compared to the 1994-2006 data set to exclude outliers.

Station location, parameters analyzed, and the period of record analyzed are summarized in **Table 3** and **Figure 15**. The new monitoring stations shown on Figure 16 were not included in the analysis since sampling did not occur before October 2007.

Station Name	Frequency	Period of Record	Parameters
11, 13, 18C, 18D ¹	12x/Year	1994-2006	DO, salinity, TKN, TP, turbidity, Chlorophyll-a (corrected), As, Cu. Metals were collected quarterly.
LWL 1 ² LWL 3 LWL 9 LWL 11 LWL 13 LWL 18	12x/Year	1994-2006	DO, salinity, TKN, TP, turbidity, Chlorophyll-a (corrected), As, Cu. Metals were collected quarterly.

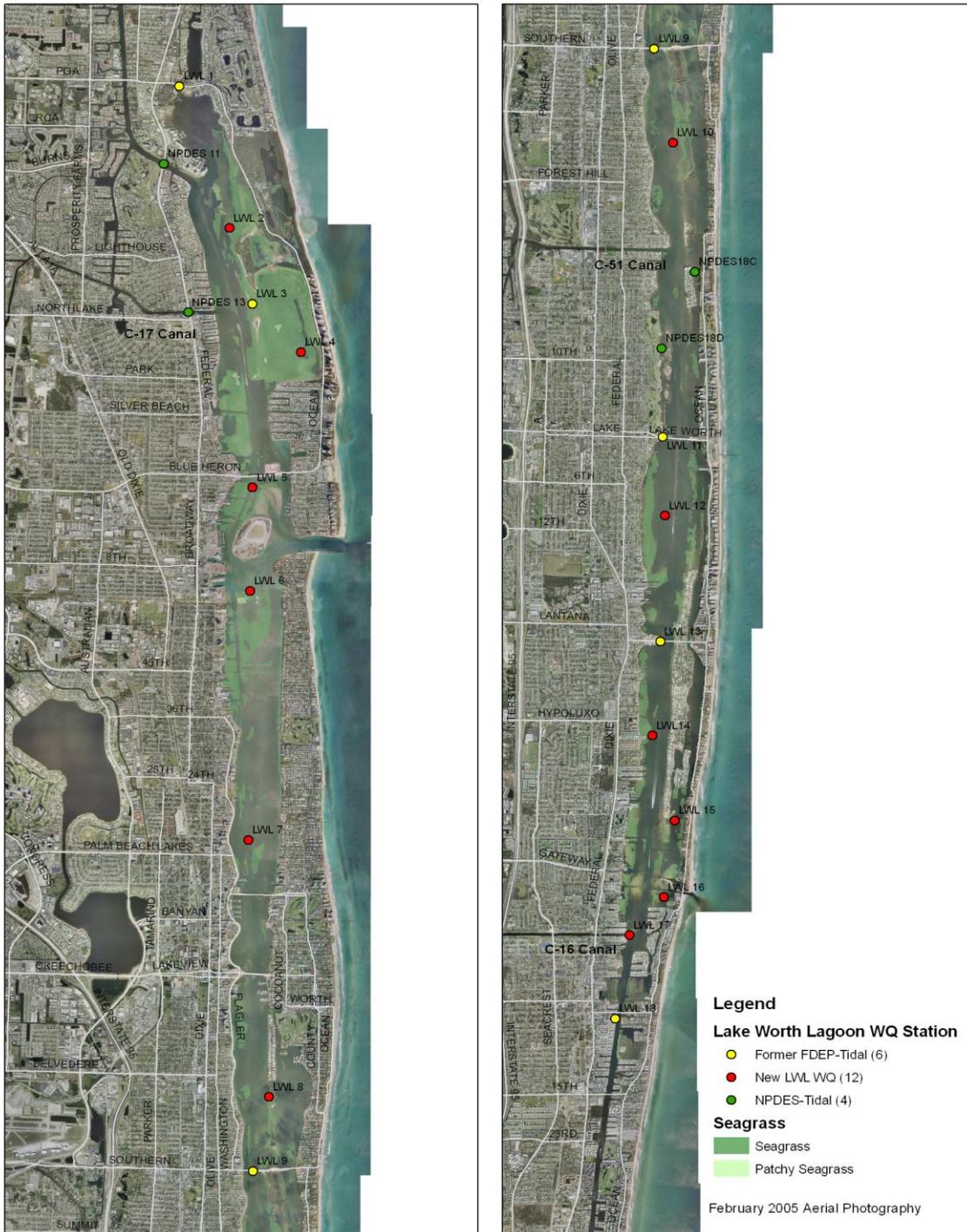
Table 3: Frequency and Parameters for LWL Surface Water Samples

¹ Collected by PBCERM

² Formerly collected by FDEP and renamed in 2007. Currently collected by PBCERM.

Lake Worth Lagoon Water Quality Stations

FDEP Tidal Stations to be monitored by PBC
All stations monthly sampling



Lake Worth Lagoon

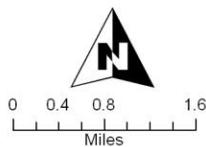


Figure 15: LWL Sampling Site Locations and Future Monitoring locations

Analysis Results

The description of the data is presented in time series graphs and statistical box plots (**Appendix A**). For statistical purposes, monthly and yearly data were considered to establish trends. In the occurrence where multiple samples were collected within a given month, arithmetic means were calculated. Correlations between data were determined by the nonparametric Spearman rank method, which was deemed significant only in those cases where the 95% confidence interval determined by bootstrap resampling circumscribed critical values all possessing P values less than 0.05; in those cases where this criterion was met, the P value reported is that determined by the statistic (Zar 1998). Trends were evaluated utilizing the nonparametric Seasonal Kendall Trend test, using the twelve months as individual seasons.

Results of the water quality baseline for the 1994-2006 period of record (POR) are summarized below:

- Dissolved oxygen was not categorized as a concern in the LWL with mean (average) and median concentrations of 5.8 mg/l and 6.0 mg/l, respectively. The surface water quality standard for Class III Marine criteria is 4.0 mg/l.
- TP showed mean and median concentrations of 0.138 mg/l and 0.067 mg/l, respectively. The mean and median values reflect obvious outliers in the earlier data reaching up to 22 mg/l for the 1994-1999 POR. Evaluating only the data within the 2000-2006 timeframe however, results in mean and median TP concentrations of 0.061 and 0.057 mg/l, respectively, with no apparent trend. These values are below the median TP value among Florida Estuaries of 0.100 mg/l (Hand 2004)
- TN showed mean and median concentrations of 0.83mg/l and 0.72 mg/l respectively, above the median value among other Florida Estuaries of 0.67 mg/l (Hand 2004). A statistical significant increase in TN was observed from 2002 to 2006. It has to be noted that the active hurricane season in 2004 and 2005 might have had an effect on the trend.
- Chlorophyll-a data are only available from 2001. Results showed an apparent upward trend with mean and median concentrations of 4.4 µg/l and 3.2 µg/l respectively. The median value of Chlorophyll-a among Florida Estuaries is 6.1 µg/l (Hand 2004).
- Mean and median turbidity concentrations are 4.6 and 3.1 NTU, respectively. These values are in agreement with the median value among Florida Estuaries of 3.1 NTU (Hand 2004). Turbidity is also showing an apparent increasing trend lagoon-wide from 2001 to 2006.

- Salinity levels also showed that the increasing freshwater discharges from the C-51 Canal decrease conductivity, leading to a freshening of the lagoon and causing a salinity drop in the surrounding areas.
- TN, TP, Turbidity, Salinity and Chlorophyll-a are significantly correlated with flow discharges from the C-51 Canal at the S-155 structure. TN and Turbidity in fact showed a significant increase near the C-51 Canal. The inverse correlation of salinity with TN, TP and turbidity, with TN (N=427, $\rho=-0.555$, $P<0.001$), TP (N=639, $\rho=-0.261$, $P<0.001$), and turbidity (N=691, $\rho=-0.309$, $P<0.001$), suggests that C-51 canal discharges result in increases in these constituents. These effects are more pronounced as the distance to the C-51 canal mouth decreases.
- Results from heavy metals (Cu and As) analysis showed some exceedences in water quality standards for Cu, and no exceedences for As. Overall mean and median concentrations for Cu were below water quality state criteria of 3.7 mg/l. Exceedences in Cu have been reported just south of the LWL. Mean and median concentrations for As were below the state water quality criteria of 50 mg/l.

Since the C-51 plays a pivotal role both in the water quality of the lagoon as well as one the focus of restoration efforts, a better examination of its direct effects may be facilitated by restricting the analysis to only the pair of water quality monitoring sites immediately above and below the canal mouth (Station LWL 9 and LWL 11). Within this limited zone, discharge (cfs) is significantly correlated ($P<0.001$) with chlorophyll, TN, turbidity, and inversely as anticipated to conductivity. At these two sites adjacent to the canal (**Table 4**), turbidity is higher than the median value among Florida's estuaries (3.1 NTU; Hand 2004) more than 75% of the time, and about double that value in half of the observations. The turbidity maximum of 16 NTU is cause for probable concern. Chlorophyll concentrations are higher than the Florida's guidelines for impairment (11ug/l; 62-303 FAC) in more than 25% of the samples. Nearly a quarter of the samples taken contained TN concentrations in excess of 1.0 mg/l. Discharges were not correlated with TP, DO, pH, or temperature (Draft SSR 2007).

	Turbidity	Chlorophyll-a	Total Nitrogen
N of Cases	101	98	86
Minimum	0.50 NTU	0.82 $\mu\text{g/l}$	0.15 mg/l
Maximum	16.00 NTU	59.15 $\mu\text{g/l}$	1.67 mg/l
Mean	6.24 NTU	9.60 $\mu\text{g/l}$	0.77 mg/l
Median	6.00 NTU	6.30 $\mu\text{g/l}$	0.76 mg/l
25%	4.00	3.20	0.51
75%	8.00	12.30	0.99

Table 4. Basic Statistics of water quality constituents significantly correlated to the C-51 canal, from the two sites adjacent to the canal mouth (Table adapted from the Draft System Status Report 2007).

Conclusions

The water quality in the LWL is generally good based upon this data set; however, significant increases have been occurring for few parameters like TN, Chlorophyll-a, and Turbidity. Freshwater inflows affect turbidity, salinity, and nitrogen levels in the lagoon, and increasing proximity to the C-51 canal equates with worsening water quality conditions (Draft SSR 2007). The effect of the C-51 Canal discharges from the S-155 structure is more apparent in the central portion of the lagoon than in the south or north. High concentrations of TN are, in conjunction with other factors, often associated with algal blooms, as well as dense aquatic plant growth. Statistical analysis (a best subset regression of transformed data), indicates that TN is likely the causative agent driving chlorophyll dynamics and the limiting nutrient for algal blooms (Draft SSR 2007). The increasing nitrogen trend will have to be monitored closely in order to exclude potential biases from storm activities that increased discharges and runoff in the lagoon in 2004 and 2005. The apparent increasing trend in Chlorophyll-a lagoon-wide is worrisome and should also be monitored closely. Elevated concentrations of Chlorophyll-a can reflect, as previously mentioned, an increase in nutrient loads and can indicate the eutrophication of a system.

It should be noted that it was not in the scope of this baseline to analyze other parameters of concerns such as fecal coliforms, NH_4 (Ammonia), NO_x (Nitrite + Nitrate), or Total Suspended Solids (TSS) due to the lack of long-term dataset for these parameters. The enhanced LWL WQ monitoring network (**Figure 15**) will provide additional data useful to detect changes and trends in the water quality column.

General Bathymetry

The LWL is a shallow water body typically ranging in depth from 1ft to 10ft. The ICW is maintained at a depth of ~10ft (NGVD datum) and depths of up to 40ft can be found in the channel east of the Port of Palm Beach (**Figure 16**). Isolated holes from previous dredging activities are scattered primarily in the north and central lagoon, which can be significantly deeper (up to 30 feet deep) than the surrounding depths. The shallow areas are found primarily in the southern half of the LWL, with some key areas found in the northeast portion of the lagoon, north of Peanut Island and south of Lake Worth Bridge. These areas can be more biologically productive when water quality is good. In contrast, the extensive deeper areas along North Palm Beach and West Palm Beach shorelines are noticeable compared to the rest of the lagoon.

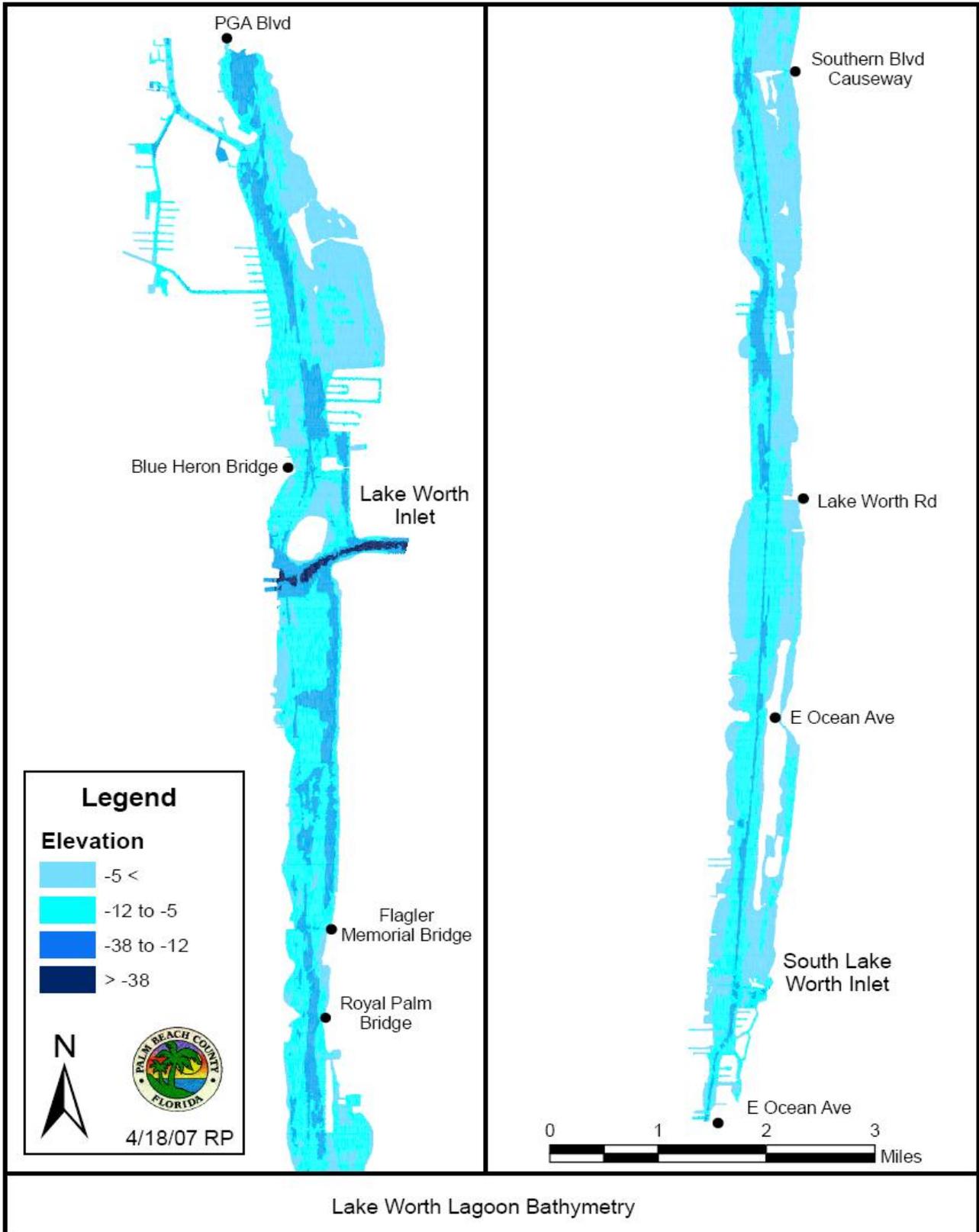


Figure 16. Lake Worth Lagoon Bathymetry Map

LWL Dredge Hole Assessment Study

A joint project with FWC and the Smithsonian Institute conducted in 2005 was designed to evaluate fisheries and macrobenthic habitat in 10 selected dredge holes³ in LWL because potential management options have included filling dredge holes in LWL. Fishes and benthic epifauna were surveyed using a combination of bottom otter trawl, epibenthic dredge, baited wire fish traps, and rod-and-reel gear. Sediment samples from the study sites were characterized and analyzed for water and organic content. Temperature data loggers were deployed at several of the holes to examine the temperature variation and determine if temperature conditions existed that provide thermal refuge for fisheries. **Figure 17** presents the 10 dredge hole study locations in LWL.

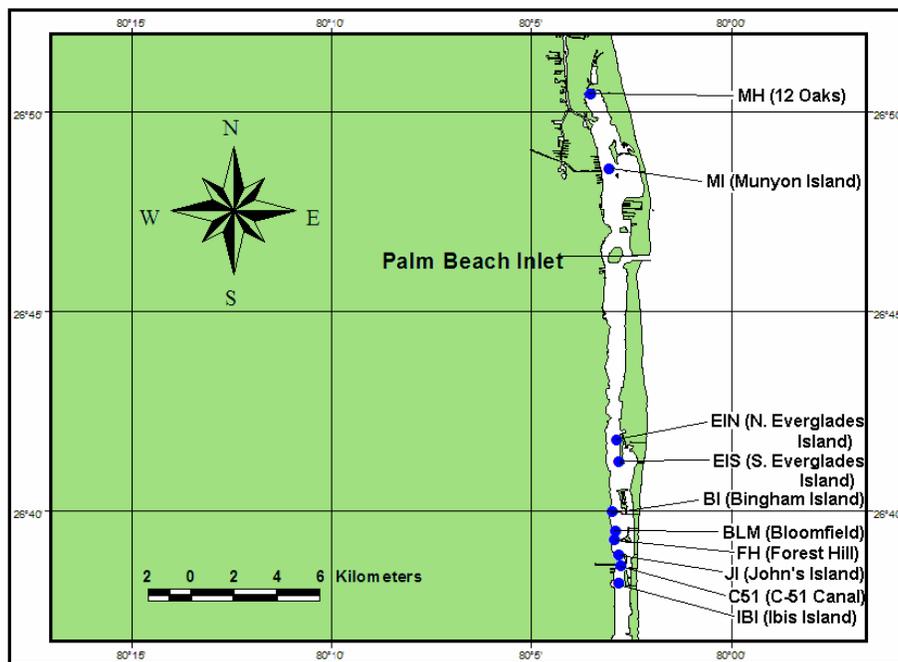


Figure 17. Dredge Hole Study site locations in Lake Worth Lagoon, Florida (PBCERM 2005b)

According to the study, sediment conditions, benthic communities, fishes, and macro invertebrates observed in the study dredge holes are highly variable. On the basis of food availability for fishes, an abundance of juvenile pink shrimp (*Farfantepenaeus duorum*) in most of the depressions indicates these habitats may be providing some benefit to fisheries within the Lagoon. The high abundance of the amphipod, *Ampelisca abdita*, in certain parts of 12 Oaks, Bingham Island, C-51 and Ibis Island dredge holes suggests that these may be important feeding areas for some fish species. The benthic results indicate good conditions present at Munyon Island, Everglades Island North, Everglades Island South, Johns Island, and C-51 holes. The general abundance was, however, low at Munyon Island. Less favorable conditions were recorded at Forest Hill and Bloomfield holes and to some extent at the Bingham Island hole. Furthermore, the presence of hard

³ At least 10 additional dredge holes exist in LWL.

bottom habitat in Munyon Island, Everglades Island South, and John's Island holes precludes these sites from capping and fill alternatives (PBCERM 2005b).

Sediment sampling showed that moisture and organic content was very high at Ibis Island hole, which may be an indication of lower habitat quality. The very low organic content at Everglades Island North, Everglades Island South, C-51 and Johns Island holes, combined with the high "macrofaunal quality" confirm that the conditions are good in these locations. From a sediment quality perspective, less favorable conditions exist at Forest Hill, Bloomfield, Bingham Island, and Ibis Island holes. Adequate evaluation of the fish populations was not possible at Forest Hill and Bloomfield holes due to physical constraints (PBCERM 2005b).

Recommendations from the study indicate that of the 10 dredged holes studied:

- Everglades Island North, Everglades Island South, John's Island, C-51 and Munyon holes were found to have generally good benthic, fisheries and sediment characteristics and should not be filled. These holes may be suitable candidates for enhancement with artificial reef materials.
- Bingham, Bloomfield, Forest Hill and Ibis holes were found to have less favorable conditions with regard to benthics (low diversity and abundance) and contained sediments with high organics. These holes may be suitable candidates for depth modification (filling).
- Stone crabs are common in the 12 Oaks hole. Reef construction to enhance stone crab habitat may be suitable for the 12 Oaks area.
- There is very little evidence that the depressions studied provide a thermal refuge to cold intolerant fishes or other marine animals. It has been observed that these holes can trap colder, denser water, which was particularly evident during coastal upwelling events in the spring and summer of 2004.

Sediment Characteristics

Natural sediments in the LWL are composed primarily of sand or shell fragments. A common occurrence during the last fifty or more years has been the deposition of fine-grained silt and clay-enriched organic sediments known as "muck". These organic sediments began accumulating on top of the historic sandy/shelly bottoms in areas downstream from freshwater discharge points, which convey stormwater runoff (non-point source pollution) from upstream agricultural and urban sources into the lagoon. By blanketing the substrate, the sediments inhibit colonization by desirable flora and fauna in the lagoon (PBCERM 2003b). The unconsolidated sediments are prone to resuspension through wave or tidal action, reducing light penetration and blocking the growth of submerged aquatic vegetation (Crigger et al. 2005), further inhibiting the growth of seagrasses and other natural vegetation.

In 2002, PBCERM initiated the Muck Sediment Monitoring and Management project to identify the location of the muck deposits in relation to the lagoon's bathymetry (**Figure 16**) and its present physical and chemical properties. Results from this study showed the spatial extent of 42 muck deposits greater than 1 foot deep from Everglades Island to the Woolbright Road Bridge (12 miles), encompassing approximately 423 acres of the lagoon's surface area (**Figure 18**). Muck has been observed in areas near major stormwater discharge locations, within deep dredge holes (greater than 10' deep), and in the vicinity of the C-51 Canal (PBCERM 2003b). The most significant muck deposit has been observed directly south of the C-51 Canal discharge, along a deep section, on the west side of the lagoon. This muck deposit extends for approximately two miles and encompasses 113 acres. Based on this survey, it was estimated that at least 1,200,000 cubic yards of muck are contained in those thick deposits (SFWMD 2006). Portions of the muck deposits have been capped by the Snook Island project since the muck survey was conducted, however, an accurate estimate of the capped sediments has not yet been determined.

Even though the muck sediments appear to be patchily distributed within the lagoon, the area adjacent to C-51 Canal accounts for 27% of the total muck deposit within the surveyed area. The area near the mouth of C-51 is almost completely devoid of seagrasses, and it is known as the "dead zone" (Crigger et al. 2005) because of these muck deposits. The decomposition of SAV due to the accumulation of sediments in this area, has resulted in hypoxic (low dissolved oxygen levels) and anoxic (no dissolved oxygen levels) conditions, resulting in fish kill (Crigger et al. 2005). An important observation from this study was that while muck can be found concentrated in many of the deeper areas, where management options such as capping may be feasible, there is extensive coverage of a thin layer (<1') over much of the lagoon. This poses a difficult challenge in selecting appropriate management options for this thin layer of muck.



Figure 18. Muck Distribution Map from Central and Southern Portion of LWL

Chemical Analysis of Sediments

As part of this study (*Lake Worth Lagoon Monitoring Project 2003*), an analysis of the concentrations of nutrients, metals and toxins associated with sediment deposition were performed. The evaluation of muck deposits was designed to identify elevated levels of contaminants associated with sediment deposition in the LWL, and to provide sediment composition and accumulation rates. A total of three sediment core samples were collected: two near the northwest corner of Ibis Isle, and one upstream of control structure S155, in the C-51 Canal (ponar dredge sample). Ibis Isle was selected due to the proximity to the mouth of the C-51 Canal, and had been identified in earlier surveys as having a deep accumulation of muck sediments. Five sub-samples were taken from core Ibis-1, and four sub-samples from core Ibis-FD. The following parameters were analyzed:

Percent Solids	Arsenic (As)	Mercury (Hg)
Total Kjeldahl Nitrogen (TKN)	Cadmium (Cd)	Nickel (Ni)
Total Phosphorus (TP)	Chromium (Cr)	Silver (Ag)
Nitrite (NO ₂)	Copper (Cu)	PCBs
Nitrate (NO ₃)	Iron (Fe)	PAHs
Aluminum (Al)	Lead (Pb)	

Results of this preliminary analysis showed that five samples were above the “Method Detection Limit (MDL), for Arsenic (As). These samples showed As levels above the MDL (0.75 mg/kg), which exceeds the level for disposal in residential landfills (0.8 mg/kg) according to FDEP criteria in 2003. The current soil cleanup goals set by FDEP for As in residential and commercial/industrial soils when the study was performed were 0.80 and 3.7 mg/kg, respectively. However, all the samples were below the Threshold Effects Level (TEL), except for one core sub-sample where the concentration of As was found at 11.8 mg/kg. The TEL for this parameter is 7.24 mg/kg. The range of concentrations that could, potentially, be associated with biological effects (i.e., the possible effects range) is delineated by the TEL, the lower limit, and the Probable Exposure Level (PEL), the upper limit. Within this range of concentrations, adverse biological effects are possible; however, it is difficult to predict the occurrence, nature, and/or severity of these effects. When contaminant concentrations fall within this range, further investigation is recommended to determine if sediment-associated contaminants represent significant hazards to aquatic organisms (MacDonald 1994). It has to be noted that As soil standards were changed in 2005. The new soil cleanup target levels for residential and commercial/industrial are 2.1 mg/kg and 12 mg/kg respectively.

The analysis also showed significant anthropogenic contributions of Cu and Pb, although none on the concentrations exceeded the TELs that are used as guidelines for evaluating sediment quality. Since these sub-samples were collected at different depths, higher concentrations of As were found in the bottom layers, while Cu and Pb were found in the upper layers. These results confirmed that As concentrations were from older deposits,

while Cu and Pb were accumulated more recently, inferring the anthropogenic nature of these parameters. The presence of As could also be anthropogenic, however in addition to arsenic being a historical constituent of wood preservatives (as chromated copper arsenate), and cattle dips, it is found naturally in rock, which can obscure identification of As sources. In the C-51 Canal sample, all the parameters were below the TEL. The findings of this sediment survey were compared to findings in Indian River Lagoon (IRL) by Trefty, et al. (1990). It appears that LWL had significantly less contaminants than IRL for certain parameters (Hg, Cu, and Pb). Cd levels were approximately the same as IRL (PBCERM 2003b).

Based upon these preliminary results, a more extensive sampling event was performed. Three additional sites were sampled, within the two mile range from the mouth of the C-51 Canal. At each site, six cores were collected:

- Three were composited, and analyzed for the full range of parameters
- One was collected and separated into distinct layers for analysis, for the purpose of comparison with the composited cores
- One was collected for grain size analysis and percent organics
- One was collected for isotopes analysis, in order to determine sediment accumulation rates

Results from this second sampling event showed anthropogenic contributions of Cu, Pb and Zinc, although none of the results exceeded the TEL or PEL in any samples. The other parameters were either Below Detection Level (BDL) or below the range of concentrations of the TEL or PEL. These results are summarized and compared to the findings in the IRL (Trefty et al. 1990) in (Table 5).

Table 5 – Comparison between LWL and IRL

Parameter	TEL (mg/Kg)	PEL (mg/Kg)	LWL Highest Concentration (mg/Kg)	IRL Highest Concentration (mg/Kg)
Cd	0.68	4.21	<MDL	0.6
Hg	0.13	0.696	<MDL	0.5
Cu	18.7	108	12	~150
Pb	30.2	112	26.9	~85
Cr	52.3	160	9.45	N/A
Ni	15.9	42.8	2.5	N/A
As	7.24	41.6	4.57	N/A
Zn	124	271	82.1	~205

The report concluded that there were no hazardous levels of contamination within the sediments. Rather the primary concern of the sediments is the light attenuation caused by sediment resuspension, and the effect upon growth of seagrasses and other

photosynthetically-reliant biota. Accumulation rates were found to be highest (ranging from 0.738 to 0.945 cm/year) near the mouth of the C-51 Canal, and higher south of the C-51 Canal than north of the canal (0.080 to 0.114 cm/year). In summary, this project found the LWL to be heavily impacted by the settling of muck sediments in its central section, and that it is the physical properties of the muck that are a threat to the lagoon rather than any toxins they might contain. The future requires a renewed focus on expanding stormwater treatment, solving muck management challenges, and evaluating how the Lagoon responds to changes.

Sediment Transport Study

The C-51 Canal supplies approximately half of the freshwater inflow to the LWL which is suspected as a substantial contributor of sediments blanketing the lagoon floor as well as those remaining in suspension. The major cause of these sediment deposits most likely is due to stormwater heavily laden with fluvial sediment, discharging through the S-155 control structure on the West Palm Beach (C-51) Canal (Lietz and Debiak 2005). As part of the CERP plan, the S-155A control structure near 20-mile bend was constructed to divert the west basin of the C-51 into the Loxahatchee National Wildlife Refuge and into the Everglades, though the diversion of the west basin has not yet occurred.

The U.S. Geological Survey (USGS) and PBCERM engaged in a joint partnership to evaluate the effects of the diversion and other management initiatives on the C-51. This is being done through regression analysis, with turbidity serving as a surrogate for suspended sediment concentrations (SSC), and discharge (flow) serving as the independent variable. Turbidity and flow are correlated because discharges can affect the suspension of sediments. A continuous, in-stream water-quality monitoring station that records turbidity data in real time was installed upstream of structure S-155. Point samples were collected near the probe, and depth- and width-integrated samples were collected along the stream cross section. The water samples were collected over a range of seasonal and hydrologic conditions and analyzed at a U.S. Geological Survey sediment laboratory. Four rating curve estimators were developed based on simple linear and multiple linear regression analyses to estimate suspended-sediment concentrations upstream of structure S-155 using the logarithms of turbidity, turbidity and discharge, and discharge. The coefficients of determination (R^2) ranged from 0.75 to 0.90.

Analysis indicates that the logarithm of both turbidity and discharge as explanatory variables is the best estimator for computing suspended-sediment concentrations and loads at the stream cross section. **Figure 19** presents measured suspended-sediment concentrations and mean daily suspended-sediment concentrations estimated using turbidity, turbidity and discharge, and discharge as explanatory variables for the 2004 water year (Lietz and Debiak 2005).

The ongoing study will be completed in 2008; however, the USGS has continued to collect SSC data with the objective of verifying or revising algorithms that were developed in the report: *Development of Rating Curve Estimators for Suspended Sediment Concentration and Transport in the C-51 Canal Based on Surrogate Technology, Palm Beach County, Florida, 2004-2005*. Based on additional sample data that has been collected over a larger range of turbidity and SSC values, different algorithms for the relationship between discharge, turbidity and SSC are being developed by USGS.

Results of this study indicate substantial loading of suspended sediments to LWL. Based on data during water years 2003 and 2004, approximately 5,000 tons of suspended sediments are delivered to LWL annually.

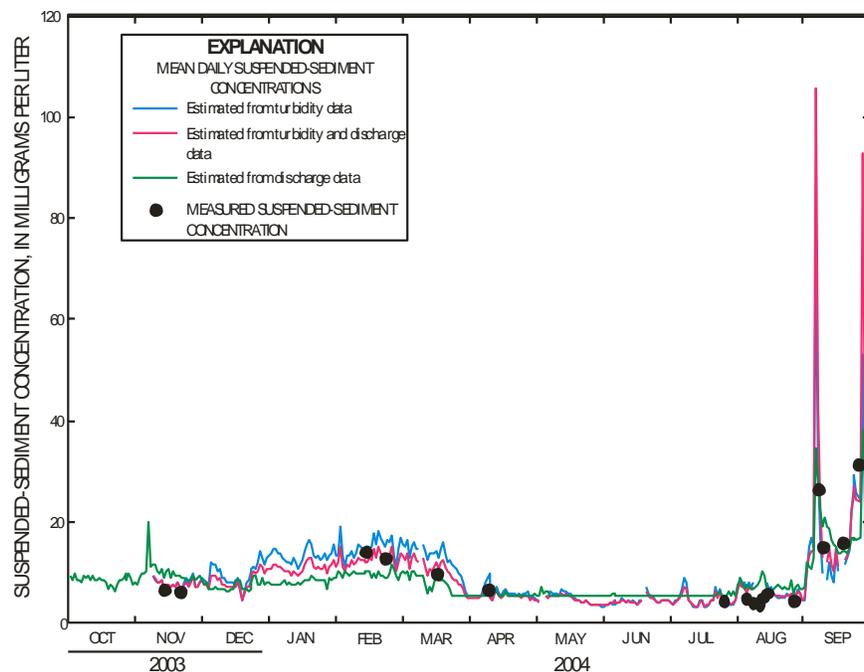


Figure 19. Measured suspended-sediment concentrations and mean daily suspended-sediment concentrations estimated using turbidity, turbidity and discharge, and discharge as explanatory variables for the 2004 water year (October 2003 to September 2004; Lietz and Debiak 2005)

Salinity Distribution and Flow Management Studies for Lake Worth Lagoon

In 1996 the SFWMD, in cooperation with the PBC Board of County Commissioners, sponsored a preliminary study (Tomasello, 1996) to develop a three-dimensional circulation model of LWL to use as a tool for analyzing existing and future variable controlled freshwater flows from canal discharge, rainfall, runoff, groundwater inflows, and tides. The Environmental Fluid Dynamics Code (EFDC) Model was used for the analysis (Hamrick, 1992, and Hamrick and Wu, 1996). The preliminary study recommended that two additional tasks would greatly improve the calibration of the model: conducting one month of tidal amplitude and salinity observations and obtaining

additional bathymetric data for the lagoon, inlets, and Lake Worth Creek. In 2003, new hydrodynamic/salinity data and extended project boundaries were used to create an updated model for the Lagoon that considered seasonal freshwater needs. The boundary limits of LWL were extended to the northern boundary of Lake Worth Creek (i.e. where it meets the Loxahatchee River) and southward to the Ocean Avenue Bridge in Boynton Beach. This will allow District staff to link this study to another modeling effort that is being directed at the Indian River Lagoon/Loxahatchee River and Estuary Systems. The updated LWL EFDC Hydrodynamic/Salinity Model, was commissioned by the SFWMD and will be used to define LWL salinity temporal and spatial distributions associated with various scenarios of freshwater inflows and operational procedures for dry and wet periods. The EFDC Model is scheduled to be utilized in the Northern Palm Beach County CERP Project. Additional bathymetry data is available now to improve the grid structure and additional sediment transport data may be collected to input into the model

Results from the Study

The salinity regime in LWL is strongly influenced by freshwater flows from C-17, C-51 and C-16 through their respective control structures (S-44, S-155, S-41). Other controlling factors include salt water intrusion from tidal inlets, precipitation, and evaporation. In this project, the EFDC Model was applied to predict saltwater transport and salinity regime within the Lagoon as a function of conditions prescribed by three distinct cases of flows from the Water Preserve Areas Feasibility Study (1999). The model tests showed that LWL can be divided into three zones, each characterized by a distinctive salinity regime. A large 17-km-long central zone between Palm Beach Inlet and South Lake Worth Inlet was characterized by frequent low salinity events occurring at the meteorological time scale of a few days to a few weeks with salinities of 5 to 15 practical salinity units (psu) and later rebounding to levels at or below 25 psu. A northern zone of high salinity was identified from Palm Beach Inlet northward. Salinity values in this region generally remain above 20 psu. A third southern zone of LWL was characterized by low salinity; however, salinity values generally rebounded to between 25 and 30 psu. The study concluded that it would be appropriate to establish salinity targets for each section of LWL based on the observed dynamics, practical operating constraints, and ecosystem function.

3. GOALS FOR THE LAGOON

MISSION AND GOALS

The mission statement from the 1998 LWLMP is:

“To restore, conserve and manage the Lake Worth Lagoon ecosystem to a level of quality to obtain measurable and significant improvements to the Lagoon's water and sediment quality; to provide habitat for native plants, fish and wildlife, and aesthetic, recreational and economic benefits for the residents and visitors of Palm Beach County; and to encourage, develop and promote a partnership of public and private interests to manage the Lagoon.”

While an overview of the numerous problems and issues within the LWL system have already been addressed in earlier chapters, five broad areas within the system are recognized and used in this revised management plan to identify specific goals, and objectives for restoring the lagoon. These areas are Water and Sediment Quality, Habitat Restoration and Enhancement, Public Use and Outreach, Interagency Planning and Coordination, and Funding. Goals identified in the original 1998 LWLMP have been expanded and revised according to this new effort and they are summarized below:

Water and Sediment Quality

- Expand and implement a long term water quality ambient monitoring program in the LWL for baseline purposes and trend analysis.
- Increased focus on decreasing inputs of suspended materials, nutrients, and toxic substances from point and nonpoint sources.
- Identify and reduce septic loadings in LWL.

Habitat Restoration and Enhancement

- Restore, enhance, and create emergent mangrove wetlands, coastal hammock habitat, and protective upland buffer zones.
- Preserve and restore existing seagrass habitat and create new seagrass beds
- Preserve existing oyster reefs and create new oyster habitat.
- Add riprap to vertical seawalls to reduce wave-generated sediment resuspension and provide additional hardbottom habitat.
- Construct artificial reefs that provide juvenile, intermediate and adult habitats required by the life cycle of estuarine and marine dependent fish and invertebrate species.
- Evaluate the status and protect sea turtles, manatees, and other endangered, threatened, and rare species, and species of special concern using LWL.

Public Use and Outreach

- Develop a Lake Worth Lagoon Initiative (LWLI) to facilitate stake holder partnerships and to seek funding assistance for projects that would improve and protect the natural resources within the LWL and its watershed.

- Develop public awareness programs to involve and inform the residents, visitors, and decision makers about the LWL ecosystem.
- Develop new school education programs within the PBC science curriculum that emphasize the ecology of LWL ecosystem and ways to help to preserve it.

Interagency Planning and Coordination

- Build partnerships with government agencies, municipalities and stakeholders for the implementation of the management plan.

Funding

- Increase and maintain consistent program funding at State level each year for the next five years, and obtain federal funding. Increase the number of municipal partners in the program and public/private partnerships.

The vision for the lagoon and its management is an attainable one. At the core of this effort is the overall goal to improve and maintain this ecosystem. Today’s challenges call for a new direction, one that involves all the stakeholders and secures commitments to the Action Plans.

INTRODUCTION TO ACTION PLANS

The revised management plan presents a comprehensive series of actions to assist with the implementation of the management plan. Actions Plans for the LWL identify a range of specific objectives and strategies based upon the goals established in the previous section. Each Action Plan contains a background of the issue being addressed, a step by step strategy on how to implement the plan, the cost, the schedule, and the expected benefits. These specific and attainable targets will allow governmental agencies, municipalities, businesses and industry, non-profit groups and concerned citizens to get involved by committing to specific Action Plans that are attainable, and that will maximize the environmental benefits. This approach will also allow local governments to identify and focus their limited resources in the most cost-effective manner. References in the Action Plan to local governments/agencies under the headline “Responsible parties”, attempt to identify the leading partner with the best technical knowledge, skill set, or jurisdiction for the implementation of that specific plan.

The key strategy for the successful implementation of the Action Plans is partnership. The restoration efforts should include consideration for best current and future uses of the lagoon, and must be supported by clearly defined funding and sound management strategies to implement the Action Plans. Broad community support and a united effort by environmental managers in government and industry will assure attainable and realistic goals within the next five years. To achieve those goals, local governments and agency partners are encouraged to adopt by Resolution a commitment to undertake specific Action Plans within this document, and to support and promote the LWLMP. This formal commitment will assure that the lagoon’s most pressing issues are quickly addressed from the range of acceptable alternatives described in its series of Actions.

4. WATER AND SEDIMENT QUALITY

OVERVIEW

The goal of the *Water and Sediment Quality* program in the 1998 LWLMP was to reduce adverse impacts on lagoon salinity and decrease pollutant loadings into the system to acceptable levels. With the projected growth forecasted in the next 30 years in PBC, maintaining and improving water and sediment quality will require more effort every year in order to compensate for the increased pollution associated with growth. Most of the water quality gains have been attributed to wastewater treatment technologies, which have significantly reduced municipal sewage discharges in the lagoon. Point sources of pollution have been greatly reduced from the 1950's when an estimated 10 million gallons of raw sewage was discharged in the lagoon. By early 90's, approximately 2.4 million of gallons of secondarily treated sewage effluent were still discharged into the LWL watershed. These former discharges have been nearly eliminated with the exception of two package plants, emergency sewer discharges, and broken sewer mains. Nonpoint sources are now the primary source of pollution in the LWL. A total of 381 outfalls were identified within the lagoon in the *Lake Worth Lagoon Natural Resources Inventory and Enhancement Study* (PBCERM 1990). The various LWLPG projects implemented in the lagoon have offset to some degree the amount of pollutant loading from these sources, but with the drainage that the lagoon receives from its 450 square miles watershed, the impact of these projects cannot be fully evaluated.

Local governments and agencies are already making significant investments each year in pollution prevention and stormwater improvements. Action Plans targeted specifically to improve and monitor the Lagoon water quality (WQ), and to reduce wastewater (WW), stormwater (SW), and sediments (SE), are outlined below and in Appendix C:

WATER AND SEDIMENT QUALITY GOALS:

- WQ-1 Implement Water Quality Monitoring Goals
- WQ-2 Reduce the Occurrence of Municipal Sewer overflows
- WQ-3 Install Additional Sewage Pump-out Facilities for Recreational Boaters and Live- aboard Vessels
- WQ-4 Improve Fueling and Bilge-Pumping Practices Among Recreational Boaters
- WW-1 Identify Septic and Municipal Wastewater Loading to Lake Worth Lagoon
- WW-2 Provide Additional Sanitary Sewer Connections to Priority Areas
- SW-1 Reduce Discharge of Freshwater and Total Suspended Solids
- SW-2 Implement Best Management Practices on Golf Courses near the Lake Worth Lagoon
- SW-3 Identify and Increase Stormwater Retrofit Projects
- SW-4 Encourage Use of Best Management Practices
- SE -1 Substrate Characterization
- SE -2 C-51 Basin and Lake Worth Lagoon Sediment Sourcing Study
- SE -3 Manage Sediments in Lake Worth Lagoon

ACTION PLAN *Water & Sediment Quality*

WQ-1

Implement Water Quality Monitoring Goals

ACTION:

Monitor the health of the Lake Worth Lagoon (LWL) and trend analysis by increasing the number of water quality stations from 10 to 22.

BACKGROUND:

Monitoring the health of LWL is central to the success of the restoration and protection of the lagoon. An effective monitoring program provides the data necessary to assess the status and trends in the health and abundance of the lagoon's resources and habitats. Monitoring program data are used to evaluate progress towards restoration and protection goals of the LWLMP. The data are also used to evaluate the effectiveness of management strategies of the Comprehensive Everglades Restoration Plan (CERP), the direct or indirect effect on the health of the ecosystem, and to indicate if CERP restoration goals have been met. The monitoring program for LWL includes a water quality component and should answer the following questions:

- How are phytoplankton biomass levels (chlorophyll-a concentrations) changing?
- Are nutrient concentrations increasing, decreasing, or remaining stable?
- Is water clarity increasing, decreasing, or remaining stable?
- Is suspended sediment concentration increasing, decreasing or remaining stable?

The improved water quality monitoring program will expand the current fixed stations with the addition of new fixed stations, and high-frequency in-situ sampling. ERM took over the monitoring of the six existing Florida Department of Environmental Protection (FDEP) baseline stations. Twelve (12) new stations will be added for a total of twenty-two (22) sites. Additionally, 5 high-frequency in-situ sondes will be deployed to augment the monitoring network.

STRATEGY:

STEP 1 Complete Monitoring Plan for the proposed new water quality monitoring network and identify proposed parameters.

Responsible parties: PBCERM and SFWMD

STEP 2 Develop a Water Quality Monitoring Database to be shared with local governments, State Agencies and stakeholders, and conduct a formal annual interagency review of the new Monitoring Plan Network.

Responsible parties: PBCERM

STEP 3 Identify willing partners that could and will assist in the long-term funding of the LWL Monitoring Plan Network.
Responsible parties: PBCERM and, SFWMD

SCHEDULE:

The proposed Monitoring Plan identified in Step 1 has been completed. Steps 2 and 3 will be initiated after the implementation on the network.

COST:

Annual costs for staff, equipment, materials, and laboratory analysis are estimated at approximately \$134,000 per year.

EXPECTED BENEFITS:

Determine status and trends in water quality for the LWL, and evaluate if water quality and habitat projects have significantly impacted the lagoon's resources and habitats.

MONITORING ENVIRONMENTAL RESPONSES:

Data will be collected, analyzed and integrated with existing monitoring program.

REGULATORY NEEDS:

None anticipated. Although not mandated by the legislature, the data can be used in verification of other potential impairments that have not yet been verified due to lack of relevant data, and for TMDL development. In addition, the baseline developed from these data will provide critical information to CERP/RECOVER for assessing performance measures and the impact of CERP projects to the LWL.

FUNDING:

Funding sources are potentially committed for 2 years of monitoring by SFWMD and PBCERM. Additional funding sources are needed from the 3rd year and on.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FDEP, Local governments

*Listed Agencies have not fully committed funds for the 2nd year, and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

WQ-2

Reduce the Occurrence of Municipal Sewer Overflows

ACTION:

Encourage local governments to prepare maintenance plans identifying overflow areas within their sewage collection systems. Address those areas in their maintenance programs by encouraging local municipalities to join the Environmental Protection Agency (EPA) Management Operation and Maintenance (MOM) Program. Improve data collection, and keep information on overflows at a central location in the County. Develop a unified and standardized reporting form for all utilities.

BACKGROUND:

Accidental sewer overflows are a growing problem in the Lake Worth Lagoon (LWL) watershed, as sewage transport and collection systems age and increasing population growth strain the capacity of these networks to accommodate increased flows. Identifying the location and condition of potential sewer overflow systems that are within the LWL is an important effort toward the lagoon's restoration. The overflow of wastewater and raw sewage poses a threat to public health, environmental resources, and the economic viability of tourist-driven local economies.

According to a report published by the Clean Water Fund (CWF), a national non-profit organization, in 2004 over 55.8 million gallons⁴ of raw and partially treated sewage spilled into Florida waterways, in many instances causing beach closures (CWF 2006). Due to the lack of a standardized spill reporting system among agencies responsible for maintaining spill records such as FDEP, Department of Health, PBC Water Utilities Department, and Local Utilities Departments, accurate overflow information is difficult to quantify. A good source of information is currently the Division of Emergency Management's State Warning Point (SWP) database. In 2005, CWF conducted a survey in PBC to document the number of overflow spills. According to the survey's results, 43 spills were reported to SWP in 2005, however only 25 were over 1,000 gallons. It should be noted that some major spills reported by local newspapers⁵ and promptly addressed by the local agencies, were not reported in the SWP database. Sewage overflows are a major concern especially during hurricane season when lift stations are likely to be affected if a power loss occurs. Lift-station failure is one of the most common causes for spills related to power outages caused by storm activity (CWF 2006).

The EPA's Office of Wastewater Management sponsored a series of community-based demonstration projects to find innovative solutions to capacity problems that cause

⁴ The discharge reported by CWF in 2004 has not been confirmed by the SWP database and FDEP.

⁵ "Sewage Spill Closes Boca, Boynton Beaches", Sun Sentinel, March 26, 2005

overflows of sanitary sewers. Public sewer utilities in the South East (Region 4) have been asked to implement MOM programs. Participating municipalities complete self-assessments of their utilities and submit recommendations for improvements of their infrastructures to the Region, along with prioritized implementation schedules. MOM project successes in Region 4 have contributed to national development of the capacity, management, operations, and maintenance (CMOM) approach (www.epa.gov).

The City of Clearwater in Florida is one example of the successful implementation of the MOM program. Since the City joined the program and submitted its MOM Plan in 1999, the numbers of sanitary sewer overflows have decreased substantially. Major achievements to date since the MOM's inception have been:

- Backups and pump station failures reduced by 40%
- Proactive maintenance increased by 65%, while reactive maintenance decreased by 35%

STRATEGY:

STEP 1: Ask local governments and utility providers to identify the location of previous sewer overflows within the LWL and detail the condition of these systems.

Responsible parties: FDEP, PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, FDEP, PBC Planning Department, in cooperation with PBCERM

STEP 2: Map in GIS all areas with known sewer overflows within the LWL and identify which systems need improvements. In addition, map all potential areas of concern.

Responsible parties: FDEP, PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, PBC Planning Department

STEP 3: Ask local governments and utility providers to participate in the EPA Region 4 MOM Program.

Responsible parties: FDEP, PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, FDEP, PBC Planning Department, in cooperation with PBCERM

STEP 4: Monitor all future sewer overflows to determine estimated wastewater and sewage spills. Work with local, County, and State governments to improve data collection, develop a unified and standardized reporting form for all PBC utilities, and keep information on overflows at a central location in the County or the Florida DOH Healthy Beaches web site. Make the data available to the public on the participating agencies' and municipalities' web sites.

Responsible parties: PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, FDEP,

PBC Planning Department

STEP 5: Work with local, County, and State governments to require reporting of all spills within the County.

Responsible parties: PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, FDEP, PBC Planning Department

STEP 6: Support local government efforts to gain grant funding to replace substandard or aging sewer overflow systems.

Responsible parties: PBCERM, FDEP

STEP 7: Work with local utilities to identify funding sources for installation and maintenance of back-up power systems for lift stations in the event of power failures.

Responsible parties: PBC Water Utilities Department, Local Utilities Department, Florida Health Department, PBC Health Department, FDEP, PBC Planning Department

SCHEDULE:

Step 1 and 2 could be implemented within 3 years from the adoption of the LWLMP.

Steps 3 through 7 could be implemented within 5 years.

COST:

The cost of initial identification and mapping of historical and potential spill locations is to be determined. Monitoring costs for spills would depend on level of monitoring. Since most local utilities already have routine maintenance programs for their sewer systems, the steps above should help to evaluate and direct expenditures to areas where specific problems have been identified, and seek funding for maintenance and upgrades to these systems. Additionally, an aggressive preventive maintenance program may prove most cost-effective in the long run.

EXPECTED BENEFITS:

Regular inspections and maintenance of sewer collection systems, utilizing BMP's will reduce the occurrence of sewer overflows, resulting in increased public health and water quality protection.

MONITORING ENVIRONMENTAL RESPONSES:

Routine water quality monitoring by both local and state governments will document the success of the efforts to reduce municipal sewer overflows and resulting benefits to the Lake Worth Lagoon.

REGULATORY NEEDS:

None anticipated.

FUNDING:

Funding to be determined.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

EPA Region 4, FDEP, Local governments, PBCERM

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

WQ-3

Install Additional Sewage Pump-out Facilities for Recreational Boaters and Live-aboard Vessels

ACTION:

Assist local governments in obtaining assistance through the Florida Clean Vessel Act grant program to construct sewage pump-out facilities at publicly owned marinas in the Lake Worth Lagoon (LWL).

BACKGROUND:

With implementation of increasing pollution prevention rules, efforts have been made to reduce sewer overflows within the LWL and adjacent water bodies. Some of Palm Beach County's older residential communities are planning, or are in the process of converting individual residential septic tanks to centralized sanitary sewage systems. The Town of Hypoluxo has converted nearly all of its residential homes to sanitary sewer. The Town of Cloud Lake and areas surrounding Lake Osborne have embarked on plans to convert to sanitary sewer. These efforts will reduce fecal coliform, nitrogen and suspended solids loads associated with sewage. At the same time efforts need to focus on the continual discharges from boaters who are routinely on the lagoon. The 1998 LWLMP identifies the need to develop and implement a Boater Compliance Program to address proper disposal of waste material and protection of LWL resources.

The 2006 Manatee Protection Plan identifies 182 marinas located in PBC with three or more slips. Within the LWL, 80 marinas with a total estimated capacity of 4,600 dry and wet slips have been identified. Five of those marinas have been given the Clean Marina designation by FDEP. According to FDEP, there are also 12 marinas with pumpout stations within the LWL, and two marinas with pumpout boats. A pumpout is a fixed unit tied to either a sewer line, or to a bulk holding tank serviced by a sanitary waste hauler.

Many of the estimated 46,000 registered boats in PBC, along with many unknown transient boaters utilized the lagoon. Human waste and associated pathogens can severely impact water quality and public health when discharged directly to water bodies. Providing more pump-out facilities would help reduce waste loads while encouraging boaters to become more responsible stewards of the LWL. However, such factors as boat size, boating use patterns, coastal water characteristics, sensitive areas, flushing capacity, etc., should play a large role establishing needs for facilities.

STRATEGY:

- STEP 1 Identify and map all marinas located within the LWL, survey to determine which marinas have pump-out facilities and are certified as Clean Marinas.
Responsible parties: FDEP, local governments, Lagoon Keepers, and PBC ERM, Marine Industries Association (MIA)
- STEP 2 Identify the busiest marinas for outreach and educational purposes.
Responsible parties: Local governments, PBC Sheriff Office, FWC, Marine Patrol, local boating clubs, Lagoon Keepers, and PBCERM, MIA
- STEP 3 Encourage participation in the Clean Vessel Act grant program, Florida's Clean Marina program, which provides financial assistance to older marinas for installing sewage pump-out systems.
Responsible parties: FDEP, local governments, PBCERM, MIA
- STEP 4 Construct pump-out facilities or contract for portable systems.
Responsible parties: Local governments, marina owners, MIA
- STEP 5 Provide educational materials to boaters explaining the importance of the pump-out facilities or portable systems and how to use it. Disseminate educational materials to boating clubs in the region making them aware of the facility.
Responsible parties: Local governments, local boating clubs, Lagoon Keepers, PBCERM, MIA, West Palm Beach Fishing Club

SCHEDULE:

PBC ERM will enlist the organizations listed above to evaluate on-going programs and materials, and develop a plan to implement the steps outlined above by December 2008.

COST:

Installation and construction costs vary depending on type of equipment selected. According to the Tampa Bay Restoration Plan costs for stationary or portable pump-out units range from approximately \$2,000 to \$6,000. Costs for a portable toilet waste station may vary from \$1,100 to \$1,800. State grants could pay approximately 75 percent of the construction costs. In addition, construction and maintenance costs could be recouped by charging boaters a minimal user fee.

Costs to develop and distribute educational materials will be determined based on format selected, but should be accomplished through existing resources or available grants.

EXPECTED BENEFITS:

Providing sewage pump-out services for boaters will help reduce pathogens as well as nitrogen and solids in the LWL.

MONITORING ENVIRONMENTAL RESPONSES:

Use of the pump-out stations through sales' receipts can be tracked to determine effectiveness. Receipts will be submitted to the FDEP's Clean Marina program.

REGULATORY NEEDS:

None anticipated, with the exception of the FDEP authorization. These facilities are typically given a de minimus exemption.

FUNDING:

FDEP, Florida's Clean Vessel Act grant program, Florida's Clean Marina program, Palm Beach County Boater Registration

POTENTIAL PARTNERS AND FUNDING SOURCES*:

FDEP, Local governments, PBCERM

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

WQ-4

Improve Fueling and Bilge-Pumping Practices Among Recreational Boaters

ACTION:

Improve fueling and bilge pumping practices among recreational boaters.

BACKGROUND:

As the number of recreational boaters utilizing the Lake Worth Lagoon (LWL) increases, small fuel spills and releases of oily bilge water are also expected to increase. With more than 46,000 registered vessels in Palm Beach County, and with the number of boaters expected to increase⁶, even small spills are a big threat to the state's aquatic resources. According to *Charting the Course for Tampa Bay* (1996), small, but chronic spills occur routinely through improper fueling habits, operation of outboard motors, discharges of oily bilge water and improper disposal of used oil products. Studies performed by the National Research Council (NRC 1985), highlighted that these small spills account for 90 percent of the oil that ends up in the nation's waterways.

Although many boaters store their boats on land, many vessels remain in the lagoon at marinas, yacht clubs and docks. Typically, recreational vessels stored dockside use automatic bilge pumps to prevent accidental sinking from equipment failures or storms. These pumps are activated when the interior volume of water reaches a certain level. The bilge water may contain small amounts of fuel, cleaning solutions and other chemicals that pollute the lagoon. In addition, spills frequently occur when boats are fueled at dockside. Boat owners often can't tell when the tank is full until the overflow valve discharges diesel or gasoline into the lagoon. Boaters can take an active role in protecting the environment by using basic boat maintenance to prevent oil spills caused by cracked oil or fuel lines, poor fittings, failed gaskets, and automatic bilge pumps that send the oil overboard. Gas and oil spills poison aquatic life, and a poorly maintained boat can also be deadly if it leads to a fire, explosion or sinking.

STRATEGY:

The strategy to improve fueling and bilge-pumping practices encourages boat owners to install fuel-overfill protection devices and oil-water separators, where feasible. It also emphasizes boater education and outreach to yacht clubs, sailing organizations, marinas, and high-dry facilities where boats are stored. The use of oil-absorbent pads should be promoted to all vessel owners.

⁶ According to PBC Marine Industries Association
Chapter 4

STEP 1 Encourage registered boat owners to install fuel overfill protection devices and fuel-water and oil-water separators in automatic bilge pumps.
Responsible parties: FDEP, U.S. Coast Guard Auxiliary, Marine Industries Association, Lagoon Keepers

STEP 2 Develop educational materials that will stimulate solutions to bilge contamination and fuel handling situations. Ideally, materials will include a free “oil-absorbant” product that will allow the recreational boater to see, first hand, its practical application.
Responsible parties: FDEP, U.S. Coast Guard Auxiliary, Lagoon Keepers, in cooperation with PBCERM

STEP 3 Investigate the number of recreational bilge pump-out facilities in LWL. If a marina has drums set up to receive oily water for a pump-out for a fee (which pays for the proper disposal of drums), its services could be promoted as part of the educational outreach program.
Responsible parties: FDEP in cooperation with PBCERM

SCHEDULE:

PBCERM will enlist the organizations listed above to evaluate on-going programs and materials, and develop a plan to implement the steps outlined above by December 2008.

COST:

Costs to develop and distribute educational materials will be determined based on format selected, but should be accomplished through existing resources or available grants.

EXPECTED BENEFITS:

Reduced small spills during fueling and during automatic bilge pumping will improve water quality within the lagoon.

MONITORING ENVIRONMENTAL RESPONSES:

The measure of success for this action will be a water quality improvement on a long-term basis, a reduction in the number of minor spills reported, and a greater involvement by boaters and the marine industries in responsible boating practices. Spot surveying could be utilized to monitor boaters’ awareness in responsible boating practices.

REGULATORY NEEDS:

None anticipated.

FUNDING:

To be determined.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

FDEP, U.S. Coast Guard Auxiliary, PBCERM, Lagoon Keepers, Local Municipalities

*Listed Agencies have not committed funds and are subject to Agencies’ budget approvals

ACTION PLAN *Water & Sediment Quality*

WQ-5

Provide a Pump-out service to Live-aboard Vessels and Other Boat Owners

ACTION:

Provide sewage removal from vessels within the Lake Worth Lagoon (LWL) to live-aboard vessels through a pump-out boat.

BACKGROUND:

A pump-out boat is a boat that pulls up to other boats and empties their waste tank into a holding tank on the pump-out boat. It takes the waste to a fixed unit on a dock, or shore area and unloads the waste into sewer lines. This process keeps boaters from disposing waste into our local waterways, and helps them to remove sewage in a safe and responsible matter. Pump-out boats can make a great difference in keeping the water quality in LWL. Human waste and associated pathogens can severely impact water quality and public health when discharged directly to water bodies. Providing this free service would help reduce waste loads while encouraging boaters to become more responsible stewards of the LWL.

Martin County has been very successful in establishing a County program that provides a free pump-out service to customers. The pump-out boat was purchased with grants from the Florida Department of Environmental Protection (FDEP) Clean Vessel Act grant program (as part of the Clean Marina Program), and the Florida Inland Navigation District (FIND). The grants paid for 75% of the initial start-up costs. Below are the highlights of this program:

- The pump-out boat is stationed in one the marinas in Manatee Pocket Bay. Customers can arrange for service either by VHS marine radio channel or cell phone.
- When a customer has contacted the operator of the pump-out boat a time will be arranged.
- Service during the summer is provided Tuesday through Saturday
- The pump-out boat shows up and connects a hose to the waste fitting on the vessel. The operator then starts the waste removal pump and removes the waste contained in the holding tank(s).
- The customer is issued a disposal receipt and the pump-out boat leaves.
- Waste is transported to a county operated wastewater treatment facility.
- There is no charge for this service; however donations are accepted to help defray the cost of operating this program.

Since the inception of this program in 2000, approximately 165,000 gallons of raw sewage have been safely disposed through this operation.

STRATEGY:

STEP 1 Obtain authorization and funding commitment from the Board of County Commissioners (BCC) for the implementation of this program.

Responsible parties: PBC or Municipalities

STEP 2 Apply for FDEP grants to offset start-up costs.

Responsible parties: Applicants

STEP 3 Identify a public or municipal marina to dock the pump-out boat and bid out contract for services.

Responsible parties: Applicants

STEP 4 Provide educational materials to boaters explaining how to use this new service and the importance of pump-out boats. Disseminate educational materials to boating clubs in the region making them aware of this service.

Responsible parties: FDEP, Local governments, local boating clubs, Lagoon Keepers, PBC

SCHEDULE:

Interested parties will apply for the FDEP reimbursement grant once the program has been adopted by the BCC by December 2008. The organizations listed above enlisted will be enlisted to evaluate educational materials and to implement the steps outlined above.

COST:

Costs vary depending on type of pump-out boat selected and the size. The annual cost to run this program is estimated to be \$70,000/year. This amount includes a full-time contractor to run the service, and the associated costs for docking fees.

EXPECTED BENEFITS:

Providing sewage pump-out service for boaters will help reduce pathogens as well as nitrogen and solids in the LWL.

MONITORING ENVIRONMENTAL RESPONSES:

Use of the pump-out boat through disposal receipts can be tracked to determine effectiveness. Receipts will be submitted to the FDEP's Clean Marina program.

REGULATORY NEEDS:

None anticipated.

FUNDING:

FDEP, Florida's Clean Vessel Act grant program, Florida's Clean Marina program, Palm Beach County Boater Registration, FIND grant program.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

FDEP, FIND, Local governments, PBC

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

WW-1

Identify Septic and Municipal Wastewater Loading to Lake Worth Lagoon and associated watershed

ACTION:

Identify and evaluate septic systems and wastewater treatment plants that discharge to Lake Worth Lagoon (LWL) and its associated watershed.

BACKGROUND:

Many homes constructed around LWL use septic systems for wastewater treatment and disposal. Many of these homes were built during the 1950's, prior to centralized sanitary sewer availability in the area. Other communities, particularly adjacent to LWL, do not have wastewater treatment plants or are not located near central sewer lines.

In some instances the link to septic tanks as the cause of contamination is strong; in other areas, less so. This action calls for a review of current knowledge regarding the environmental impacts of septic tanks and the appropriate next steps. The steps may include additional source tracking and/or epidemiological studies to quantify the human health risks associated with the levels of pollutants in PBC waters. Bacterial contamination at some level is common in all surface waters. Sources of these contaminants range from wildlife and domestic animal waste to septic tanks, leaking/broken sewage pipes, and sewer overflows.

During the 1950s, an estimated ten million gallons per day (MGD) of raw sewage was discharged in the LWL resulting in extensive bacterial and nutrient pollution. By 1970, seven major wastewater treatment plants had been constructed, discharging 18.49 MGD of secondarily treated sewage effluent. The volume was reduced to 2.98 MGD by 1984, largely as a result of the NPDES program administered by the USEPA and FDEP. Currently, two wastewater treatment plants ("package plants") discharge directly to LWS. The remaining 12 domestic wastewater facilities dispose of secondary-treated wastewater via land application (ponds, drainfields, injection wells, etc). Septic systems are still in use for much of Manalapan, Ocean Ridge and, on the freshwater side, Lake Clarke Shores and other smaller municipalities.

STRATEGY:

STEP 1 Acquire ArcGIS compatible files of septic systems and sanitary sewer connection coverage from PBC Utilities and municipalities within the watershed. Compile data into spatial database.

Responsible parties: PBCERM, PBC Utilities, and Municipalities

STEP 2 Implement a bacteriological assessment of the LWL and associated watershed to identify problem areas associated with septic and wastewater loading

Responsible parties: PBCERM

STEP 3 Identify and evaluate facilities that discharge wastewater into LWL, quantify inputs, and review respective wastewater permits.

Responsible parties: FDEP, DOH

STEP 4 Develop maps and report detailing septic systems adjacent to LWL and its watershed. Include detail on wastewater permits.

Responsible parties: PBCERM

STEP 5 Make recommendations to convert septic systems to sanitary sewer connections and eliminate “package plant” wastewater discharges to LWL.

Responsible parties: PBCERM, PBC Utilities, FDEP, and Municipalities

SCHEDULE:

Steps 1, 2 and 3 will be completed by June 2009. Step 4 will be one year after assemblage of data. Step 5 will be completed no later than six months after submission of report.

COST:

Costs for staff, database development, and report preparation are estimated at approximately \$125,000. Costs associated with bacteriological assessment to be determined upon development of sampling surrogate, range and frequency.

EXPECTED BENEFITS:

Identification of septic and wastewater discharges to LWL, and its watershed. Ultimately, these discharges can be reduced and/or eliminated reducing public health risk and nutrient input to receiving water bodies.

MONITORING ENVIRONMENTAL RESPONSES:

Data will be collected, analyzed and integrated with the existing water quality monitoring program.

REGULATORY NEEDS:

Not applicable.

FUNDING:

Funding sources need to be identified.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBC Board of County Commissioners, FDEP, Palm Beach County Health Unit, EPA, NOAA FACE Program, Local Municipalities.

*Listed Agencies have not committed funds and are subject to Agencies’ budget approvals

ACTION PLAN *Water & Sediment Quality*

WW-2

Provide Additional Sanitary Sewer Connections to Priority Areas

ACTION:

Provide additional sanitary sewer connections to priority areas of Lake Worth Lagoon (LWL) and associated watershed.

BACKGROUND:

Many homes constructed around LWL still use septic systems for wastewater treatment and disposal. Many of these homes were built during the 1950's, prior to centralized sanitary sewer availability in the area. Other communities, particularly adjacent to the LWL, do not have wastewater treatment plants or are not located near central sewer lines. While most septic system investigations performed in Florida have focused on the impact of nitrogen loading from septic tanks, recent studies have shifted the spotlight to bacterial pollution from older, malfunctioning septic tanks. While the nitrogen loading from septic systems is a concern, so are other chemicals including phosphates and "emerging contaminants" such as pharmaceuticals and metabolites.

Older septic systems dominate in the largely residential communities bordering the shore of LWL, and efforts to convert portions of these neighborhoods to sanitary sewer service are underway. Several communities are either converting to sanitary sewer or have plans to make the conversion.

Conversion from septic to sewer service can be costly, with residential hookup fees ranging anywhere from \$2,000 to \$20,000 or more. That underscores the need for financing options such as interest-free loans and cost-sharing grants to assist residents in areas slated for conversion. Additionally, the availability of central sewer service may actually encourage higher density development in environmentally sensitive areas, an issue local governments must consider in their long-term planning. Alternatives to large regional wastewater treatment plants in these environmentally sensitive areas, currently on individual onsite septic systems, should be explored. Highly engineered high-level treatment and properly managed clustered onsite wastewater treatment systems, could be a valuable alternative to the centralized wastewater treatment system.

STRATEGY:

STEP 1 Review data from GIS geodatabase of septic systems and review surface water quality data as well as data from Florida's Healthy Beaches program to determine if correlations exist.

Responsible parties: PBCERM, PBC Utilities, and Municipalities

- STEP 2 Convene small working group of local health department designees, along with experts from FDEP, SFWMD and PBC, to:
- a. Review relevant findings from the Healthy Beaches report and EPA's 1997 Response to Congress on the Use of Decentralized Wastewater Treatment Systems.
 - b. Prioritize problem areas for feasibility analysis of conversion from septic to sanitary sewer.

Responsible parties: FDEP, PBCERM, Municipalities

- STEP 3 Assess progress in the project area and determine whether additional research is needed:
- a. Evaluate progress on sewerage older areas dominated by septic tanks.
 - b. Assess progress towards removal of package plants.
 - c. Determine factors contributing to failure of septic systems and create a map overlay of these factors.
 - d. Identify areas where additional research is needed to quantify level of impacts, to confirm human fecal contamination, and to trace sources or associated human health risks.
 - e. Obtain funding and conduct studies to confirm impacts
 - f. Educate public about the impacts and the benefits of conversion.
 - g. Evaluate alternatives to centralized sanitary sewer systems in environmental sensitive areas such as clustered or decentralized wastewater treatment systems.

- STEP 4 Identify and secure funding for eliminating septic and package plant systems contributing to poor water quality.

Responsible parties: All Partners.

SCHEDULE:

PBC to convene working groups as noted above during 2008-2009.

COST:

To be determined.

EXPECTED BENEFITS:

Identification of septic and wastewater discharge to LWL, and its watershed. Ultimately, these discharges will be reduced and/or eliminated reducing public health risk and nutrient input to receiving water bodies.

MONITORING ENVIRONMENTAL RESPONSES:

Data will be collected, analyzed and integrated with existing PBC and Healthy Beaches water quality monitoring program.

REGULATORY NEEDS:

Not applicable.

FUNDING:

Funding sources need to be identified.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBC Board of County Commissioners, FDEP, Palm Beach County Health Unit, EPA, NOAA FACE Program, Local Municipalities, SFWMD.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SW- 1

Reduce Discharge of Freshwater and Total Suspended Solids

ACTION:

Reduce large volumes of freshwater and suspended sediment discharges through the C-51 Canal.

BACKGROUND:

The most significant source of freshwater to the Lake Worth Lagoon (LWL) is the C-51 Canal which drains 177 square miles and contributes approximately 50% of the total freshwater inflow. The canal carries water from the Everglades Agricultural Area and Lake Okeechobee, potentially contributing over half of the suspended sediment load to the lagoon. Suspended matter transported into LWL has blanketed a large area of the estuary with a layer of muck. Muck is defined by grain-size analysis and includes the combination of sandy silt, silt and peat substrate. This muck has been attributed to decreases in benthic invertebrate diversity, and has prevented colonization by seagrass, an important component of the estuarine community. In addition to the smothering impacts of sediment, it also transports bound nitrogen and Phosphorus into the lagoon. Reducing nutrient and suspended sediment loads to LWL will maximize the potential growth of such valued ecosystem components (VECs) as oysters (*Crassostrea virginica*), and seagrasses (represented by *Halophila decipiens*, *H. johnsonii*, and *Halodule wrightii*). These species are key estuarine components currently present in LWL but impacted by anthropogenic stressors⁷.

The North Palm Beach Project (NPBC-1; with storage and sediment traps) will affect flows and loads to LWL: it has been hypothesized by CERP that if the natural hydrology within the watershed is restored to the conditions of the Natural Systems Model (NSM), the transport of sediment and sediment-bound nutrient and contaminant loads will be reduced. The NSM is a tool that simulates the hydrologic response of a pre-drained Everglades system. The model does not attempt to simulate the pre-drained hydrology. It uses instead recent input data (e.g. rainfall, potential evapotranspiration, tidal and inflow boundaries), for meaningful comparisons between the current managed system and the natural system under identical climatic conditions (www.sfwmd.gov). According to the NPBC-1 project, water from the C-51 canal will be diverted to the west of the C-51 basin. Due to this diversion, flow from the C-51 canal is expected to be reduced by approximately 50%. The flow reduction from the C-51 canal is estimated to decrease suspended sediment inflow to the LWL from 8000 tons to 4000 tons per year. Construction of a sediment trap and/or the implementation of upstream BMPs will further

⁷ Background is largely from RECOVER Northern Estuary Module – Water Quality Performance Measure Chapter 4

reduce sediment inflow and will be measured against the pre- and post-diversion baselines. Management of suspended sediment into the lagoon will maximize the potential growth of seagrass, oysters, and other flora and fauna.

STRATEGY:

STEP 1: Reduce by 50% the frequency, rate, and/or volume of freshwater from inflow structures, by direct capture and treatment of flow. This step will reduce anthropogenically-induced stress on estuarine populations by reducing sediment loads and improving estuarine benthic quality.

Responsible parties: SFWMD

STEP 2: Explore and create options for the precipitation of sediment and sediment-bound loads prior entering the LWL. Options include sediment traps, canal dredging, and stormwater treatment facilities.

Responsible parties: SFWMD, PBCERM

SCHEDULE:

Steps 1 will be implemented by 2014. Step 2 has been initiated with the C-51 Sediment Management Project in May 2005.

COST:

The total cost of the NPBC-1 Project with all its components is estimated to be \$ 425,079,000; however, the proposed allocated sum for the LWL is 2.2 million. The C-51 dredging/sediment trap project is \$3 million. The SFWMD and Palm Beach County have contributed \$1.5 million each for this project up date.

EXPECTED BENEFITS:

Improve the quality of water released to tide by promoting establishment, maintenance, and sustenance of a healthy, well-balanced assemblage of estuarine flora and fauna. Reservoirs, aquifer storage and recovery units, and storm-water treatment areas (STAs) planned as part of CERP are expected to reduce loadings of nutrients, solids and contaminants to the LWL.

MONITORING ENVIRONMENTAL RESPONSES:

Monitoring of water quality, SAV, oyster health in the lagoon, and water quality in the C-51 Canal and at the site of implemented BMPs, will allow an evaluation of this focused approach to improving water quality in the LWL.

REGULATORY NEEDS:

Permits required by FDEP or SFWMD and USACE.

FUNDING:

Funding for CERP is contingent upon yearly State and Federal annual appropriations.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

SFWMD, USACE, PBCERM, FDEP

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SW- 2

Implement Best Management Practices on Golf Courses near the Lake Worth Lagoon

ACTION:

Encourage Golf Courses located near the Lake Worth Lagoon (LWL) to implement Best Management Practices (BMPs) to minimize pollution and reduce stormwater runoff.

BACKGROUND:

A typical 18-hole golf course requires three to four tons of various germicides, herbicides, and pesticides every year to keep the green and fairways healthy, to combat weeds, and kill insects. The nitrogen and phosphorus in the fertilizers mix with rainwater and eventually flow via runoff to the nearest waterbody. The high nutrient content in the water can stimulate the growth of algae. There are 13 golf courses adjacent or close to the LWL. Engaging these golf courses in practicing BMPs is one the goals of this action plan.

In January 2007, Florida Department of Environmental Protection (FDEP), in collaboration with the Florida Golf Course Superintendents Association, the University of Florida and many private sector partners, released an updated edition of *Best Management Practices for the Enhancement of Environmental Quality on Florida Golf Courses*. The manual aims to develop guidelines for minimizing pollution and conserving Florida's water resources. It provides the superintendent or golf course operator with sound management strategies to maintain the golf course in a positive manner with respect to environmental protection, water quality protection, and conservation. It is also intended to provide elected officials, regulators, developers, and others with an overview of golf course management practices and how they relate to environmental issues. A comprehensive program of BMPs should include a combination of components that are properly selected, designed, operated, and maintained. BMP options should be screened for feasibility based on the following factors:

- Physical and technical limitations,
- Operational and management limitations,
- Pollutant reduction/water conservation effects,
- Profitability/cost considerations,
- Other benefits or disadvantages, and
- Public acceptance.

STRATEGY:

STEP 1 Provide Golf Courses along the LWL with the BMP manual developed by

FDEP and encourage them to adopt it and implement the following BMPs' priorities:

1. To correct any identified existing water quality/quantity problems.
2. To minimize water quality/quantity problems resulting from land use and operations.
3. To improve the effectiveness of existing BMPs implemented.
4. To seek additional improvement of BMPs based on new, quantifiable information.

Responsible parties: LWL Outreach Advisory Committee (OAC)

STEP 2 Monitor the environmental effects of implemented BMPs along the LWL.
Responsible parties: Participating Golf Courses with FDEP assistance

STEP 3 Develop new BMPs or revise existing implemented BMPs to further improve water quality, and reduce stormwater runoff to the lagoon.
Responsible parties: Participating Golf Courses with FDEP assistance

SCHEDULE:

Step 1 will be implemented during 2008. Step 2 will be initiated after BMPs implementation according to FDEP guidelines. Step 3 will be initiated after monitoring results are available.

COST:

Initial costs would be minimal since this manual is available on-line and can be duplicated on CD. Since most golf courses already have routine maintenance programs, this action could help to direct expenditures to areas where specific problems have been identified, and seek funding for maintenance and upgrades to these systems. Additionally, an aggressive preventive maintenance program may prove most cost-effective in the long run.

REGULATORY NEEDS:

None anticipated. In the event that these BMPs are adopted by rule, as provided by Subsection 403.067(7)(c)1, Florida Statutes (F.S.), certain protection from liabilities may be established through the voluntary implementation of BMPs that have been verified by FDEP to be effective in protecting water quality.

FUNDING:

To be determined.

EXPECTED BENEFITS:

Improved BMP's and pollution prevention standards will reduce the amount of fertilizer, pesticide, and nutrients being introduced into the LWL through stormwater runoff and

provide increased water quality conditions.

POTENTIAL PARTNERS AND FUNDING SOURCES:

FDEP, IFAS, SFWMD, Environmental Education Centers, Lagoon Keepers

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SW- 3

Identify and Increase Stormwater Retrofit Projects

ACTION:

Identify and increase the number of stormwater retrofit projects to benefit water quality of Lake Worth Lagoon (LWL).

BACKGROUND:

Stormwater pollution is one of the most significant threats to LWL. Much of the urban and coastal area surrounding the lagoon was developed before the 1980's when stormwater treatment standards began to be required. As a result, much of the stormwater discharged is untreated. Because of the density of development, the lack of vacant land is a major limiting factor in the ability to treat stormwater. The coastal basin is particularly challenging, but has a direct impact on the lagoon. As a result, more innovative and expensive treatment technologies are required. Since 1998, the Florida Legislature has supported the restoration and enhancement of the Lake Worth Lagoon by appropriating a total of \$13,885,000 for the Lake Worth Lagoon Partnership Grant Program. The South Florida Water Management District (SFWMD) has supported restoration through \$1.1 million in funding. The grant program funds construction projects to benefit water quality and habitat in the lagoon. Twenty-two water quality projects that involve stormwater retrofits have been constructed and now effectively treat more than 1,700 acres of runoff in areas that were previously untreated. The use of pollution control devices, stormwater ponds, wetland treatment, and treatment swales has reduced the amount of nutrients, sediments, and heavy metals entering Lake Worth Lagoon. Large stormwater treatment systems have been constructed by the Cities/Towns of West Palm Beach, Palm Beach, Boynton Beach and Ocean Ridge. Additional large municipal systems need to be considered for North Palm Beach, Riviera Beach, Lake Worth and Lantana. This action plan calls for identifying areas with little or no treatment before discharging to LWL or a receiving water body that discharges to LWL, identifying potential treatment solutions, and identifying funding sources for the construction of the most effective stormwater treatment projects.

STRATEGY:

STEP 1 Identify and collect ArcGIS compatible data of existing outfalls that discharge to LWL or receiving water body. Develop spatial coverage of areas with no stormwater treatment and produce maps depicting outfalls with natural resource coverage.

Responsible parties: PBCERM, FDEP, SFWMD, PBC NPDES Program

STEP 2 Prioritize stormwater basins in need of retrofits based on size of drainage basin,

proximity to the lagoon, potential for pollutant reduction, cost, impacts to natural resources, and other factors.

Responsible parties: *PBCERM, FDEP, SFWMD, PBC NPDES Program*

STEP 3 Identify and provide funding mechanisms and grant opportunities to implement retrofits in high priority locations.

Responsible parties: *PBCERM, PBC NPDES Program, FDEP, SFWMD*

STEP 4 Allocate funds to targeted stormwater retrofit projects in high priority locations.

Responsible parties: *PBCERM, FDEP*

SCHEDULE:

Steps 1 through 2 will be implemented by 2010. Step 3 to be completed by 2012.

COST:

The anticipated cost of the ArcGIS coverage of stormwater outfalls and project prioritization is \$50,000. The potential cost of constructing a major municipal stormwater treatment system is \$4.5 million.

EXPECTED BENEFITS:

Improve water quality by treating stormwater before entering LWL. Reduction in TSS, nutrients, and metals is anticipated.

MONITORING ENVIRONMENTAL RESPONSES:

Data will be collected, analyzed and integrated with existing water quality monitoring program.

REGULATORY NEEDS:

Permits are required by SFWMD after FDEP review.

FUNDING:

Funding sources to be determined.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

SFWMD, PBCERM, FDEP, Municipalities, PBC NPDES Program

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SE-1

Substrate Characterization

ACTION:

Map substrate characteristics in the Lake Worth Lagoon (LWL) that includes subaqueous soil and benthic habitat classifications through the use of emerging technologies such as hyperspectral imaging. Perform complete dredge hole evaluation including fish and benthic utilization in the LWL to determine management options.

BACKGROUND:

A comprehensive assessment of substrate in the LWL is an important baseline study needed to manage the estuary. While it is known that LWL is negatively impacted by deposits of muck sediments, the areal extent of this impact has not been adequately quantified. A bathymetric survey performed in 2003 identified muck deposits greater than 1.0 feet in depth, and less than 1.0 feet of muck. Muck is defined by grain-size analysis and includes the combination of sandy silt, silt and peat substrate. The study did not adequately quantify the deep deposits. It was determined that muck deposits cover expansive shallow bottom areas of LWL and dredge holes in this area. The spatial extent of muck deposits greater than 1.0 foot is approximately 423 acres in the central portion of the LWL based on the 2003 survey. It is estimated that at least 1.2 million cubic yards of muck are located within a 2 mile radius of the C-51 canal discharge.

A joint project with Florida Wildlife Research Institute and the Smithsonian Institute conducted in 2005 was designed to evaluate habitat value in 10 selected deep holes in the lagoon (PBC 2005b). Fishes and benthic epifauna were surveyed and temperature, water quality, and sediment data were gathered. Of the 10 holes studied, four had muck-covered substrate and were suitable for capping or dredging; three others had sandy substrate and could potentially have material added for fisheries enhancement; three had hard bottom and were determined as non-suitable candidates for addition of material. It was determined that some dredge holes provide valuable habitat.

Accurately mapping the substrate and characterizing the remaining dredge holes of the LWL is necessary to identify and prioritize problem areas for the subsequent formulation of restoration plans, including potential sediment dredging and capping projects discussed in Action Plan SE-3. This mapping effort will also provide key information for habitat restoration projects and will include subaqueous and benthic habitat classification.

STRATEGY:

STEP 1: Review the 2003 muck survey and develop a draft scope of work (SOW) for further determining substrate characteristics, muck depth and quantification, and subaqueous soil and benthic habitat classification. Work will be broken out into phases with Phase 1 evaluating substrate in the central LWL. Distribute SOW to potential partners.

STEP 2: Review the 2005 dredge hole study, *Preliminary Evaluation of Dredge Hole Depressions in Lake Worth Lagoon: Habitat Utilization by Fishes and Macrobenthos* (PBC 2005b), and develop a study for remaining dredge holes in LWL.

STEP 3: Obtain funding

STEP 4: Implement studies.

SCHEDULE:

STEP 1: Develop SOW for Phase 1 of the substrate characterization and distribute to agencies/consultants by January 2008.

STEP 2: Finalize Phase 1 of SOW, funding contracts, and execute interagency agreements by March 2009.

STEP 3: Develop a SOW for remaining phases of the substrate characterization when funding becomes available.

COST:

Approximately \$125,000 for substrate characterization.

Approximately \$100,000 for dredge hole study.

EXPECTED BENEFITS:

Accurately mapping the substrate of LWL will help to set targets for the expansion of seagrass beds and oyster reefs, allow quantification of the areal extent and total volume of muck deposits, and allow for improved planning and prioritization of restoration projects.

MONITORING ENVIRONMENTAL RESPONSES:

Perform substrate characterization at 5-year intervals to assess changes in substrate and benthic habitat classification.

REGULATORY NEEDS:

There are no regulatory needs associated with this study.

FUNDING:

Funding could be achieved through the Lake Worth Lagoon Partnership Grant Program. As this project will provide data necessary for setting numerical targets for the expansion of seagrass and/or oyster beds by RECOVER, partial funding may be available through RECOVER or SFWMD.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

RECOVER, SFWMD, FWC, FIND, FDEP

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SE-2

C-51 Basin and Lake Worth Lagoon Sediment Sourcing Study

ACTION:

Implement a study to assess the relative loads of sediments and nutrients entering Lake Worth Lagoon (LWL) with emphasis on the C-51 Canal. Determine sources of total suspended solids (TSS) as well as the relative importance of the different components of TSS in attenuating light. Identify potential sediment sources via GIS basin analysis based on land use data. Use the information to target specific BMPs to a prioritized list of stormwater outfalls and associated drainage areas.

BACKGROUND:

The decline of seagrass in LWL is partly explained by decreased light penetration due to elevated levels of TSS. Little is currently known about the relative importance of the different components of TSS in attenuating light. Likely sources for the various light-attenuating components of TSS will be determined.

Muck sediments blanket large areas of the LWL, covering the bottom with an anaerobic substrate inhibiting seagrass growth and lowering the species diversity of the benthic community. These fine-grained sediments are easily resuspended by wind and wave action, increasing turbidity and attenuating light.

The C-51 Canal contributes approximately half of the freshwater inflow to the Lake Worth Lagoon. Because it delivers water from the Everglades Agricultural Area and Lake Okeechobee, it is expected that it contributes over half of the suspended sediment load to the lagoon. In addition to identifying sources of sediment inflow, this study will identify sources of nutrients and other constituents. Once significant contributors to water quality degradation have been identified, strategies and BMPs can be developed and implemented to reduce pollution. This project will allow for the identification and prioritization of stormwater treatment projects, and to assist in identifying and prioritizing these projects to areas where they will contribute most efficiently to improving the overall health of the lagoon. Information from this study will also be used to compliment future efforts in evaluating and potentially maintaining the sediment trap created by the C-51 Sediment Management Project. Details of this project can be found in Appendix B.

STRATEGY:

STEP 1: Develop draft scope of work (SOW) for determining substrate characteristics, sources of total suspended solids, and importance of the different components of TSS in attenuating light in LWL. Distribute SOW to potential partners

STEP 2: Finalize SOW and craft interagency agreements to perform the study.

STEP 3: Implement the study.

SCHEDULE:

STEP 1: Develop scope of work and distribute by January 2008.

STEP 2: Finalize SOW and execute interagency agreements by March 2008.

STEP 3: Implement study during 2009.

COST:

Approximately \$150,000

EXPECTED BENEFITS:

Assessing the relative contribution of TSS and nutrients from within the C-51 Canal basin and LWL will allow for prioritization of problem areas and the more efficient focusing of available funds to finance projects that will improve overall water quality in the LWL.

MONITORING ENVIRONMENTAL RESPONSES:

Monitoring of water quality in the lagoon, the C-51 Canal, and at the site of implemented BMPs will allow an evaluation of this focused approach to improving water quality in the LWL.

REGULATORY NEEDS:

There are no regulatory needs associated with this project.

FUNDING:

To be identified.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

SFWMD, FDEP, PBCERM, LWDD

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Water & Sediment Quality*

SE-3

Manage Sediments in Lake Worth Lagoon

ACTION:

Identify and implement a pilot project for capping of muck sediments in Lake Worth Lagoon (LWL) to create sandy submerged bottom habitat, potential oyster or seagrass habitat, or emergent mangrove habitat, or to prevent resuspension of fine-grained sediments.

BACKGROUND:

Muck sediments blanket large areas of the LWL, covering the bottom with an anaerobic substrate inhibiting seagrass growth and negatively impacting the diversity of the benthic community. These fine-grained sediments are easily resuspended by wind and wave action, increasing turbidity and attenuating light penetration, thereby further impacting the lagoon environment. Some, but not all, dredge holes created during the process of shoreline development often contain large volumes of muck sediments at times deep as 10 feet. Muck also covers expansive shallow bottom areas in the central lagoon. The spatial extent of muck deposits greater than 1.0 foot is approximately 423 acres in the central and southern portion of the LWL based on a 2003 survey. In a 2 mile radius of the C-51 discharge muck volume is estimated to be at least 1.2 million cubic yards. Capping of muck will contain these sediments to prevent their resuspension and can provide habitat for seagrass, oysters, and/or mangroves.

Much of the muck is distributed in relatively thin layers over broad expanses of bottom rather than being concentrated in pockets. This significantly complicates management options since treating large areas is logistically complicated and can have unintended impacts. This project involves determining the technical and economical feasibility of capping sediments and identification of suitable areas for use of capping technology. It has to be noted that although the implementation of this pilot project is not directly linked to the NPBC-1 project, it could provide CERP valuable information and be considered as an alternative for muck management projects. The draft PIR identifies several projects where capping of muck sediments is the preferred method of muck management. Action The data collected for Action Plan SE-1 Substrate Characterization will be used to select and prioritize sediment capping projects.

STRATEGY:

STEP 1 Review existing information on muck deposits and dredge holes in LWL. Identify potential sites for sediment capping. Candidate sites shall include dredge holes as well as thinner deposits or depressions where elevations may be increased for recruitment of seagrass. Evaluate potential for creating muck accumulation pits that use natural processes to concentrate muck for capping.

Perform feasibility study evaluating the cost per cubic yard or cost per acre of different muck management options.

STEP 2 Identify funding sources, develop a scope of work, initiate permitting, and define monitoring requirements for a pilot project. Identify sand sources for capping.

STEP 3 Implement sediment capping pilot project in LWL.

SCHEDULE:

Step 1 to be completed during 2008-2009. Additional steps contingent upon step 1.

COST:

\$2,000,000

EXPECTED BENEFITS:

Conversion of muck deposits to suitable habitat for environmental restoration. Habitat includes seagrass, oysters, mangroves, and spartina. Capping of fine-grained muck deposits will reduce resuspension of material directly improving water quality.

MONITORING ENVIRONMENTAL RESPONSES:

Both pre- and post-construction monitoring (water clarity, seagrass coverage, benthic invertebrates) will be required to assess the positive impact of the project.

REGULATORY NEEDS:

Environmental Resource permits will be required from SFWMD, FDEP and USACE.

FUNDING:

Potential funding mechanisms include CERP, SFWMD, DEP, NMFS, FIND and USACE

POTENTIAL PARTNERS AND FUNDING SOURCES*:

SFWMD, USFWS, EPA, USACE, PBC, LWLPG, FIND

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

5. HABITAT RESTORATION ENHANCEMENT AND MONITORING

OVERVIEW

The restoration and protection of diverse habitats within the LWL is crucial to the lagoon's health. Recent studies and surveys performed by ERM indicate that 1,626 acres of seagrass beds are currently present within this estuary. These studies also identify approximately 278 acres of mangroves in the lagoon. Oyster reefs currently mapped or observed within the lagoon show a small but relatively healthy oyster population (~5 acres). Increasing and preserving the quantity, quality and diversity of these communities are the long-term goals of this management plan. The overall target within the next five years is to restore approximately of 125 acres of tidal marsh habitat, add a minimum of 16 acres of oyster reef habitat, and to protect and enhance the lagoon's existing mangrove and seagrass areas. Artificial reefs and land acquisitions are also planned as part of the overall restoration. These goals will be accomplished through 29 specific projects (Appendix C). Proposed projects in Table C.1, Appendix C, are designed to meet habitat enhancement/restoration goals and are not intended to be incorporated in part or in whole for private mitigation purposes.

Implementation of the PBC Manatee Protection Plan is also one of the Action items in the revised LWLMP, and it is included for the reason that habitat restoration is a key component of the manatee plan. Monitoring is also an important component of the *Habitat Restoration and Enhancement* program and has been incorporated in a series of specific Action Plans. A summary of these plans for Habitat Enhancement (HE) and Environmental Monitoring (EM) is outlined in the following paragraph:

SUMMARY OF ACTIONS FOR HABITAT RESTORATION ENHANCEMENT AND MONITORING IN LWL

- HE - 1 Expand Oyster Habitat
- HE - 2 Restore, Create and Protect Mangrove and Spartina Habitats
- HE - 3 Implement the Palm Beach County Manatee Protection Plan
- HE - 4 Develop a Seagrass Restoration Target
- HE - 5 Expand Reef Habitats
- HE - 6 Acquisition of Submerged lands in Lake Worth Lagoon
- EM - 1 Implement Sea Turtle Monitoring
- EM - 2 Develop a Fishery Monitoring Program
- EM - 3 Develop a Submerged Aquatic Vegetation (SAV) Monitoring Program
- EM - 4 Monitor Oyster Reef Habitats

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

HE-1

Expand Oyster Habitat

ACTION:

Increase the Lake Worth Lagoon (LWL) oyster population through enhancement of impacted habitat.

BACKGROUND:

Oysters form an important part of a healthy estuarine ecosystem, providing habitat for a wide variety of species. Oysters also perform an important function of filtering water, thereby removing some particulates in the water column. Recent evidence indicates that the oyster population in LWL may not be recruitment-limited, rather, limited by the availability of suitable substrate and proper salinity fluctuations. Oysters have recruited well on limestone rock placed in the inter-tidal zone. Provisional information indicates that oyster populations appear viable in the central segment of the LWL. An ongoing Florida Fish and Wildlife Conservation Commission (FWC) study indicates LWL has the densest oyster population among the northern estuaries⁸. Natural oyster reefs are located along a rocky spine that transects much of the estuary; however, most of the area is impacted by sediment deposits inhibiting oyster colonization. The area adjacent the rocky spine in the central segment of the lagoon is identified as a suitable location for artificial oyster reef, due to its proximity to an existent oyster reef (Figure 11). Addition of material (rock, concrete rubble, oyster shell, etc.) to this area will increase the oyster population in the lagoon.

STRATEGY:

STEP 1 Develop, permit and construct an oyster reef pilot project of approximately 3 acres in LWL.

Responsible parties: PBCERM

STEP 2 Add additional 15 acres of oyster habitat in the next 5 years.

Responsible parties: PBCERM

STEP 3 Develop and implement a monitoring plan to track oyster recruitment and health on the created oyster reef and the lagoon.

Responsible parties: PBCERM, FWC, SFWMD

SCHEDULE:

The placement of material for the purpose of oyster reef creation, identified in step 1, will

⁸ Northern Estuaries refer to Lake Worth Lagoon, Loxahatchee River Estuary, Indian River Lagoon, and Caloosahatchee River Estuary

be implemented by 2008. Step 2 will be initiated upon completion of step 1. Step 3 has been addressed in Action Plan EM-4.

COST:

Construction of 3 acre oyster reef pilot project: \$530,000

Construction of 15 acres oyster reef over 5 year period: \$3.5 million within the next 5 years. Staff time involved in project design and management: \$350,000

EXPECTED BENEFITS:

Enhancement of hardbottom habitat impacted by sediment deposits through the placement of material to promote oyster recruitment. This will add to the area high quality complex habitat in the lagoon, which supports a wide variety of species, and will likely improve water quality.

MONITORING ENVIRONMENTAL RESPONSES:

Annual monitoring will be conducted by PBCERM and FWC staff to assess aerial extent and health of oysters on deployed substrate. See Action Plan EM-4.

REGULATORY NEEDS:

Permits will be required by FDEP and USACE.

FUNDING:

Funding will be sought by PBC.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FDEP, NOAA / NMFS, FWC, Town of Palm Beach, City of West Palm Beach, Audubon of Florida, Bird Island Trust.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

HE- 2

Restore, Create and Protect Mangrove and Spartina Habitats

ACTION:

Increase mangrove coverage within the Lake Worth Lagoon through implementation of projects to create new mangrove and spartina wetlands and to protect and enhance existing resources.

BACKGROUND:

The restoration, creation and protection of mangrove/spartina wetlands is paramount to the continued health of the Lake Worth Lagoon and its associated fisheries and wildlife. These critical habitats have been rapidly replaced and degraded by decades of developmental pressures. Between 1940 and 1975, an estimated 87% of shoreline mangroves were eliminated by development (Harris et.al, 1983). In 1985 aerial photographs indicated that Lake Worth Lagoon supported approximately 273 acres of mangrove habitat. A 2004 report (PBCERM 2004b) and trend analysis of mangroves between 1985 to 2001, show an increase of 5 acres for a total of 278 acres of mangrove habitat within the Lagoon. Given the number of mangrove restoration projects constructed by ERM in the last 15 years, it appears that restoration efforts have not yet significantly offset historical habitat loss associated with development since 1985.

Mangrove/spartina wetland communities provide habitat for marine organisms, protect shorelines from erosion and enhance water quality by acting as natural filters. Detrital material produced by mangroves is the basis of the food chain for South Florida's marine and estuarine ecosystems (PBCERM 1990). An estimated 75% of game fish and 90% of commercial fishery species in south Florida depend on the mangrove system at some point in their lifecycle. Specific strategies and goals to increase the acreages of these critical wetland habitats, while preserving and enhancing existing resources must be established.

STRATEGY:

STEP 1 Identify/map existing mangrove/spartina resources and identify level of protection needed to sustain the remaining resources.

Responsible parties: PBCERM, SFWMD, USACE, FDEP

STEP 2 Design, permit, fund and construct priority habitat restoration projects identified in Table C-1.

Responsible parties: PBCERM, SFWMD, FDEP, USACE

STEP 3 Establish Interlocal Agreements with municipalities or land owners to restore and create mangrove/spartina habitats within their jurisdiction, and protect these habitats through education.

Responsible parties: PBCERM, State, Audubon, and Municipalities:

North Palm Beach, Lake Park, Palm Beach, Lantana, Lake Worth, Riviera Beach, South Palm Beach, West Palm Beach, Hypoluxo, Palm Beach Shores, Manalapan, Ocean Ridge

SCHEDULE: 2007-2013

Step 1 was initiated with LWL aerial photography flown summer 2007. Digitizing and report of spartina/mangrove acreage and mangrove acreage trend analysis from 2001 to 2007, to be completed by summer 2008. The report will be sent to permitting agencies with a request for recommendations to improve protection for existing habitats.

Step 2 High priority projects in Table C-1 have been initiated and are scheduled for completion by 2013. Medium and low priority projects will be evaluated and prioritized considering ownership, permitting and funding. Conceptual design of medium priority projects is scheduled to be completed by 2013 (see Appendix C-1).

Step 3 will be initiated in June 2008 as restoration/enhancement project areas are identified and evaluated, then letters will be sent to appropriate municipalities to request partnership through interlocal agreement with Palm Beach County.

COST:

Design and permitting: \$250,000/year/project = staff time & permit fees

Construction costs: \$2,000,000/year

Monitoring/maintenance \$100,000/year

EXPECTED BENEFITS:

- Habitat and nursery grounds for invertebrates and fisheries with important recreational and commercial value.
- Roosting and nesting sites for wading and overwintering birds.
- Shoreline protection and reduced re-suspension of sediments
- Mangroves trap and cycle organic materials and nutrients within the estuarine ecosystem
- Water quality/clarity improvements through filtration of runoff & sediment trapping
- Mangroves contribute to the economy of our coastal communities
- Manatee refuge and habitat.

MONITORING ENVIRONMENTAL RESPONSES:

Progress in implementing mangrove habitat restoration will be monitored by PBCERM.

REGULATORY NEEDS:

Permits required by FDEP or SFWMD and USACE

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBC, FIND, SFWMD, USACE, FDEP, FWC, NOAA, USFWS, EPA, Bird Island Trust.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

HE-3

Implement Palm Beach County Manatee Protection Plan

ACTION:

Increase manatee protection around the Lake Worth Lagoon (LWL) by implementing the Palm Beach County Manatee Protection Plan (PBCMPP).

BACKGROUND:

Palm Beach County is one of thirteen (13) counties identified in a 1989 Governor and Cabinet Policy Directive as a “key” county for manatee protection. The State requires that a MPP be developed to reduce impacts to manatees and their habitats. To comply with the Florida Manatee Sanctuary Act, the final MPP was approved by the County in August 2007. This document presents background information, an inventory of existing conditions, and recommended strategies for reducing impacts to manatees in PBC. The plan was approved by the Florida Fish and Wildlife Conservation Commission (FWC) with the concurrence of the US Fish and Wildlife Service (USFWS). The plan includes recommendations for: public education; boater education; local law enforcement efforts; and a boat facility siting plan that addresses expansion of existing and development of new marinas, boat ramps, and other multi-slip boating facilities.

The objective of the PBCMPP is to improve overall protection for manatees while ensuring adequate public access to County waterways. Its primary goal is to establish guidelines and policies that direct new (or expanded) boating facilities to areas posing the least risk to manatees and away from areas of relatively high risk. Other goals include protecting manatee habitat, promoting compliance with waterway speed zones, and increasing public awareness of ways to protect manatees and their habitat. The PBCMPP relies heavily on education and enforcement of existing speed zones as a means of protecting manatees within the County and mitigating for the effects of new boat slips. For the implementation of the MPP, the PBC Board of County Commissioners committed \$1,000,000 per year.

STRATEGY:

STEP 1 Continue and expand upon public education efforts through more aggressive outreach to boaters, fishers, shoreline residents, restaurants, marinas, and the general public.

Responsible parties: PBCERM, FWC, SFWMD, DEP, municipalities, environmental education centers, LagoonKeepers.

STEP 2 Work with local governments, FWC, and local marine law enforcement units to ensure adequate enforcement of boating speed and entry restrictions within

the manatees protection zones.

Responsible parties: PBCERM, FWC, PBSO, local law enforcement agencies, local governments

STEP 3 Set-up a Grant Program for local and State law enforcement marine patrol units working in PBC for the enforcement of manatee zones and public education. The grants will be disbursed to these law enforcement agencies to assist in manatee protection.

Responsible parties: PBCERM

STEP 4 Encourage municipalities to adopt the MPP.

Responsible parties: PBCERM, municipalities

STEP 5 Identify potential manatee habitat creation opportunities within the lagoon that may be permitted, and constructed within a 5 year period (See HE-2).

Responsible parties: PBCERM

SCHEDULE:

Step 1 has been initiated but needs to expand to other local environmental action groups. Local schools and businesses will be also asked to participate in the outreach efforts. Steps 2 and 3 have already been initiated. PBCERM has met several times with local law enforcement agencies to plan a series of actions (including a law enforcement grant program), and to encourage the enforcement of manatee zones. Step 4 has been initiated. Step 5 has already been initiated and will be implemented as the habitat restoration projects progress.

COST:

The Law Enforcement Grant Program (LEGP) will cost approximately \$200,000 per year. An additional \$100,000 is allocated to studies and public outreach. Habitat creation and restoration projects that benefit manatee and manatee habitat are allocated \$700,000 per year.

EXPECTED BENEFITS:

Implementation of a coordinated manatee protection plan that includes a boat facility siting component will provide a more unified, countywide approach to manatee conservation. Enforcement of waterway speed zones will increase protection of manatees and vital seagrass habitats within the lagoon. Increased public awareness of the lagoon's natural resources and the usage of these habitats by the manatees will improve their protection, as well as the habitats they depend upon. Habitat restoration projects will provide additional manatee food sources and improve water quality in the lagoon.

MONITORING ENVIRONMENTAL RESPONSES:

Annual statistics issued by FWC will be used to monitor manatee mortality in the LWL. These statistics will be combined with an inventory of existing boat slips and number of registered boats in an annual report that evaluates change over time. This report will also highlight outreach efforts from local communities on manatee protection and education,

special projects and awards and summarize habitat restoration progress.

REGULATORY NEEDS:

None anticipated.

FUNDING:

The MPP implementation will be funded through annual allocations by the BCC.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

FWC, USFWS, PBSO, Municipalities, FDEP

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

HE-4

Develop Seagrass Restoration Target

ACTION:

Develop a seagrass restoration target for Lake Worth Lagoon (LWL).

BACKGROUND:

Developing a numeric goal based on available understanding of the history and physical characteristics of LWL sets up guidelines for ongoing and future habitat restoration projects. PBCERM has developed a methodology to model a target in LWL. Potential seagrass habitat is identified using the existing bathymetric survey to develop a digital elevation model. Seagrass is mapped from aerial photography to determine seagrass distribution by depth, and estuarine substrate characteristics are used to identify potential areas of recruitment. A user can determine where seagrass restoration or recruitment is likely to occur and can assist in setting a restoration target based on these factors. The information developed provides an effective management tool to determine where restorative and protection efforts should be focused. The information developed will be utilized as baseline information for RECOVER SAV Performance Measure development.

Seagrass covers at least 1,626 acres or 22% of LWL. The acreage is based on 2001 aerial photographic interpretations. The coverage varies throughout the three segments of the lagoon. The overall seagrass coverage within each of the segments is 33.5% in the north, 9% in the central segment, and 17% in the south segment of the lagoon. The average maximum depth that seagrass will grow in the north segment is 5.0 feet (NGVD), 4.4 feet in the central segment, and 3.4 in the south segment. The restoration target entails setting an average maximum depth at which seagrass will grow and recruit. The target should be revisited as restoration and CERP efforts are ongoing and integrated with new seagrass data as it becomes available.

STRATEGY:

- STEP 1 Assemble a Technical Advisory Committee (TAC) to peer review the model methodology and make recommendations.
Responsible parties: PBCERM

- STEP 2 The TAC will propose a seagrass restoration target to be shared with local governments, State agencies and stakeholders.
Responsible parties: PBCERM, Florida DEP, FWC, SFWMD, USFWS, and NOAA / NMFS

- STEP 3 Develop and implement a Seagrass Monitoring Plan to identify spatial and

temporal changes in seagrass coverage and function.
Responsible parties: PBCERM, SFWMD

SCHEDULE:

The TAC identified in step 1 will be completed by February, 2008. Step 2 is scheduled for one year after assemblage of the TAC. Step 3 should be completed no later than one year after acceptance of the restoration target by stakeholders.

COST:

Annual costs for staff, TAC meetings, and materials are estimated at approximately \$50,000.

EXPECTED BENEFITS:

The restoration target provides an effective management tool to determine where restorative and protection efforts of seagrass should be focused in LWL. Manatee habitat restoration projects and water quality improvements planned in the next five years are expected to increase SAV coverage especially in the North and South segment of the lagoon.

MONITORING ENVIRONMENTAL RESPONSES:

Data will be collected, analyzed and integrated with existing monitoring program.

REGULATORY NEEDS:

None anticipated.

FUNDING:

Funding sources need to be identified.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FWC, US FWS, NOAA / NMFS, FDEP, USACE, LWLPG.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

HE-5

Expand Reef Habitats

ACTION:

Increase fisheries and benthic habitat in Lake Worth Lagoon (LWL) through additional artificial reefs while enhancing impacted areas.

BACKGROUND:

Artificial reef structures have been placed in deeper areas of the lagoon since the initial deployment of Artificial Reef Modules (ARM) in 1991 in what is now Sugar Sands Ledges (SSL). SSL is now a complex of concrete “ledges” with limerock boulders scattered around to increase habitat complexity. Snook regularly inhabit the ledges and generally 50% or more of the observed fish are juveniles. These artificial reefs provide habitat that enhances the Lagoon’s nursery function. Data collected by the Reef Research Team has demonstrated that these estuarine reefs support a higher proportion of juvenile fish than the offshore reefs. Additionally, reefs, such as those at Rybovich Snook Ledges, Kelsey Park, Lantana Reef, Peanut Island, and Boynton Inlet provide complex habitat for benthic organisms. Epifauna include sponges, tunicates, hydroids, and both hard corals and gorgonians. Additional locations within the Lagoon will be identified and artificial reefs of limerock boulders and/or concrete structures will be planned and built within LWL.

STRATEGY:

STEP 1 Identify additional locations, especially artificially-deepened areas for artificial reef placement in Lake Worth Lagoon.

Responsible parties: PBCERM

STEP 2 Develop, permit and construct artificial reefs in Lake Worth Lagoon.

Responsible parties: PBCERM, Environmental Education Centers

STEP 3 Continue monitoring existing and new artificial reefs.

Responsible parties: PBCERM, PBC Reef Research Team, FWC, Environmental Education Centers

SCHEDULE:

The placement of artificial reef materials for habitat enhancement in the Lagoon is an on-going endeavor, as identified in steps 1 and 2. Step 3 is an on-going effort.

COST:

Construction of 1 acres/year at \$ 200,000/year, plus staff time involved in project design and management.

EXPECTED BENEFITS:

Enhancement of dredged areas, by the placement of artificial reef materials, promotes settlement of epifaunal organisms which in turn promotes fisheries nurseries within the Lagoon. Existing Lagoon artificial reefs can have as much as 80% of fish on the reef representing the juvenile class and are important developmental refuges for fish that have value to the commercial and recreational fisheries. These artificial reefs add high quality complex habitat the lagoon and they support a wide variety of species.

MONITORING ENVIRONMENTAL RESPONSES:

Regular monitoring already occurs with the Sugar Sands Ledges and Rybovich Reef artificial reefs using the Reef Research Team. PBCERM will be monitoring the other artificial reefs within the Lagoon.

REGULATORY NEEDS:

Permits will be required by FDEP and USACE.

FUNDING:

Funding is available through the County Vessel Registration Fee and additional funding will be sought.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, FWC, Environmental Education Centers, FIND, FDEP

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

HE-6

Acquisition of Submerged Lands in Lake Worth Lagoon

ACTION:

Acquisition and conservation of privately owned submerged lands within the Lake Worth Lagoon (LWL).

BACKGROUND:

Increasing and preserving the quantity, quality and diversity of the lagoon's mangrove and seagrass habitats, through acquisition of privately owned submerged lands, is one the long-term goals of this management plan. Fifty-six (56) parcels of privately owned submerged lands have been identified within the LWL, totaling 218 acres. These submerged lands are primarily located within three municipalities of the County: the City of Riviera Beach, the Town of Palm Beach, and the City of Lake Worth. The majority of these parcels have been identified as areas that either support existing healthy seagrass beds, or provide valuable estuarine habitats with great potential for restoration.

Twenty-eight (28) parcels located in the City of Riviera Beach adjacent to Singer Island, are the highest priority for acquisition and conservation. These 154 acres of submerged parcels include the most abundant area of seagrass habitat within the LWL and in Palm Beach County. This area is critical to fish and wildlife. It provides nursery grounds for juvenile fish and shellfish, as well as feeding areas for many types of birds and animals including manatees and green sea turtles. A previous attempt to purchase these parcels in 1997 was not successful; however it did generate significant support from the community with \$103,100 collected from voluntary contributions, and the donation of an approximate three-acre parcel of submerged land containing valuable seagrasses to Palm Beach County. This critical habitat will be the focal point of a larger plan to acquire submerged lands for preservation and enhancement of existing habitats within the LWL. If these acquisitions are successful, Palm Beach County and/or State will develop a long-term management plan to preserve these valuable estuarine habitats.

STRATEGY:

STEP 1 Identify and obtain funding and develop an acquisition schedule.

Responsible parties: PBCERM

STEP 2 Estimate total acquisition costs based on pre-appraisals projections.

Responsible parties: PBCERM, PBC Property & Real Estate Management (PREM)

STEP 3 Notify property owners of the intent to acquire their property.
Responsible parties: PBCERM, PREM

STEP 4 Send letter and maps to all permitting agencies recommending that acquisition of these properties be considered as partial mitigation for unavoidable impacts when evaluating permits.
Responsible parties: PBCERM, PREM

SCHEDULE:

Step 1 is contingent upon the successful identification of a secure funding source. Step 2 and 3 are contingent upon Step 1. If a funding source for Step 1 is obtained, Step 2 will be implemented within two months. Step 3 will be implemented between 1 to 2 years. Step 4 will be implemented in 2008.

COST:

Acquisition costs for each parcel need to be evaluated.

EXPECTED BENEFITS:

The purchase of submerged lands will increase and preserve in perpetuity critical habitats utilized by the estuarine species in the LWL.

MONITORING ENVIRONMENTAL RESPONSES:

Information obtained by the monitoring of valued ecosystem species such as seagrasses, sea turtles and manatees, will be analyzed and integrated with existing monitoring programs.

REGULATORY NEEDS:

None anticipated.

FUNDING:

Funding sources need to be identified.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, US FWS, NOAA / NMFS, FWC, local Municipalities

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

EM-1

Implement Sea Turtle Monitoring

ACTION:

Monitor the health of the sea turtle population utilizing Lake Worth Lagoon (LWL) by continuing to perform quarterly netting events for 5 years.

BACKGROUND:

Though much is known about sea turtles utilizing Palm Beach County's nesting beaches, little is known about the sea turtle population in LWL. Because sea turtles can function as an indicator species as to habitat health, it is, therefore, important to determine sea turtle utilization in LWL and to characterize the sea turtle population. Fibropapillomatosis (FP), a potentially deadly disease affecting primarily green sea turtles in polluted estuarine waters, has been documented at a high frequency in the Indian River Lagoon and Mosquito Lagoon sea turtle populations. FP is expected to occur with equal frequency in LWL, therefore, data is necessary for adequate comparison. To determine the distribution and health of the sea turtle population in LWL, a sea turtle netting study was implemented in March 2005 to answer the following questions:

- What is the population distribution of sea turtles in LWL?
- Which sea turtle species and size classes are utilizing LWL?
- What is the frequency and severity of FP and other diseases and/or injuries?
- What is the habitat preference of sea turtles utilizing LWL?

STRATEGY:

STEP 1 Continue to implement the existing sea turtle netting study scope of work for the next five years and identify potential funding sources.

Responsible parties: PBCERM

STEP 2 Include in the water quality monitoring program constituents possibly linked to FP.

Responsible parties: PBCERM

STEP 3 Promote an educational campaign regarding LWL water quality and health of its sea turtle population. Promote community participation in maintaining LWL health and protection of sea turtles, similar to beach programs.

Responsible parties: PBCERM

SCHEDULE:

Step1: the netting survey has been ongoing since March 2005 and has been conducted by InWater Research Group, Inc. and funded by an existing Sea Turtle License Plate Grant.

Additional sampling events will be scheduled quarterly for the next five years as funding is made available. Step 2 and 3 will be implemented as part of the Action Plans PE-1 and WQ-1, contingent upon available funding.

COST:

Annual costs for contractor staff, equipment, and blood and dietary sample analysis are estimated at approximately \$35,000 per year.

EXPECTED BENEFITS:

By characterizing the sea turtle population in the LWL, the impacts of water quality improvement and habitat restoration projects on sea turtle health can be documented.

MONITORING ENVIRONMENTAL RESPONSES:

Data is collected and analyzed in accordance with FWC and NMFS permits and guidelines. LWL data will be compared to that collected in similar lagoon systems, such as the Indian River Lagoon and Mosquito Lagoon.

REGULATORY NEEDS:

Although not required by any regulatory or construction activities, this study may document sea turtle habitat preferences and population distribution that should be included in LWL management decisions.

FUNDING:

Funding is available until December 2008. Additional funding sources will be needed to meet the goal of a 5 year study to be completed in 2010.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, FWC, Sea Turtle License Plate Grants Program, USFWS

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

EM-2

Develop a Fishery Monitoring Program

ACTION:

Develop a long-term, comprehensive database on fish and selected invertebrate species inhabiting the Lake Worth Lagoon (LWL).

BACKGROUND:

Fishing is an important recreational activity in the LWL and an important part of the County's economy. Loss of seagrass beds and mangrove-fringed shoreline have had a detrimental impact not only on the estuarine fish population, but also on those species which inhabit the lagoon during their larval and juvenile stages and then move out to the offshore reefs as adults. Fluctuations in salinity have also influenced the composition of the lagoon's fish community. A quantitative fish assessment has never been carried out in this estuary. Baseline data on the lagoon fishery needs to be gathered in order to assess change over time and allow managers to identify problems and design solutions. Tracking the health of the lagoon's fishery is an important component for the on-going restoration.

The Fish and Wildlife Research Institute's (FWRI) Fisheries Independent Monitoring (FIM) Program has a long-term program designed to monitor the relative abundance of fishery resources in Florida's major estuarine, coastal, and reef systems. The FIM program utilizes well-tested and established methodologies and is well-positioned to monitor fish and selected invertebrate populations in the LWL area. The FIM program's primary goals include:

- 1) Address the critical need for effective assessment techniques for an array of species and sizes of fishes and selected invertebrates,
- 2) Provide timely information for use in management plans, and
- 3) Monitor trends in the relative abundance of fishes and selected invertebrates

FWRI employs stratified random sampling to assess the abundance and distribution of fish and macroinvertebrate in the LWL. The sampling will divide the lagoon into zones based on geographic and logistical criteria and habitat type, using gear suited to that particular bottom habitat. The number, species and length of all fish and invertebrates captured will be recorded along with environmental data on water quality, habitat characteristics, and physical parameters such as current and tidal conditions will also be recorded for each sample.

STRATEGY:

STEP 1 Develop a sampling universe (or area) for stratified-random sampling in the LWL. The study area will be divided into sampling zones based on geographic and logistical criteria. All significant habitat types within the lagoon should be

sampled.

Responsible parties: FWC/FWRI in cooperation with PBCERM

STEP 2 Conduct monthly/quarterly (depending on support level) stratified-random sampling in the LWL. Biological samples will be collected and provided to investigators in a timely manner for studies on individual species or populations.

Responsible parties: FWC/FWRI in cooperation with PBCERM

STEP 3 Prepare quarterly and annual reports that summarize data from the FIM study area. The report will include a summary of overall sampling effort, species composition, and abundance from the study area and more detailed data summaries such as catch rates, size distribution, and spatial and temporal distribution for more abundant species and species of economic importance.

Responsible parties: FWC/FWRI in cooperation with PBCERM

SCHEDULE:

Step 1 will be initiated when funding is available. Step 2 and 3 are contingent upon Step 1.

COST:

The estimated annual cost for this monitoring program is \$150,000. The estimated costs are based on monthly sampling including three full-time staff personnel, boat and vehicle fuel, travel time, nets, boat/vehicle repairs and upkeep, and expendable routine supplies.

EXPECTED BENEFITS:

Quantify LWL fish population and establish a monitoring program that will provide more comprehensive information about status and trends. Its implementation will allow managers to identify problems and design solutions to preserve and enhance fish stocks in the lagoon.

MONITORING ENVIRONMENTAL RESPONSES:

FWRI will monitor the health and the abundance of fisheries within the LWL. Monthly monitoring will be incorporated in quarterly and annual reports that will be used for restoration purposes.

REGULATORY NEEDS:

None anticipated.

FUNDING:

FWC/FWRI will contribute \$75,000 in-kind services towards this monitoring program. The remaining \$75,000 is contingent upon receiving additional funds.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, FWC / FWRI, NOAA / NMFS, WPB FISHING CLUB

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

EM-3

Develop a Submerged Aquatic Vegetation (SAV) Monitoring Program

ACTION:

Develop a long-term, comprehensive SAV monitoring program for Lake Worth Lagoon (LWL).

BACKGROUND:

SAV beds provide important habitat for numerous organisms including fish, invertebrates, marine mammals and turtles. Subsequently they and their associated communities are important indicators of a healthy estuary. It is important to identify areas of change and those that are stable over time to gain a better understanding of seagrass and estuarine dynamics.

The Comprehensive Everglades Restoration Plan (CERP) was developed with the goal of restoring more natural freshwater discharges to the Northern Estuaries including LWL, enabling them to revert to more stable and desirable conditions (e.g., lowered salinity variability) that are amenable to the re-establishment of floral and faunal communities that are similar to those found historically. Specifically, it is expected that the restoration of a more natural hydrology will result in the improvement of the spatial and structural characteristics of SAV and its associated biological communities.

SAV populations in LWL have been much reduced in distribution via the inflow of suspended sediments and the fluctuating salinity resulting from current water management practices. Although LWL supports a comparatively low diversity of seagrass species within the Northern Estuaries, it does provide critical habitat for the threatened seagrass, *Halophila johnsonii* (listed in 1998 by the National Marine Fisheries Service, *H. johnsonii* is the first marine plant species to be listed under the Endangered Species Act). The lagoon contains the largest known beds of *H. johnsonii*.

A baseline condition for seagrasses in LWL was established in 2001 from an interpretation of aerial photographs and *in situ* groundtruthing. Following the conversion of the 2001 aerial photographs to digital orthophotography, a schedule was developed to acquire aerial photographs with the intent of tracking SAV in the LWL every five years to document large-scale trends. Currently, the next scheduled flight is in the spring of 2007. A suite of transect sites (n = 9) are currently being monitored by PBC ERM. Transect monitoring originally (2000) included transects at five sites, but beginning in 2001, this effort was expanded to include four additional sites. The transects are located throughout LWL in areas where the depth gradient changes by 30 to 60 cm within 15 to 30 m shoreward and offshore of the seagrass bed edge. Three one-meter square quadrats along each transect are monitored for species presence/absence, Braun-Blanquet density estimates, depth distribution and abundance. In addition, distance to edge of bed from the center quadrat is measured. Analysis of transect data has not revealed any apparent

trends. This is likely due to an inadequate sampling regime that does not detect spatial and temporal change.

STRATEGY:

STEP 1 Develop a monitoring protocol capable of detecting SAV changes in both short- and long term spatial and temporal scales. The current monitoring protocol utilized by PBCERM will be modified when a standardized monitoring protocol is developed by the RECOVER Northern Estuaries SAV sub-team.

Responsible parties: PBCERM, SFWMD, and FDEP

STEP 2 Implement a SAV monitoring program that will include aerial mapping and fixed transect monitoring. Identify and perform a suite of statistical analyses.

Responsible parties: PBCERM in cooperation with SFWMD and FDEP

STEP 3 Prepare annual reports that summarize data from aerial mapping, fixed transect monitoring, statistical analyses, and correlations with water quality parameters.

Responsible parties: PBCERM in cooperation with SFWMD and FDEP

SCHEDULE:

Step 1 will be initiated in the summer of 2007. Step 2 and 3 are contingent upon Step 1.

COST:

The estimated annual cost for fixed transect monitoring program is \$60,000 and aerial mapping is estimated at \$80,000, to be completed every three to five years.

EXPECTED BENEFITS:

Quantify coverage of LWL SAV and establish a monitoring program that will provide more comprehensive information about status and trends. The monitoring program implementation will allow managers to identify problems and design solutions to recruit and protect SAV resources.

MONITORING ENVIRONMENTAL RESPONSES:

PBC ERM will monitor SAV with cooperation from SFWMD and FDEP within the LWL. Semi-annually monitoring will be incorporated in annual reports.

REGULATORY NEEDS:

None anticipated.

FUNDING:

Funding may be available through the LWL Partnership Grant Program, CERP/RECOVER funding and NOAA. Additional funding could be pursued through grants and partnerships with other governmental agencies.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FDEP, NOAA / NMFS, Bird Island Trust.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Habitat Restoration Enhancement and Monitoring*

EM-4

Monitor Oyster Reef Habitats

ACTION:

Increase monitoring of the oyster population in Lake Worth Lagoon (LWL).

BACKGROUND:

The establishment of a monitoring baseline for oysters in the lagoon is currently ongoing through a long-term monitoring program headed by the Florida Fish and Wildlife Conservation Commission (FWC). FWC has been conducting a comprehensive study in LWL under the RECOVER Monitoring and Assessment Plan since January 2005. The existing distribution of natural reefs/beds has been mapped by FWC during this effort (Figure 11). This study should provide an accurate estimate of the current status of living oysters in some areas of the lagoon, their health, growth and reproduction at selected representative sites. Despite the effectiveness and value of this long term monitoring program, the aerial extent of the monitored areas is limited. Though restoration projects such as Snook Islands showed that successful oyster recruitment occurred, these projects are not included in the current FWC study area. Expanding the current FWC monitoring program to the entire lagoon will provide crucial data necessary to determine if the health and spatial extent of oysters is improving with time, as the LWLMP and CERP are implemented, and will provide data to detect the environmental responses of the ecosystem to changes in stressors (i.e. salinity fluctuations and pollutants). The program will be expanded to map oysters on all substrates including natural and manmade features. The expanded oyster monitoring program's primary goals will include:

- Spatial and size distribution patterns of adult oysters
- Elevation for optimal growth in different locations of the lagoon
- Distribution and frequency patterns of oyster diseases
- Reproduction and recruitment
- Juvenile oyster growth and survival

The results of the monitoring will be integrated with the current CERP performance measures for the LWL restoration success.

STRATEGY:

STEP 1 Continue to implement and expand the oyster monitoring study scope of work for the next five years and identify potential funding sources.

Responsible parties: FWC, PBCERM, RECOVER

STEP 2 Conduct mapping of the entire lagoon every five years and fixed station monitoring monthly or quarterly (depending on support level).

Responsible parties: PBCERM

STEP 3 Prepare annual reports that summarize data from mapping, fixed station monitoring, statistical analyses, correlations with water quality parameters, fresh water discharges, and other stressors.

Responsible parties: FWC, PBCERM, RECOVER

STEP 4 Make recommendations for restoration criteria to guide design of habitat enhancement projects.

Responsible parties: FWC, PBC ERM, RECOVER

SCHEDULE:

Step 1 will be initiated in the summer of 2008. Step 2, 3, and 4 are contingent upon Step 1 and available funding.

COST:

Approximately \$70,000/year.

EXPECTED BENEFITS:

Quantify LWL oyster population and establish a monitoring program that will provide more comprehensive information about status and trends. Its implementation will allow managers to identify problems and design solutions to preserve and enhance the oyster population in the lagoon.

MONITORING ENVIRONMENTAL RESPONSES:

Annual monitoring will be conducted by PBCERM and FWC staff to assess aerial extent and health of oysters on existing and deployed substrates.

FUNDING:

Funding will be sought by PBC and SFWMD.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FDEP, NOAA / NMFS, FWC

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

6. PUBLIC USE AND OUTREACH

OVERVIEW

Interested, informed citizens are the lagoon's best hope for the future. The Public Outreach Program is committed to creating an engaged constituency of citizens who understand both the environmental, recreational and economic value of the LWL, and actively participate in restoring and protecting it. Approximately 16 of the 26 outreach projects originally identified in the 1998 LWLMP have been implemented; however more needs to be done. Public awareness about the natural resources within the LWL is still insufficient. Anecdotal surveys randomly conducted by PBCERM showed that many local residents are still unaware of the significance of this estuarine system and its valuable natural resources. The establishment of an Outreach Advisory Committee (OAC) is one of the proposed Action Plans to address this issue. The OAC will develop strategies and activities for awareness programs to involve and inform the residents, visitors and decision makers about the LWL ecosystem.

Although much has been achieved in the way of restoration, additional projects, awareness and political support is needed to effectively keep pace with population pressure in the watershed. The establishment of a Lake Worth Lagoon Initiative (LWLI), to facilitate stakeholder partnerships and seek funding assistance for projects, would achieve the objectives of improving and protecting the natural resources within the LWL and its watershed. The LWL Initiative will focus on major issues involving Lake Worth Lagoon including: (1) watershed drainage and discharge and its negative impact on estuarine productivity; (2) habitat losses of seagrasses, mangroves and oysters; (3) coordinating local, state, or federal programs and effort to optimize the environmental quality and protection of the lagoon; and (4) need for public education to incorporate science into decision-making; (5) heighten the public awareness of the LWL and its resources. The SFWMD has been participating in several initiatives throughout the State. With the support and participation of the SFWMD to the LWLI, State legislative appropriations and efforts can be combined with the current Palm Beach County efforts for legislative budget requests through the Lake Worth Lagoon Partnership Grant Program. The LWL is a Surface Water Improvement and Management (SWIM) prioritized waterbody of regional/or Statewide significance, along with other estuaries and waterbodies such as Loxahatchee River, Indian River Lagoon (IRL) and Biscayne Bay.

Another important program to achieve public outreach objectives is the Florida Yards & Neighborhoods Program (FYN). Fertilizers and pesticides from residential areas are serious threats to the health of Florida's water and ecosystems. FYN's purpose is to help protect Florida's natural resources by creating attractive, low-maintenance Florida friendly landscapes. Principles advocated by the program include conserving water, improving stormwater runoff and reducing the need for pesticides and fertilizer application - all of which improve the quality and reduce the quantity of stormwater

runoff to the lagoon. The community's participation in FYN Program practices is essential for long-term preservation and enhancement of the lagoon. Public use and outreach goals will be accomplished through specific actions listed below:

SUMMARY OF ACTIONS FOR PUBLIC USE AND OUTREACH

- PO - 1 Develop the Lake Worth Lagoon Initiative
- PO - 2 Promote Public Outreach in Lagoon Restoration and Protection
- PO - 3 Implementation of Pollution Prevention Initiatives and the Florida Yards & Neighborhoods Program
- PO - 4 Provide Passive Public Use of and Access to Lake Worth Lagoon

ACTION PLAN *Public Use and Outreach*

PO-1

Develop the Lake Worth Lagoon Initiative

ACTION:

Develop a Lake Worth Lagoon Initiative (LWLI) to facilitate stakeholder partnerships and to seek funding assistance for projects that would improve and protect the natural resources within the Lake Worth Lagoon (LWL) and its watershed.

BACKGROUND:

Since 1998, Lake Worth Lagoon stakeholders have been active in implementing habitat restoration and stormwater projects in the watershed via the Lake Worth Lagoon Partnership Grant program. The LWL is a Surface Water Improvement and Management (SWIM) prioritized water body of regional/or Statewide significance. More than 37 habitat restoration projects have been completed and baseline monitoring to assess the health of the lagoon has been initiated. Although much has been achieved in the way of restoration, additional projects, awareness and political support is needed to effectively keep pace with urban expansion within the watershed. The LWL Initiative will focus on: (1) watershed drainage and discharge and its negative impact on estuarine productivity; (2) restoration of seagrass, mangrove and oyster habitat; (3) coordinating local, state, and federal programs and efforts to optimize the environmental quality of the lagoon; (4) the need for public education to incorporate science into decision-making; and, (5) heighten public awareness of the LWL and its resources. The South Florida Water Management District (SFWMD) has been participating in several initiatives throughout the State. With the support and participation of the SFWMD in the LWLI, State legislative appropriation requests can more readily be combined and technical expertise shared with the current Palm Beach County efforts through the Lake Worth Lagoon Partnership Grant Program.

STRATEGY:

STEP 1 Pass a Resolution to support and endorse the LWLMP and the LWLI.
Responsible parties: All LWL governmental stakeholders

STEP 2 Increase coordination among government agencies and stakeholders concerning funding, outreach, monitoring, and technical expertise.
Responsible parties: LWL Stakeholders

SCHEDULE:

Step 1 to be completed in 2008.

Step 2 is ongoing.

COST:

Annual costs for projects are based upon municipal requests for funding, approval by the LWLI Committee and subsequent legislative funds. Average appropriations since 1998 have been almost \$1.7 million per year.

EXPECTED BENEFITS:

Initiating a LWLI will result in increased awareness of the lagoon and associated problems. It will also provide improved coordination, new opportunities for funding, improve the coordination of research, monitoring and habitat restoration projects by improved sharing of technical expertise,

MONITORING ENVIRONMENTAL RESPONSES:

Environmental response will be monitored through the established LWL monitoring programs and newly formed monitoring programs under the LWLI.

REGULATORY NEEDS:

Not applicable.

FUNDING:

State Legislative Requests and local funding match.

POTENTIAL PARTNERS AND FUNDING SOURCES:

All LWL stakeholders.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Public Use and Outreach*

PO-2

Promote Public Outreach in Lagoon Restoration and Protection

ACTION:

Educate the public about the Lake Worth Lagoon (LWL) watershed and the restoration and enhancement effort underway and involve citizens in activities that help protect, restore and enhance the lagoon.

BACKGROUND:

Public Use and Outreach was one of five program areas included in the *Lake Worth Lagoon Management Plan*, adopted in August 1998. Specific objectives were: “(1) to develop awareness programs to involve and inform the residents, visitors and decision makers about the LWL ecosystem, and (2) to develop school education programs within the Palm Beach County School District science curriculum to emphasize the LWL and how to preserve it.” Decision maker, stakeholder and citizen support continue to be needed to ensure the long-term health of the lagoon.

The Public Outreach program aims to build a constituency of informed citizens who actively participate in the lagoon’s restoration and enhancement. Existing educational resources, programs, and volunteer events focused on the lagoon are limited. There is a need to expand and coordinate outreach activities, educational programs, and volunteer events among partner organizations to successfully reach more citizens and to improve services to LWL stakeholders.

STRATEGY:

STEP 1 Create an Outreach Advisory Committee (OAC) to support the expansion and coordination of outreach activities, educational programs, and volunteer events. The committee should meet quarterly and be composed of representatives from government agencies, businesses, non-profit organizations, and concerned citizens.

Responsible parties: PBCERM and Cooperative Extension Service/UF-IFAS

Schedule: The committee will meet quarterly with the first meeting to be held in January 2008.

STEP 2 Develop an identity or “trademark” for the lagoon by which all the stakeholders will recognize the LWL and the associated restoration and enhancement efforts that are underway. The trademark will be incorporated into all brochures, newsletters, posters and educational materials developed.

Responsible parties: LWL OAC

Schedule: September 2008

- STEP 3 Hire a full-time volunteer program coordinator who will be a member of and work with the OAC to develop and implement outreach activities, educational programs, and volunteer events that engage and motivate citizens to protect, restore and/or enhance the lagoon.
Responsible parties: LWL OAC, PBCERM
Schedule: October 2008
- STEP 4 Plan, coordinate and implement hands-on educational programs and volunteer events to involve and inform LWL stakeholders of their role in protecting and enhancing the lagoon. In the near term, existing events such as the Florida Coastal Cleanup in LWL will be planned and implemented. Potential activities may include but are not limited to: Adopt-a-Shoreline Program (a lagoon environmental steward program), additional cleanup events, native planting events, storm drain placard project, fishing tournaments, a citizens water quality monitoring program, and the Lake Worth Lagoon Bird Survey.
Responsible parties: LWL OAC, PBCERM
Schedule: Beginning with the Coastal Cleanup in September 2007, events will be conducted under a phased approach depending on resources.
- STEP 5 Update existing and develop new educational materials for use in educational programs in elementary, middle and high school, and/or for distribution at public outreach events. Educational materials to be developed and/or updated may include, but are not limited to: the Lake Worth Lagoon Urban Estuary CD-ROM, Lake Worth Lagoon: Saving Nature's Nursery video and Educators Guide, Guide to Boating and Angling in Lake Worth Lagoon, Understanding Lake Worth Lagoon brochure, a new Lake Worth Lagoon poster, newsletter, tabletop display board, and slide (PowerPoint) presentation.
Responsible parties: LWL OAC, PBCERM
Schedule: Educational materials will be developed in a phased approach depending on resources.
- STEP 6 Develop educational programming that will reach a wide audience, specifically through production of a cable-quality documentary on Lake Worth Lagoon that may be broadcast locally on cable TV. Topics may include those that are directly related to the LWL, as well as related topics such as "Where does the muck come from?" and the lagoon's relationship to the aquifer. Short awareness DVDs may also be developed with recreational and/or eco-tourism use in mind.
Responsible parties: LWL OAC, PBCERM
Schedule: Educational programming will be developed in a phased approach depending on resources.
- STEP 7 Develop and erect informational kiosks at restored public access sites that are accessible either by land or by boat and other select locations. All signs could include general information about LWL plus site specific information. Appropriate information regarding responsible public stewardship and LWL goals may be described.
Responsible parties: LWL OAC, PBCERM

Schedule: Educational programming will be developed in a phased approach depending on resources.

STEP 8 Conduct pro-active educational programs to increase stakeholders' knowledge of the lagoon, restoration and enhancement efforts, and the roles of individuals and stakeholder groups in protecting and enhancing the lagoon. Target audiences may include but are not limited to the PBC School District, Rotary, Kiwanis, Chambers of Commerce, homeowner associations, garden clubs and the general public.

Responsible parties: LWL OAC, PBCERM, PBC Cooperative Extension Service/UF-IFAS

Schedule: Educational programs will be developed in a phased approach depending on resources.

STEP 9 Identify and conduct pro-active public outreach events to increase stakeholders' knowledge of the lagoon, restoration and enhancement efforts, and the roles of individuals and stakeholder groups in protecting and enhancing the lagoon. Example outreach events include the South Florida Fair, Earth Day and the Palm Beach County Boat Show.

Responsible parties: LWL OAC, PBCERM

Schedule: Participation in public outreach events will be conducted in a phased approach depending on resources.

STEP 10 Conduct Lake Worth Lagoon tours for LWL stakeholders to increase knowledge of the Lake Worth Lagoon, restoration and enhancement efforts, and the roles of individuals and stakeholder groups in protecting and enhancing the lagoon.

Responsible parties: LWL OAC, PBCERM

Schedule: Lake Worth Lagoon tours will be conducted in a phased approach depending on resources.

COST:

Annual costs for staff are estimated at approximately \$75,000 per year, plus costs for DVDs and brochures.

REGULATORY NEEDS:

Not applicable.

FUNDING:

Funding will be sought by Palm Beach County.

POTENTIAL PARTNERS*:

PBCERM, IFAS, SFWMD, FDEP, FWC, Environmental Education Centers, Lagoon Keeper, Tourist Development Council.

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Public Use and Outreach*

PO-3

Implementation of Pollution Prevention Initiatives and the Florida Yards & Neighborhoods Program

ACTION:

Continue support for the Florida Yards & Neighborhoods Program and similar education initiatives that encourage homeowners to conserve water, reduce residential stormwater runoff, and implement best management practices to protect water resources. Continue to educate retailers, developers, and the landscaping and pest control industries to practice and promote these concepts.

BACKGROUND:

The Florida Yards and Neighborhood program (FY&N) was developed in response to the increasing problem of nonpoint source water pollution. This program focuses on reducing stormwater runoff from residential areas. Runoff can carry nutrients and chemicals, polluting Florida's lakes, canals and coastal waters (including the Lake Worth Lagoon).

In Palm Beach County, the FY&N program is coordinated by Palm Beach County Cooperative Extension/ UF/IFAS by one Extension Agent. The FY&N Extension agent conducted educational programs on designing and implementing Florida-friendly yards and gardens. Homeowners learn how appropriate use of fertilizers and pesticides, water conservation, and how to minimize pollution and stormwater runoff.

As part of pollution prevention initiatives, an educational program that addresses liquefied fat, oil, or grease (FOG) poured down kitchen sinks, is important in reducing FOG's from entering the septic system and the LWL watershed. Homeowners and businesses (mostly restaurants), are encouraged to recycle, apply kitchen best management practices, and properly dispose of cooking oil and grease trap waste in the County.

STRATEGY:

STEP 1 Focus on outreach to organized communities, neighborhood associations, and individual homeowners adjacent Lake Worth Lagoon.

Responsible parties: FY&N, Palm Beach County UF/ IFAS Education Extension, Local governments, PBCERM

STEP 2 Promote Florida Yard and Neighborhood at local municipalities' government centers, retail outlets, and public events.

Responsible parties: FY&N, Palm Beach County UF/ IFAS Education Extension, Local governments, PBCERM

STEP 3 Increase marketing through mass-media, public announcements, internet, etc.

Responsible parties: FY&N, Palm Beach County UF/ IFAS Education Extension, Local governments, PBCERM

STEP 4 Encourage FY&N and pollution prevention education outreach to businesses, including builders, developers, and irrigation and landscaping specialists.

Responsible parties: FY&N, Palm Beach County UF/ IFAS Education Extension, Local governments, PBCERM

STEP 5 Encourage and educate homeowners and restaurants about recycling and proper disposal of fat, oil, or grease (FOG) poured down kitchen sinks.

Responsible parties: FY&N, Palm Beach County UF/ IFAS Education Extension, Local governments, PBCERM

SCHEDULE:

FY&N programs are ongoing but additional outreach should be focus on properties adjacent to the Lake Worth Lagoon and businesses. Increase efforts in 2008.

COST:

Annual costs for staff and educational material are estimated at approximately \$100,000 per year.

EXPECTED BENEFITS:

- Aesthetic landscapes increase the value of houses and properties
- Reduction of the water bill up to 40% after plants are established
- Plant diversity increase interest and reduces the spread of insects and disease
- Decreases the level of weekly maintenance in yards
- Reduction in stormwater runoff to protect the fish and birds dependant on Lake Worth Lagoon
- Decreases [non point source pollution](#) going into the water bodies
- Creates habitat for [birds](#) and [butterflies](#)
- Protects our natural resources

MONITORING ENVIRONMENTAL RESPONSES:

Survey FY&N participants to assess landscape management changes as a result of the program. Public interest in the FY&N also can be gauged by tracking distribution of materials, number of professionals certified in FY&N concepts, and number of certified Florida Yards.

REGULATORY NEEDS:

None anticipated.

FUNDING:

Funding will be sought by potential partners.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBC IFAS / UF Education Extension, FDEP, PBCERM, Local governments,

SFWMD, SWWMD, Mounts Botanical Gardens, Bush Wildlife Sanctuary

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

ACTION PLAN *Public Use and Outreach*

PO-4

Provide Passive Public Use of and Access to Lake Worth Lagoon

ACTION:

Identify and construct areas around the Lake Worth Lagoon (LWL) for public access features dedicated to non-motorized vessels such as kayaks and canoes, and features promoting birding, fishing, etc.

BACKGROUND:

The *Lake Worth Lagoon Management Plan*, adopted in August 1998, identified five public use features that would allow residents and visitors access to LWL. Three of the five projects identified in the plan have been constructed: the boat dock and fishing pier at Peanut Island, the recreational boating “island” near South Lake Worth Inlet, and the boat access improvements with additional parking at Boynton Boat Club Park. The remaining two features, the boat dock at Munyon Island, and the boat ramp and parking at Light Harbor Marina Park, are in process of being completed. As a result of public comments received in response to the management plan update, initiated in September 2006 and presented to the public in June 2007, this action plan has been added to specifically address the addition of public use features to provide passive recreational opportunities for non-motorized vessels, fishing, birding, etc. These public access features will also include informational kiosks to educate the public about the LWL watershed and the restoration and enhancement effort underway. To the greatest extent possible, features should be constructed in close proximity to habitat restoration and enhancement projects. These access areas could be eventually tied to the Ocean to Lake Trail and future greenways.

STRATEGY:

STEP 1: Identify potential areas for public use and access. Parking areas, kayak/canoe launching facilities, and informational kiosks with brochure boxes may be included as components of these public access features.

Responsible parties: LWL Outreach Advisory Committee, Municipalities, Tourist Development Council (TDC), FIND, FWC

STEP 2: Develop, permit and construct three public access features in the next five years.

Responsible parties: PBCERM, PBC Parks & Recreation, Municipalities, TDC, FIND

SCHEDULE:

Step 1 will be implemented during 2008. Step 2 will be initiated upon completion of Step 1.

COST:

Siting and construction of public access facilities is contingent upon the type of facilities selected at each location.

EXPECTED BENEFIT:

Residents and visitors will have several exclusive areas dedicated to passive recreation and non-motorized vessel access to LWL. Increased paddling opportunities on LWL will give users a greater appreciation of the value of the lagoon, and is likely to built increased public support for improved management and restoration. Kiosks will provide educational information about the lagoon’s watershed and updates of on-going restoration efforts.

MONITORING/MAINTENANCE:

Weekly inspections will be needed by municipal staff to address trash removal, landscaping needs, brochures, etc. This task may potentially be accomplished by volunteers or LWL stewards.

REGULATORY:

Permits will be required by FDEP, USACE, and associated Municipalities.

FUNDING:

Funding will be sought by PBC.

POTENTIAL PARTNERS AND FUNDING SOURCES:

PBCERM, PBC Parks & Recreation, SFWMD, FDEP, FWC, Municipalities

*Listed Agencies have not committed funds and are subject to Agencies’ budget approvals

7. INTERAGENCY PLANNING AND COORDINATION

PARTICIPATING AGENCIES AND THEIR ROLE

When the 1998 LWLMP was completed, key policy leaders representing state, local and federal government, members of the scientific community, businesses and other stakeholders actively participated in the development of the plan. Some of the most successful restoration and partnership projects, illustrating some of the opportunities that different agencies have utilized to provide significant improvements to the LWL over the years, are discussed in greater detail in **Appendix B**.

PALM BEACH COUNTY

On May 16, 2007, more than 250 environmental professionals, educators, residents, industry and community leaders converged at Palm Beach Atlantic University for the 2nd Lake Worth Lagoon Symposium. Researchers, managers, and local government officials shared updates on the state of the lagoon, conservation and habitat enhancement efforts, and economic aspects of the lagoon. Participants received the latest research on seagrasses, sea turtles, manatees, oysters, and water quality. Speakers provided presentations on the Snook Islands Natural Area, the C-51 Canal Innovative Muck Dredging Project, West Palm Beach Stormwater Improvements Initiative, and the North Palm Beach County Comprehensive Everglades Restoration Plan. Marine industry representatives shared information on waterway access, recreational fishing, and port activities. For more information on the *Lake Worth Lagoon Symposium* and to view program presentations, visit <http://www.pbcgov.com/erm/lwlsymposium>.

It is PBC both a goal and a necessity that the revised management plan and its programmatic activities coordinate with other agency and local government plans or programs. The Coastal Element of the PBC Comprehensive Plan directs the County's Planning, Zoning and Building Department, ERM and the Department of Emergency Management for guiding implementation of the goals and objectives of this element. Protection of wildlife and natural habitat is one of the key components of the Coastal and Conservation Elements. ERM has developed an environmental enhancement program designed to restore estuarine shorelines, improve their productivity and offset the negative effects of development. PBC Engineering and PBC Planning, Zoning and Building are responsible for implementing the Stormwater Sub-Element of the Utilities Element of the Comprehensive Plan which include goals to improve stormwater quality.

PBC also monitors estuarine water quality through its own programs at a network of sites around the lagoon and the County. Continued implementation and expansion of these programs provide valuable information that help identify point and non-point sources of pollution, and guide the coordination with other agencies and municipalities to ensure compliance with National Pollution Discharge Elimination System (NPDES) regulations, particularly with the SFWMD regarding its role in complying with Florida Water Policy

(Chapter 62-40, F.A.C.) and State water quality regulations (Chapter 62-302, F.A.C.). Coordination with other agency programs will achieve mutual restoration goals, and the cost-sharing of expenses associated with restoration monitoring, applied research, and management. Those plans and programs that are described below are currently in the forefront of LWL management.

Through funding provided by FDEP and SFWMD, PBC has been responsible for implementing the LWL Partnership Grant Program, the primary funding mechanism for LWL restoration, and it has been actively investigating other funding sources to achieve the goals of the Management Plan. PBC has taken the lead in coordinating regular planning meetings with other agencies, is integrally involved with CERP planning and is active in improving public outreach and education.

South Lake Worth Inlet Management Plan

The South Lake Worth Inlet, also known as the Boynton Inlet, separates the Town of Manalapan located on Palm Beach Island to the north from the Town of Ocean Ridge to the south. This inlet is the southern most and smaller of the two inlets connecting LWL with the Atlantic Ocean. Following the settlement agreement in 1996 between the Town of Manalapan, the Town of Ocean Ridge, PBC and FDEP, a study report (*South Lake Worth Inlet Management Plan, September 1998*) prepared by Coastal Planning and Engineering, Inc. was completed. The purpose of this report was to evaluate the erosive impact of the inlet on adjacent beaches, and to recommend corrective measures to mitigate identified impacts. Navigation improvements and other issues were also included in the study in accordance with the settlement agreement to resolve judicial and administrative proceedings between the parties. The inlet management plan has been approved by the State and PBC is responsible for managing the inlet. The goals of the *Lake Worth Lagoon Management Plan* need to be coordinated with the *South Lake Worth Inlet Management Plan*.

Agricultural Best Management Practices (BMPs)

Nonpoint source pollution from agricultural areas can be addressed through the development of Best Management Practices (BMPs) as authorized under the Florida Watershed Restoration Act. BMPs are designed to provide industry guidance for various agricultural activities to promote water quality and conservation objectives. There are currently a number of published BMPs that are applicable to agricultural practices within PBC. The state BMP rule is administered by the Florida Department of Agriculture and Consumer Services (FDACS).

Farmers and growers in PBC that voluntarily implement BMPs receive a “presumption of compliance” relating to stormwater runoff from FDEP and SFWMD. Throughout Florida, several innovative cost-share programs exist for nurseries and agricultural operations utilizing effective BMPs. In addition, the SFWMD and FDACS have

partnered with local organizations to create BMP cost-share programs in surrounding areas.

Palm Beach Soil & Water Conservation District (PBSWCD) entered into an agreement with PBC to manage parcels owned by the county in the Ag Reserve. The properties are leased for agricultural production and PBSWCD works with the lessees to customize a three-year BMP plan based on the crop(s) grown. The plan will provide ongoing assurance that acceptable agricultural practices are conducted in the form of verified implementation of BMPs. In addition, PBSWCD develops maps indicating locations of all field and water control structures as well as provides soil maps and interpretation. BSWCD is currently cooperating with the SFWMD to manage properties as part of the Everglades restoration effort.

Implementation of the various programs identified above should improve the quality of water in PBC. The County will continue to work cooperatively with the agencies and community groups to assist with implementation of these programs and will also continue to coordinate with the State of Florida and EPA to comply with Section 303(d) of the Clean Water Act. The continuation or expansion of its program will identify waterways that may likely become “impaired” if restorative projects are not undertaken, and continue efforts to improve these water bodies.

SOUTH FLORIDA WATER MANAGEMENT DISTRICT

The SFWMD is primarily responsible for controlling storm water runoff on a regional basis with independent drainage districts managing runoff on a sub-regional basis. This agency manages and protects regional water resources by balancing and improving water quality, flood control, natural systems and water supply. To restore and preserve the Florida Everglades, enhance water supplies, and maintain flood protection, the USACE in partnership with the SFWMD and numerous other federal, state, local and tribal partners, has developed a plan to restore the Everglades. CERP provides a framework and guide to restore, protect and preserve the water resources of central and southern Florida, including the Everglades (www.sfwmd.gov). The SFWMD has been an important partner. The agency has provided funding for salinity modeling, water quality monitoring, sediment transport studies, C-51 sediment trap construction, habitat restoration, and public outreach.

CERP In Relation To Lake Worth Lagoon

CERP is a multibillion dollar Federal and State program to restore the South Florida ecosystem, while providing flood control and enhancing water supplies. The project area covers sixteen counties, over an 18,000 square mile area, and updates the USACE Central and Southern Florida (“C&SF”) Project. The Water Resources Development Acts in 1992 and 1996 provided the USACE with the authority to re-evaluate the performance and impacts of the C&SF Project and to recommend improvements and/or modifications to the project, in order to restore the South Florida ecosystem and to provide for other water

resource needs. Implementation of CERP will be completed over a 35-year period. The plan will provide surface water storage reservoirs, water storage areas, aquifer storage and recovery wells, water quality treatment areas, removal of more than 500 miles of canals and levees that are barriers to natural sheet flow, new infrastructure to move water to meet restoration goals, wastewater reuse facilities, and project operational changes. The North Palm Beach (NPBC) component of CERP includes elements that will improve water quality in the LWL and the Loxahatchee River. Several major projects are collectively designed to improve regional hydrology and water quality, and provide for increased water storage within the L-8, C-51, and C-17 basins. These projects should improve conditions in the County's coastal waters by regulating and reducing freshwater discharges. By reducing freshwater inputs, nutrients, suspended solids, and other pollutant loadings to the estuary, these programs will improve both water clarity and quality and lead to a healthier ecosystem.

The NPBC – Part 1 Project includes conceptual components in all or portions of the following basins:

- C-51 East and West Basins.
- C-18 Basin.
- L-8 Basin.
- C-17 Basin.
- City of West Palm Beach Grassy Waters Preserve.
- South Indian River Water Control District (SIRWCD).
- Intracoastal Basin.

With the increase in water deliveries to the Grassy Waters Preserve and Loxahatchee Slough, and by capturing and storing ecologically harmful excess fresh water flows, current detrimental discharges to the LWL estuarine system should be significantly reduced. More information about the NPBC CERP Project can be found at www.evergladesplan.org.

Everglades Construction Project (ECP)

The ECP is an integral part of CERP and is a massive restoration project consisting of the construction of 12 interrelated stormwater treatment areas (STA) between Lake Okeechobee and the Everglades. The STAs are constructed wetlands that use biological processes to reduce the level of nutrients, and improve the volume and timing of water entering the Everglades. As a part of the ECP, water will be diverted from the C-51 canal, thus reducing harmful freshwater flows into the LWL by approximately 40 percent. SFWMD is the primary agency for design, construction, operation and maintenance of the ECP. Four of the STAs are in Western Palm Beach County (STA-1E, STA-1W, STA-2, and STA-3/4) and will provide an effective treatment area of 34,685 acres, treating runoff from the Everglades Agricultural Area and urban runoff in the western C-51 Basin. All four of the Palm Beach County STAs are fully operational, however, full diversion into these systems is not currently taking place. With the closing of the

structure S-155A, which is designed to split the C-51 basin, STA-1E will reduce the volume of water discharged to the LWL and provide water quality treatment for urban areas of the western C-51 Basin.

The primary objectives of the ECP are:

1. to reduce the phosphorus levels in water entering the northern Everglades ecosystem to a target of 10 parts per billion, and
2. to improve the volume, timing and distribution of water entering the Everglades.

Secondary objectives are:

1. to reduce the volume of harmful discharges to sensitive estuarine systems, including the Caloosahatchee estuary, the St. Lucie estuary and Lake Worth Lagoon,
2. to reduce the volume of poor quality water discharged to Lake Okeechobee from special drainage districts adjacent to the lake,
3. to improve the flood protection in the C-51 West basin located in central Palm Beach County,
4. to restore more desirable water levels in the 25,000-acre Rotenberger Wildlife Management Area, and
5. to provide a source of clean water for the 35,500-acre Holey Land Wildlife Management Area.

The ECP was developed over 10 years through a collaborative process involving extensive public input, state and federal legislation and litigation. The scope and timeframes of the comprehensive ECP were incorporated into the 1994 Everglades Forever Act, which recognized that constructed wetlands are the best available means to achieve the interim water quality goals of Everglades' restoration. More information about the ECP can be found at: www.sfwmd.gov/org/erd/ecp .

FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION

Recognizing the need for the protection and restoration of LWL, PBC and FDEP joined forces to co-sponsor the first Lake Worth Lagoon Ecosystem Management Area Workshop on January 31, 1997. More than 150 people representing state and local government agencies, business and industry, not-for-profit organizations and concerned citizens attended the workshop. A Steering Committee and four sub-committees were formed to guide a consensus-building process which resulted in the approval of the Lake Worth Lagoon Management Plan on August 19, 1998.

That same year, the Florida State legislature appropriated the first \$1 million for the LWLPG to construct projects to benefit the lagoon's habitat and water quality. FDEP and SFWMD manage the grant program at the State level passing the money through to PBCERM (Chapter 8). PBCERM manages the grant at the local level, passing on the

grant money to municipalities and special taxing districts which must provide managing funds for approved projects. FDEP has continued to partner with the County and others for the benefit of LWL by funding the production of public outreach materials including "Understanding Lake Worth Lagoon," "Boating and Angling Guide to Lake Worth Lagoon," an updated Lake Worth Lagoon poster, and stormdrain placards stating "No Dumping - Drains to Lake Worth Lagoon." In addition, FDEP has been a primary partner in Keep Palm Beach County Beautiful's Florida Coastal Cleanup every September focusing on the cleanup of the Audubon Sanctuary Islands in the central part of Lake Worth Lagoon. FDEP was also responsible for producing the first LWL Symposium held on January 29, 2003. FDEP is currently coordinating with PBC, SFWMD, local governments and other stakeholders to assess the lagoon under the state's Impaired Waters Rule (62-303, FAC) and to development Total Maximum Daily Loads (TMDL) for verified water quality impairments. As TMDLs are established, FDEP will continue to coordinate with these entities on the development of Basin Management Action Plans (BMAP) to meet TMDL goals.

Total Maximum Daily Load

While, in general, surface waters in PBC meet many of the applicable water quality standards for their respective classifications, improvements are needed in some areas. In 2002, Florida adopted the Impaired Waters Rule (IWR), Florida Administrative Code 62-303, which provides the methodology to determine impaired waters for which a Total Maximum Daily Load (TMDL) must be established. TMDLs establish the maximum amount of a pollutant that a water body can assimilate without exceeding water quality standards. Pursuant to the IWR, water bodies that do not meet applicable water quality standards are designated as "impaired waters." The FDEP has established requirements necessary to remove a waterbody from impaired status. According to the IWR, when a body of water has been verified impaired by FDEP, it can only be removed from the verified list (delisted) when new pollution control measures have been put into place, and new water quality data indicate that the water is no longer impaired.

Each water body class has many designated uses. Recommendations for delisting include future monitoring to determine if designated uses are attained, and water quality standards are being met. As additional data is gathered and analyzed that documents the effectiveness of recovery and restoration efforts of the LWL proceed, some water bodies and segments will be delisted while others may be added to the list. The southern segment of the LWL has been listed as impaired for copper and the central and southern segment of the LWL, are verified impaired for mercury in fish tissue. Also of note, two tributaries that discharge directly to the LWL (C-51 and C-17) are listed as impaired for dissolved oxygen.

During the next few years, increased data collection and analysis will be done to establish TMDLs for impaired water bodies in PBC, and to establish initial allocations of pollutant loads needed to meet TMDLs. As such, developments of TMDLs are an important step

toward restoring our waters to their designated uses. Implementation of TMDLs refers to any combination of regulatory, non-regulatory, or incentive-based actions that attain the necessary reduction in pollutant loading. Non-regulatory or incentive-based actions may include development and implementation of Best Management Practices (BMPs), pollution prevention activities, and habitat preservation or restoration. Regulatory actions may include issuance or revision of wastewater, stormwater, or environmental resource permits to include permit conditions consistent with the TMDL. These permit conditions may be numeric effluent limitations or, for technology-based programs, requirements to use a combination of structural and non-structural BMPs needed to achieve the necessary pollutant load reduction. (From <http://www.dep.state.fl.us>) .

Currently the southern segment of the LWL is listed as impaired for copper, and three water bodies that discharge to the LWL that are also listed as impaired for dissolved oxygen. (see **Table 6**)

Water Body	Water Segment Name	Parameters of Concern from IWR	Concentration Causing Impairment	Projected Year for TMDL Development	Comments
C-17	PB Stations / D Canals	Dissolved Oxygen	< 5.0 mg/L	2010	Linked to nutrients.
C-51	C-51	Dissolved Oxygen	< 5.0 mg/L	2010	Linked to elevated TN level.
C-51	Lake Clarke	Dissolved Oxygen	< 5.0 mg/L	2010	Linked to nutrients
Intracoastal	ICW Above Pompano	Copper	> 3.7 ug/L	2010	Source Unknown

Table 6. Lake Worth Lagoon Basin IWR FDEP Adopted Verified List

The determination of the impairment for these listed waterbodies may change as additional water quality data becomes available. The implementation date for development of these TMDLs is scheduled for 2010, however in 2009 a reassessment will be conducted which may change the impairment status of these water bodies. PBCERM provides support to the TMDL program as a water quality data provider. The TMDL process will draw additional attention and resources to improve water quality.

The TMDL program efforts in PBC will be closely coordinated with other State and Federal restoration efforts in the area. As part of this data collection, PBCERM and SFWMD have increased the number of stations and monitoring frequency in support of the TMDL development and CERP.

Palm Beach County National Pollutant Discharge Elimination System (NPDES)

The NPDES is a federal program designed to eliminate stormwater pollutant discharges to receiving waters of the United States. The NPDES stormwater regulations require that

the local governments that are issued NPDES stormwater permits reduce to the maximum extent possible the discharge of pollutants both into and from municipal separate storm sewers to "Waters of the U.S." This is accomplished through the implementation of an approved stormwater management plan, which addresses the various aspects of how pollutants reach municipal storm sewers. The Stormwater Management Plan includes the following individual program components: maintenance of stormwater structural control; stormwater treatment projects; roadway maintenance activities; flood control projects; municipal solid waste facilities; pesticide, herbicide and fertilizer application; illicit connections and discharges; high risk industrial facilities; and construction activities. In addition to these individual program components, water quality monitoring is performed. The water quality monitoring is conducted within the receiving water bodies over time to determine the effectiveness of the Stormwater Management Plan. Other important aspects of the NPDES Program include regulatory prohibition of stormwater discharges to the stormwater system and the public education efforts that are part of several individual program components.

In 1997, the first 5-Year permit was issued to Palm Beach County's forty co-permittees. In November 2002, the second term 5-Year Municipal Separate Storm Sewer System (MS4) permit was issued. PBC has a cooperative program now involving thirty-nine co-permittees, the FDEP and the USEPA. Northern Palm Beach County Improvement District (NPBCID) acts as lead permittee for the PBC group. A Steering Committee was formed in 1991 to coordinate and facilitate joint activities within the PBC MS4 NPDES program. Mock•Roos, Inc. acts as staff to the Steering Committee, assisting with the administration of the program. The group maintains the following website for sharing information: <http://www.pbco-npdes.org>.

FLORIDA INLAND NAVIGATION DISTRICT (FIND)

Long Range Dredged Material Management Plan for the Intracoastal Waterway in Palm Beach County

The FIND is a Special State Taxing District and the "local sponsor" for the continued management and maintenance of the Atlantic Intracoastal Waterway Project in Florida, and is responsible for providing dredge material sites pursuant to 9J-5.006(1)(f)3. According to the 1989 Long Range Dredged Material Management Plan, FIND is required to provide land for the management of maintenance material periodically dredged from the waterway channel. ERM coordinates with FIND to manage some of the sites for environmental enhancement purposes, and to identify suitable beach deposit sites (for beach compatible dredge spoil) to augment the County's shoreline protection efforts. The plan is aimed to enhance the water quality of the lagoon by removal of these sediments, and to prevent their further re-suspension by properly disposing of the materials in approved areas for beneficial re-use.

Waterway Assistance Program and Cooperative Assistance Program

FIND's **Waterway Assistance Program (WAP)** is a grant program established by the Florida Legislature and the District for the purpose of financially cooperating with local governments to alleviate problems associated with the Atlantic Intracoastal Waterway and associated waterways within the District. The program is authorized by Section 374.976, Florida Statutes, and is administered under the provisions of Chapter 66B-2, Florida Administrative Code.

Waterway related projects must be located on natural, navigable waterways within the District. Eligible waterway related projects include navigation channel dredging, channel markers, navigation signs or buoys, boat ramps, docking facilities, fishing & viewing piers, waterfront boardwalks, inlet management, environmental education, law enforcement equipment, boating safety programs, beach re-nourishment, dredge material management, environmental mitigation, and shoreline stabilization.

Eligible local governmental agencies include municipalities, counties, port authorities and special taxing districts within the twelve counties of the District. FIND has funded and provided lands for many restoration projects in the Lake Worth Lagoon through the WAP program including Peanut Island, Munyon Island, and Snook Islands Natural Area. FIND has also provided WAP grants for construction of boat ramps to provide boater access to the LWL.

FIND's **Cooperative Assistance Program** is a grant program established by the Florida Legislature and the District for the purpose of financially cooperating with state and regional governments to alleviate problems associated with the Atlantic Intracoastal Waterway and associated waterways within the District. The program is authorized by Section 374.976, Florida Statutes, and is administered under the provisions of Chapter 66B-1, Florida Administrative Code. Eligible state and regional governmental agencies seeking to develop waterway improvement projects within the twelve counties of the District (Miami-Dade to Nassau Counties) can apply for funding assistance.

UNITED STATES ARMY CORPS OF ENGINEERS (USACE)

The Jacksonville District heads one of the most aggressive environmental restoration programs in the world. Several projects are currently in progress, including those involving the Upper St. Johns River, the Kissimmee River and the Florida Everglades. The Jacksonville District is a key player for many other initiatives in the Central and Southern Florida project areas and is represented on both the Federal Interagency Task Force for South Florida Ecosystem Restoration and the Governor's Commission on a Sustainable South Florida.

USACE is committed to restore and preserve the Florida Everglades, enhance water supplies, and maintain flood protection. The USACE, in partnership with the South Florida Water Management District and numerous other federal, state, local and tribal

partners, has developed a plan to restore the Everglades through CERP.

USACE has the authority, provided by Section 1135 and Section 206 of the Water Resources Development Act of 1986, as amended, to plan, design and construct fish and wildlife habitat restoration measures. The Corps has partnered with PBC to construct many restoration projects within the LWL through the Section 1135 program including Munyon Island, Peanut Island, Snook Islands and John's Island Restoration Projects.

Palm Beach Harbor Lake Worth Access Channel Expansion

The USACE, Jacksonville District has prepared a Draft Environmental Impact Statement (DEIS) for the Palm Beach Harbor Lake Worth Access Channel Expansion, Section 107 Small Navigation Project. The study is a cooperative effort between the USACE and FIND, with the support of the Port of Palm Beach Harbor (PBH).

The purpose of the study is to consider modifying the Federal navigation project of PBH to provide navigation access for larger and deeper-draft vessels to interior berthing, testing, and repair facilities located adjacent to PBH in Lake Worth. Existing depths in the proposed Lake Worth main access channel area are presently limited to the 10-foot deep Federal ICW channel that runs north and south from the Port. The need for this deepening project comes from the recent growth in larger/deeper-draft vessels requiring deeper water depths to safely navigate the interior area.

The study involves an analysis of a deepened access channel from the existing ten-foot depth, in one-foot increments to a 16-foot depth. Each alternative depth considered includes a one-foot required and one-foot allowable over-depth. All alternative depth main access channels have a bottom width of 125 feet for about 0.7 miles north and 4.5 miles south of the PBH project limit. Adding an appropriate depth access channel would enable larger vessels access to commercial repair and berthing facilities in the vicinity of PBH and improve operational efficiencies at other commercial and educational training facilities along Lake Worth.

Issues: The DEIS will consider impacts on seagrasses, protected species, health and safety, water quality, aesthetics and recreation, fish and wildlife resources, cultural resources, energy conservation, socio-economic resources, and other impacts identified through scoping, public involvement, and interagency coordination.

Coordination: The proposed action is being coordinated with the USFWS and the National Marine Fisheries Service under Section 7 of the Endangered Species Act, with the USFWS under the Fish and Wildlife Coordination Act, and with the State Historic Preservation Officer.

Lake Worth Inlet Management Plan

The Lake Worth Inlet, also known as the Palm Beach Inlet, is a man-made inlet that separates Palm Beach shores to the north from the Town of Palm Beach to the south. The inlet is the northernmost and larger of two inlets connecting LWL with the Atlantic Ocean. The original inlet creation, subsequent expansion and deepening, and the federal role in the Lake Worth Inlet have been a result of local navigation interests and the Port of Palm Beach District. Federal participation in the maintenance of the inlet channel and jetty structures began in 1934 and continues today. The USACE assumed responsibility for maintenance of the inlet under authorization of the River and Harbor Act of 1935. In 1993, the Town of Palm Beach agreed to undertake preparation of the Lake Worth Inlet Management Plan in cooperation with the State of Florida. The *Lake Worth Inlet Management Plan (Applied Technology and Management, Inc., 1995)* has been adopted (1997) by the State in accordance with the Beaches and Shore Preservation Act (Chapter 161, F.S.). Inlet management issues are addressed through a tri-party cooperative agreement between Palm Beach County, the Town of Palm Beach and the Port of Palm Beach. The goals of the *Lake Worth Lagoon Management Plan* need to be coordinated with the *Lake Worth Inlet Management Plan* through the intergovernmental coordination process.

ADDITIONAL INTEGRATED PROGRAMS

Surface Water Improvement and Management Plan (SWIM)

Adopted by the Florida legislature in 1987, the Surface Water Improvement and Management Plan (SWIM) Act required that plans be prepared by the SFWMD to address the following concerns:

- Point and non-point source pollution;
- Destruction of natural systems;
- Correction and prevention of surface water problems; and
- Research for better management of surface waters.

A number of SWIM management plans have subsequently been developed throughout the State (PBCERM 2006). The LWL is a SWIM prioritized water body of regional/or Statewide significance, along with other estuaries and waterbodies such as IRL and Biscayne Bay.

Municipal Government Comprehensive Plans

The submerged area and shoreline of the LWL is divided among the geographical jurisdictions of various governmental units. Most of the comprehensive plans developed by municipalities surrounding the estuary were supportive of the restoration efforts, and consistent with the County's Comprehensive Plan. The LWL Partnership Grant Program, discussed in greater detail in the following chapter, is a great example of local

municipalities actively participating in the LWL restoration. A number of waterfront redevelopment projects currently proposed around the lagoon included direct or indirect benefits and improvements to the estuarine system.

The extreme north section, including Little Lake Worth, is in unincorporated Palm Beach County. The Port of Palm Beach District has jurisdiction over the northern inlet area. The following thirteen municipalities also include portions of the Lake Worth Lagoon: *North Palm Beach, Lake Park, Riviera Beach, South Palm Beach, Palm Beach Shores, Hypoluxo, West Palm Beach, Manalapan, Palm Beach, Boynton Beach, Lake Worth, Ocean Ridge, Lantana.*

Port of Palm Beach

The Port of Palm Beach (PPB) has recently developed a new Master Plan (PPB 2006) with new goals, objectives and policies indented to further overall objectives of the 1998 LWLMP, and help maintain the environmental quality of the area. Future harbor improvements at the Port will occur within a managed environmental context. The harbor expansion and channel improvement could have a significant impact on natural resources if dredging and/or blasting is proposed. Resource impacts requiring mitigation could include loss of seagrasses, hardbottom and benthic habitat, temporary water quality degradation due to construction activities, and fisheries habitat impact (PPB 2006). The Port and its partners, in considering impacts due to expansion, have an opportunity to actively participate in the lagoon's restoration efforts. The Port has already demonstrated a significant commitment through its lease of the Peanut Island shoreline to PBC for restoration and recreational purposes, and by providing some of the funding for this project.

Existing operations and future expansion must also consider the manatee, which congregates in areas adjacent to the Port due to warm water outfalls from the Riviera Beach power plant. Manatees also feed and rest in the submerged seagrass beds in this area. According to the Port's MP, the expansion to the south onto property now owned by FP&L will require extensive study and coordination on the impacts to the existing warm water discharge which attracts Manatees to the area. It is possible that the outfall will need to be relocated or removed; however, such an activity can only occur as the result of study, extensive coordination with agencies and affected parties, and the development of a consensus-based solution (PPB 2006).

Drainage Districts

In PBC, permitting and operational jurisdiction of the classified surface waters of the State, including canals and/or natural water courses, is held by the SFWMD and various drainage districts authorized by Chapter 298, F.S. PBC will ensure that a Drainage Plan for the unincorporated area of the County is adopted. The Drainage Plan and the Future Land Use Plan will be coordinated so that development is consistent with drainage

facility capacity and the adopted level of service standards. This development will be accomplished through a cooperative effort between the County, the local drainage districts and the SFWMD.

Three primary drainage basins located in eastern Palm Beach County drain into the LWL. The three drainage basins are: the C-17/Earman River in the northern portion; the C-51/West Palm Beach Canal in the central portion; and the C-16/Boynton Beach Canal in the southern portion of the Lagoon. Inflows to C-17 are by various canals under the management of Northern Palm Beach County Improvement District and local municipalities. Inflows to C-16 basin are by various LWDD canals. Inflows to the C-51 are by:

- Lake Worth Drainage District (LWDD)
- Acme Improvement District
- Indian Trail Improvement District
- Loxahatchee Groves Water Control District
- Pine Tree Water Control District
- Seminole Water Control District

8. FUNDING

Palm Beach County continues to pursue at least two separate avenues to secure funding or in-kind support to finance restoration projects in the LWL: the LWLPG program and existing local matching funding. The updated financing strategy includes a balance of pursuing dedicated and variable funding sources at federal, state, and local levels as well as potential private and non-profit sources. The major objectives of the financing strategy are:

- Aggressively pursue state and federal partnerships for lagoon improvement, including efforts to secure funding in State agencies' budget;
- Maintain existing levels of expenditures for cost-effective projects contributing to the lagoon restoration goals;
- Evaluate programs and investigate opportunities to redirect resources to accomplish more with public dollars;
- Promote public-private partnerships with the potential for bottom-line benefits for the LWL and businesses, Trusts, environmental organizations and others;
- Evaluate the feasibility of a local option sales tax, when deemed essential for the implementation of action plans.

LAKE WORTH LAGOON PARTNERSHIP GRANT PROGRAM

The primary source of funding for the LWLMP has been the Partnership Grant Program and matching grants. Since 1998, the Florida Legislature has supported the restoration and enhancement of the LWL by appropriating a total of \$13,885,000 for the LWLPG. The SFWMD has supported restoration through \$1.1 million in funding. This pass-through grant program from FDEP and SFWMD is provided to PBC and local sponsors to fund construction projects to benefit water quality and habitat in the lagoon. A total of 37 construction projects have been funded to date. Local sponsors provide at least 50% of the total project cost in order to receive funding. They have contributed \$33,770,154 in match to date. The grant has also funded baseline monitoring projects including bathymetry, seagrass & shoreline mapping, muck mapping, sediment transport, pollutant loading reduction study and dredge hole study. The projects include:

- 22 Water Quality Projects Treating 1,700+ Acres of Runoff
- 12 Habitat Enhancement Projects: 125+ Acres
- 5 Septic to Sanitary Sewer Projects; 1 Marina Pump-out Station
- 9 Monitoring Projects

Financial Summary:

Total cost of projects implemented: \$47.1 Million

Total matching funds from local sponsors: \$33.7 Million

Total grant funds dispersed: \$14.8 Million

Twenty-two stormwater treatment projects have been implemented within the LWL watershed treating more than 1,700 acres of runoff that previously discharged directly to Lake Worth Lagoon. The use of pollution control devices, stormwater ponds, wetland treatment, and treatment swales has significantly reduced the amount of nutrients, sediments, and heavy metals entering LWL. Six projects were analyzed to estimate the decrease in pollutant loadings to this waterbody:

- City of Boynton Beach Regional Stormwater Facility
- Port of Palm Beach Master Stormwater Plan/Trench Grate Project
- West Palm Beach Renaissance Project
- West Palm Beach 54th Street, Cordova, Arkona Pollution Control Devices
- Town of Palm Beach D-12 Pump Station
- Town of Hypoluxo Sewer System Upgrades

Eleven habitat enhancement and creation projects have been implemented with the LWLPG. Some of these projects, already discussed briefly in the first Chapter, include:

- Snook Islands
- Peanut Island
- John's Island
- Ocean Ridge Restoration
- Artificial Reef Habitat
- Mangrove Planters

Artificial reefs were designed, deployed and monitored at seven locations within LWL to meet the needs of various life forms throughout the lagoon ecosystem. These habitats provide shelter, feeding and spawning habitats for juvenile and mature estuarine organisms to utilize. These structures will also form a substrate for many water purifying encrusting invertebrates, therefore, improving water quality of the lagoon artificial reefs deployed to seven sites within Lake Worth Lagoon. In addition, 2,000 linear feet of red mangroves and a prototype planter with 32 linear feet of mangroves were planted at the Palm Beach Golf Course and Lantana Cove respectively.

Septic loading

Although septic loading continues in LWL, six projects have been implemented to reduce septic loading in this estuary:

- The Town of Hypoluxo's Comprehensive Plan calls for removal of all septic tanks throughout the Town. The project removed all septic tanks east of U.S. 1 in Hypoluxo in which 99 single-family homes were connected to the municipal sewer line. Over sixty of these homes are directly on the Lake Worth Lagoon or a

canal leading to it. Some of these homes had septic tanks within 10 feet of the water. These septic tanks were contributing more than 600 lbs of Phosphorus and 1,700 lbs of nitrogen per year to Lake Worth Lagoon. The last 28 homes in Hypoluxo using septic systems will be connected to sanitary sewer in 2008.

- The Westgate/Belvedere CRA Infrastructure Improvements Project (Phases II – IV) has benefited the Lake Worth Lagoon and continues to do so with improvements to the C-51 basin. Improvements to the approximately 150-acre basin include replacement of the existing septic sewer system with a sanitary sewer system and construction of water retention areas. Approximately 500 homes are being converted to sanitary sewer. The estimated annual reduction of Phosphorus and nitrogen reaching Lake Worth Lagoon is 3,000 lbs and 8,500 lbs, respectively.
- The grant program has also funded the pump out facility for the Town of Lake Park Municipal Marina. This was accomplished by installing pumps, constructing pumpout lines and connecting the system to the existing municipal sanitary sewer system. This project benefits the Lake Worth Lagoon by reducing the occurrence of overboard discharges from vessel holding tanks.

The grant program also funded very important studies already discussed in previous chapters:

- LWL Sediment Mapping and Evaluation
- LWL Bathymetry
- LWL Dredge Hole Assessment
- Sediment Transport Study
- Seagrass Mapping
- Fixed Transect Seagrass Surveys

Overall, the studies performed in LWL tell us the estuary appears to be potentially impaired. Without a continued emphasis on improving water quality throughout the watershed and creating more habitat, population pressure will continue have a negative effect on the lagoon.

The LWLPG has been a critical component of many restoration projects and partnerships, yet more funding will be necessary if many of the proposed restoration and monitoring projects are going to be implemented. One of the limitations of the LWLPG is that this program is not a dedicated funding source, and is dependent upon legislative approval each year. Lack of funding in FY 2003 and FY2004 had a serious effect on the program in terms of a loss of momentum. A dedicated funding source is needed to effectively manage restoration of the lagoon.

Action Plans targeted specifically to increase funding for the Lagoon are outlined below:

SUMMARY OF ACTIONS FOR FUNDING IN LAKE WORTH LAGOON:

- FD-1 Increase Funding and Partnerships for the Lake Worth Lagoon Partnership Grant Program
- FD-2 Increase Funding Available For LWL Management

ACTION PLAN *Funding*

FD-1

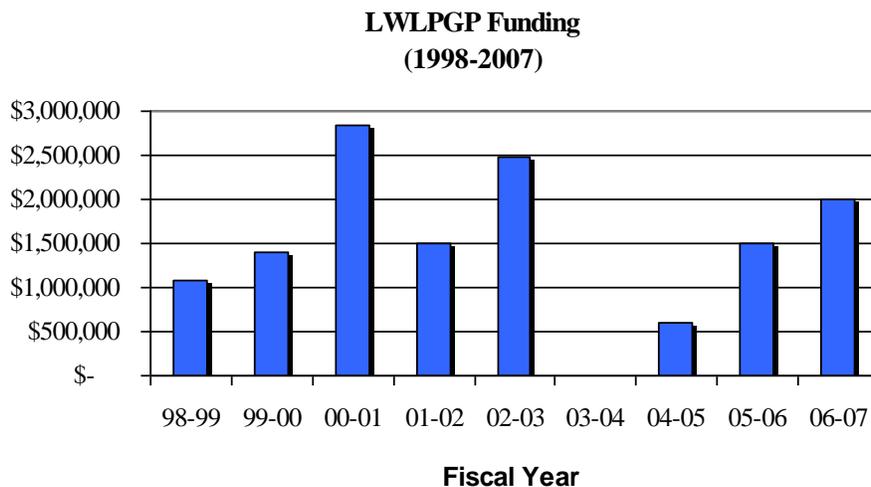
Seek Funding and Partnerships for the Lake Worth Lagoon Partnership Grant Program

ACTION:

Increase and maintain consistent program funding at State level each year for the next five years. Increase the number of municipal partners in the program.

BACKGROUND:

Since 1998, the Florida Legislature has supported the restoration and enhancement of the Lake Worth Lagoon (LWL) by appropriating a total of \$13,885,000 for the Lake Worth Lagoon Partnership Grant Program (LWLPGP). This pass-through grant program, from the Florida Department of Environmental Protection (FDEP) and SFWMD, to Palm Beach County, to local sponsors, funds construction projects to benefit water quality and habitat in the lagoon. The South Florida Water Management District (SFWMD) has supported restoration through \$1.1 million in funding. A total of 37 construction projects have been funded to date. Local sponsors provide at least 50% of the total project cost in order to receive funding. The grant has also funded baseline monitoring projects. Appropriations range from \$1,000,000 to \$3,000,000 and in Fiscal Year 2003-2004 and FY 2004-2005, no funding was appropriated by the legislature, however, the SFWMD did provide \$610,000 in FY 2004-05. Construction costs have risen dramatically in recent years and therefore, restoration costs have not kept pace with inflation



Note: No funding was appropriated by the State in FY 2003-04 and 2004-05

Over the course of the program, 15 agency and municipal partnerships have been

developed which include Boynton Beach, Lake Park, West Palm Beach, Hypoluxo, Lantana, Palm Beach, Ocean Ridge, Westgate/Belvedere Homes CRA, Port of Palm Beach, PBC School District, Florida Department of Environmental Protection, South Florida Water Management District, United States Geological Service, FWC, and NOAA/NMFS. However, of the 15 partnerships, only 7 municipalities are represented. Additional partnerships with municipalities need to be fostered.

One of the limitations of the LWLPG is that this program is not a dedicated funding source, and is dependent upon legislative appropriations each year. A dedicated funding source is needed to more effectively manage restoration of the lagoon.

Based on preliminary estimates, the cost to implement all of the Action Plans is estimated to be over \$37 million over the next five years. Since 1989, the partners have provided over \$47 million for projects that benefit the lagoon. This averages out to \$5.3 million per year in total funding of which \$1.53 million is in grant funding. If this level of funding does not increase, many of the projects outlined in the Action Plans will not be achieved. Since funding is limited, recommended actions will have to be evaluated and will need to focus on cost-effective use of existing resources and a clear return on investment.

STRATEGY:

STEP 1 Encourage local governments, agencies and other lagoon stakeholders, to adopt the LWLMP and to sign an agreement pledging to carry out the recommendations of the final management plan.

Responsible parties: LWL Stakeholders

STEP 2 Develop strategy and marketing effort to increase and maintain State legislative appropriations and obtain federal funding appropriations.

Responsible parties: PBC ERM

STEP 3 Identify alternative funding sources and create database for the potential funding sources. Prioritize and apply for funding.

Responsible parties: PBC ERM, FDEP, and SFWMD

STEP 4 Meet with municipalities to identify opportunities for stormwater treatment and habitat restoration projects. Facilitate municipalities' application for funding.

Responsible parties: PBCERM

SCHEDULE:

The strategy and marketing effort identified in step 1 will be completed by 6/30/08. Step 2 will be completed in two years. Step 3 will be conducted parallel to Steps 1 and 2 and shall be implemented prior to the next legislative session.

COST:

Annual costs for staff, database development, and grant writing are estimated at approximately \$75,000 per year.

EXPECTED BENEFITS:

The increase in funding and number of partnerships will directly translate into a greater number of stormwater treatment and habitat restoration projects in LWL. Water quality improvements as well as an increase in habitat units will be realized which will benefit species utilizing the lagoon including manatees, sea turtles, fish and birds.

MONITORING ENVIRONMENTAL RESPONSES:

Environmental response will be monitored through the existing Water Quality Monitoring Program and existing LWL monitoring program.

REGULATORY NEEDS:

Not applicable.

FUNDING:

A portion of the funding has been available through State appropriations which have been leveraged with local match funding. Additional funding sources need to be identified especially at the federal level.

POTENTIAL PARTNERS AND FUNDING SOURCES*:

PBCERM, SFWMD, FWC, USFWS, NOAA / NMFS, FDEP, FIND, Municipalities

*Listed Agencies have not committed funds and are subject to Agencies' budget approvals

OTHER FUNDING SOURCES

Although all the costs in the management plan have not been fully determined, based on very preliminary estimates, the cost to implement all of the Action Plans is estimated to be in excess of \$37 million over the next five years. Since 1989, local, state, and federal agencies have provided over \$47 million for projects that benefit the lagoon through the LWLPG. Over the nine year period that averages out to \$5.3 million per year in total funding of which \$1.53 million was grant funding. Additional programs that have provided funding through matching grants and appropriations for the construction of restoration, enhancement and stormwater projects benefiting the LWL are outlined below:

Federal - U.S. Army Corps of Engineers-Section 1135 WRDA; National Oceanographic & Atmospheric Administration; U.S. Geological Survey, U.S. Department of Agriculture.

State – Florida Inland Navigation District-Waterways & Cooperative Assistance; Florida Department of Environmental Protection; Florida State Legislative Appropriations; South Florida Water Management District; Florida Fish & Wildlife Conservation Commission.

Local – Palm Beach County-Vessel Registration Fees, Manatee Protection Fund, Recreational Bond Fund, Pollution Recovery Trust Fund, and Municipalities through local matches.

However, if the level of funding does not increase, all of the projects outlined in the Action Plans will not be achieved. Since funding is limited, recommended actions will have to be evaluated and will need to focus on cost-effective use of existing resources and a clear return on investment.

ACTION PLAN *Funding*

FD-2

Increase Funding Available For LWL Management

ACTION:

Increase funding directed toward LWL management through Federal, State and local government grants and partnerships, private-public partnerships with non-governmental organizations (NGOs), grants from privately managed trusts and direct funding from the public.

BACKGROUND:

Based on very preliminary estimates, the cost to implement all the proposed Action Plans will be well over \$37 million. If the level of presently anticipated funding does not increase, many of the projects outlined in the Action Plans will not be implemented. A more aggressive strategy is needed to ensure adequate funding, especially in light of recent budgetary restraints on both local and state levels. Federal, State and local agency funding, as well as public-private partnerships, will be sought. Emphasis should be placed in developing a Lake Worth Lagoon (LWL) Fund where public-and private resources could be combined for restoration projects as outlined in the management plan. Proceeds from local fishing tournaments and fundraising events could be directed toward the LWL Fund, as could funds collected as a result of an agency enforcement action and private donations.

Eco-tourism opportunities specifically linked to the Northeast Everglades Natural Area (NENA) have been proposed. NENA represents an interconnected system of publicly-owned natural areas and trails that stretch from Lake Okeechobee to the Atlantic Ocean. Creating kayaking access trails and fishing opportunities as eco-tourism destinations within the LWL will add recreational prospects that the tourism industry could market and sponsor. Restoration projects that include public use elements that provide educational opportunities and public awareness could also attract additional sources of funding.

Staff commitment and intergovernmental cooperation will be the key for the successful implementation of this Action Plan. Programs targeted for grants and appropriations for projects benefiting the LWL are outlined below:

- Federal - U.S. Army Corps of Engineers (USACE)-Continuing Authority Programs; National Oceanographic & Atmospheric Administration (NOAA); U.S. Geological Survey (USGS), U.S. Department of Agriculture (USDA), U.S. Environmental Protection Agency (USEPA), line-item appropriations.

- State – Florida Inland Navigation District (FIND)-Waterways & Cooperative Assistance; Florida Department of Environmental Protection (FDEP); Florida State Legislative Appropriations; South Florida Water Management District (SFWMD); Florida Fish & Wildlife Conservation Commission (FWC), Florida Department of Transportation.
- Local – Palm Beach County-Vessel Registration Fees, Manatee Protection Fund, Recreational Bond Fund, Pollution Recovery Trust Fund, Municipalities. Community Foundation for Palm Beach and Martin Counties, Tourist Development Council (TDC), individuals and privately managed trusts focused on environmental conservation and restoration.

STRATEGY:

STEP 1 Establish a LWL Fund to pursue public-private partnerships and tax-deductible donations.

Responsible parties: PBCERM

STEP 2 Research grants not exclusive to estuarine systems from federal, state, local agencies and non-profit organizations that potentially could fund restoration and recreational opportunities. Prioritize and apply for funding.

Responsible parties: PBCERM

STEP 3 Develop eco-tourism opportunities in cooperation with the TDC and NENA and seek funding from the tourism industry.

Responsible parties: PBCERM, TDC, OAC, FDEP Parks, municipalities

SCHEDULE:

The strategy identified in step 1 will be completed by 12/30/08. Step 2 is ongoing will be conducted parallel to Steps 1. Step 3 will be implemented in three years.

COST:

Annual costs for staff and grant writing are estimated at approximately \$134,000 per year.

EXPECTED BENEFITS:

The increase in funding and number of partnerships will directly translate into a greater number of stormwater treatment and habitat restoration projects in LWL. Water quality improvements as well as an increase in habitat units will be realized which will benefit species utilizing the lagoon including manatees, sea turtles, fish and birds.

MONITORING ENVIRONMENTAL RESPONSES:

Environmental response will be monitored through the existing Water Quality Monitoring Program and existing LWL monitoring program. Surveys and statistics from the TDC and NENA could account for the increase utilization of the lagoon for recreational purposes.

REGULATORY NEEDS:

Not applicable.

POTENTIAL PARTNERS AND FUNDING SOURCES:

PBCERM, SFWMD, FWC, USFWS NOAA / NMFS, FDEP, FIND, Tourism Development Council, Municipalities, Marine Industries Association

CONCLUSIONS

For the LWLMP implementation by local governments, agencies and other lagoon stakeholders, a formalized commitment is needed. This commitment will improve the effectiveness of the LWLMP and will confirm that partners are willing to work together cooperatively and commit funding and resources to the Plan. This can be achieved by signing an agreement pledging to carry out the recommendations of the final management plan. The agreement will include the specific goals that are consistent with the partner's goals and resources. Costs associated with individual actions plans are presented in their summaries. These costs represent the projected level of funding that the implementing partners should consider in budgeting these tasks, however, they should not be construed as requirements if cost-effective alternatives are available.

GLOSSARY

Algae - Aquatic, non-flowering plants that lack roots and use light energy to convert carbon dioxide and inorganic nutrients, such as nitrogen and phosphorus, into organic matter by photosynthesis. Common algae include dinoflagellates, diatoms, seaweed, and kelp.

Anoxic - A condition in which dissolved oxygen is absent.

Baffle Box - A box attached to a stormwater drain that collects debris and sediments.

Bathymetry - The physical shape of a basin which contains water, with special attention to the contours of depth; bathymetric maps of lakes are analogous to topographic maps of mountains.

Benthic - Relating to the community of animals living in and on the bottom sediments of a body of water.

Best Management Practice (BMP) - A practice or combination of practices that provide the most effective and practicable means of controlling point and nonpoint pollutants at levels compatible with environmental quality goals.

Coastal Zone - Section 380.19, Florida Statutes, defines the coastal zone as “that area of land and water from the territorial sea landward to the most inland extent of maritime influences.”

Community - Populations of plants and/or animals living in a common habitat.

Detritus - Disintegrated plant and animal material that is used for food by some animals and accumulates as sediment in mangroves and salt marshes.

Drainage Basin - The land that surrounds a body of water and contributes freshwater, either from streams, groundwater or surface water runoff, to that body of water.

Dredge-and-Fill - Commonly refers to the removal of bottom sediments (dredging) to construct and maintain canals and ship lanes, and the use of dredged material (spoil) as fill for development.

Ecosystem - A community of living organisms interacting with one another and their physical environment, such as mangroves, salt marshes or estuaries. The Lake Worth Lagoon system is considered a sum of these inter-connected ecosystems.

Effluent - The outflow of water, with or without pollutants, usually from a pipe.

Epiphyte - A plant growing on another plant. It is not parasitic, but uses the host plant for support only.

Epifauna - benthic fauna living on the substrate (as a hard sea floor) or on other

organisms.

Estuary - A semi-enclosed coastal water body which has free connection to the open sea and within which seawater is measurably diluted with freshwater.

Eutrophication - The process of nutrient enrichment in a water body. In marine systems eutrophication results principally from nitrogen and phosphorus inputs from human activities, such as sewage disposal and runoff from uplands. Such input stimulates algal blooms and bacteria growth, which contribute to depletion of oxygen in water, and anoxic conditions, and eventually leads to fish kills.

Exotic Species - Any introduced plant or animal species that is not native to the area and may be considered a nuisance.

Goal - A general statement describing what is to be achieved in the future. Goals reflect a consensual vision for a specific or general resource.

Habitat - The specific place or environment where a particular plant or animal lives. An organism's habitat must provide all the basic requirements for life and should be free of harmful contaminants. Typical habitats of the Lake Worth Lagoon include mangroves, beaches, marshes, oyster reefs, mudflats, seagrass beds, unconsolidated sediments and the water column.

Heavy Metals - Specifically, elements which occur in roadway runoff and domestic or industrial waste which have toxic properties when found in sufficiently high concentrations. Among the most common heavy metal pollutants are lead, iron, zinc, and copper.

Hydrologic - Pertaining to hydrology, the physics of water movement. A "hydrologic model" is a type of computer simulation which takes into account the known behavior of water in the form of mathematical formulas and allows one to mimic the movement of water in a river, lake or estuary.

Intracoastal Waterway (ICW) - A federally constructed and maintained deepwater channel (12 feet) that runs north and south in the Lagoon constructed to create safe passage for water-based commerce. The Atlantic ICW extends from Key West to Maine.

Invertebrates - Animals without backbones, examples include insects, worms, crustaceans, mollusks and sponges.

Lagoon - A shallow body of water which is separated from the sea by a sand bar, barrier beach or coral reef where salt water from the sea and fresh surface water runoff from the land meet and mix.

Loading - The total amount of material entering a system from all sources.

Mangrove - A tropical, aquatic tree which forms dense thickets in tidal regions. Mangroves offer an important habitat and food source for fish, shellfish and crustaceans.

Marsh - A wetland where the dominant plants are grasses and sedges, as opposed to a swamp, where woody plants like shrubs and trees are the dominant vegetation.

Muck - Fine-grained sediments that contain a significant amount of clay and silt and about ten percent organic matter. Its primary source is runoff from upstream deposits. Muck is easily resuspended to increase turbidity in the water column. The resuspension can lead to decline in seagrasses by reducing light penetration of the water column.

Nonpoint Source Pollution (NPS) - Pollution that is generated over a relatively wide area and may be discharge into surface waters through storm drains. Nonpoint source pollution includes stormwater runoff, leaking septic systems and overboard waste discharged from boats and ships.

Nutrients - Any substance required by organisms for normal growth and maintenance. Mineral nutrients usually refer to inorganic substances derived from soil and water. Excessive amounts of nutrients, including nitrogen and phosphorus, may result in excessive growth of algae, leading to oxygen depletion and water quality degradation.

Photosynthesis - The synthesis of chemical compounds with the aid of radiant energy and especially light; formation of carbohydrates in the chlorophyll-containing tissues of plants exposed to light.

Plankton - Algae and microscopic floating, aquatic plants (phytoplankton) and animals (zooplankton).

Point Source Pollution - Pollution that originates at a particular place, such as a sewage treatment plant, effluent outfall pipe or other discharge pipes into a water body. Point source pollution is generally the byproduct of a process such as wastewater treatment, manufacturing, or similar activities.

Resource - A substance or object required by an organism for normal maintenance, growth and reproduction. If the resource is scarce relative to demand, it is referred to as a limited resource. Non-renewable resources (such as space) occur in fixed amounts and can be fully utilized; renewable resources (such as food) are produced at a fixed rate, with which the rate of exploitation attains equilibrium.

Retrofit - To reconstruct an existing system with new capabilities.

Riprap or Riprap Revetment - Large boulders or clean concrete rubble, generally one to three feet in diameter, commonly used to stabilize shorelines or reinforce the face of vertical seawalls.

Runoff - The portion of precipitation that travels over land and ultimately reaches surface streams and other receiving watersheds. Runoff often carries pollutants such as oils, fertilizers and pesticides and is frequently a major component of nonpoint source pollution. See Stormwater.

Salinity - The dissolved inorganic salts in seawater expressed in grams of salt per kilogram of seawater as parts per thousand (ppt) or practical salinity units (psu).

Seagrasses - A flowering plant that lives underwater. Like land plants, seagrasses produce oxygen. The depth at which seagrasses are found is limited by water clarity because they require light to grow. They are important to ecosystems as they help maintain water clarity by trapping sediments, stabilizing the bottom with their root system, and providing a nursery habitat for fish, shellfish and crustaceans.

Septic Tank - A domestic wastewater treatment system commonly used in areas not served by central sewer systems.

Spoil - Sediments removed during dredging. Spoil may be deposited underwater or on islands created specifically for spoil disposal.

Stakeholder - One who has an interest in the restoration, conservation, and management of the Lagoon.

Storm Drain - A system of gutters, pipes and ditches used to carry stormwater from the land to streams, ponds or other surface waters. Storm drains carry a variety of harmful substances including stormwater, chemicals, organics such as lawn clippings, oil and grease, and suspended sediment.

Stormwater - The portion of the precipitation that travels over land and ultimately reaches surface streams, canals and other receiving watersheds. Stormwater often carries pollutants such as oils, fertilizers and pesticides and is frequently a major component of nonpoint source pollution. See Runoff.

Submerged Aquatic Vegetation (SAV) - Rooted vegetation that grows underwater in shallow zones where light penetrates.

Suspended Solids - Organic or inorganic particles that are suspended in and carried by the water. The term includes sand, mud, and clay particles as well as solids in wastewater.

Toxic - Poisonous or directly harmful.

Turbidity - Cloudiness of water from suspended fine solids. As the cloudiness increases, so does the turbidity. Clear water indicates low turbidity and may be associated with good water quality.

Wastewater - Water contaminated with the by-products of domestic, commercial, agricultural or industrial uses.

Wastewater Treatment - Processes that help remove solids, nutrients and other pollutants from water before it is discharged or reused.

Watershed - A region bounded at the periphery by physical barriers that cause water to

part and ultimately drain to a particular body of water.

Water Column - The water, lake, estuary or ocean which extends from the bottom sediments to the surface. Water columns contain dissolved and particulate matter and are habitat for plankton, fish and marine mammals.

Wetland - Land where the water table is usually at or near the surface. Some wetlands contain water year-round; others may remain relatively dry for months, becoming moist only during periods of heavy rain. Wetlands are vital habitats for many species of plants and animals; they are protected by local, state and federal regulations.

Zooplankton - Free-floating aquatic animals ranging in size from microscopic, single-celled organisms to large jellyfish. Zooplankton are an important source of food for many types of fish and animals.

ACRONYMS

ASR	Aquifer Storage and Recovery
BDL	Below Detection Level
BMP	Best Management Practices
C&SF	The Central and Southern Florida Project
CERP	Comprehensive Everglades Restoration Plan
CERP/RECOVER	Comprehensive Everglades Restoration Plan/Restoration Coordination & Verification
COL	Chain of Lakes
CPUE	Catch per Unit Effort
CRA	Community Redevelopment Authority
CWF	Clean Water Fund
DEIS	Draft Environmental Impact Statement
DO	Dissolved Oxygen
DOH	Department of Health
ECP	Everglades Construction Project
EIS	Environmental Impact Statement
EMA	Ecosystem Management Area
F.A.C	Florida Administrative Code
F.S.	Florida Statutes
FDACS	Florida Department of Agriculture and Consumer Services
FDEP	Florida Department of Environmental Protection
FDOT	Florida Department of Transportation
FWC	Florida Fish and Wildlife Conservation Commission
FIM	Fisheries Independent Monitoring
FIND	Florida Inland Navigation District
FP	Fibropapillomatosis
FWRI	Fish and Wildlife Research Institute
FY&N	Florida Yards & Neighborhoods Program
GIS	Geographical Information Systems
ICW	Intracoastal Waterway
IRG	Inwater Research Group, Inc.
IRL	Indian River Lagoon
LEGP	Law Enforcement Grant Program
LWC	Lake Worth Lagoon Central
LWDD	Lake Worth Drainage District
LWL	Lake Worth Lagoon
LWLMP	Lake Worth Lagoon Management Plan
LWLPG	Lake Worth Lagoon Partnership Grant Program
LWN	Lake Worth Lagoon North
LWS	Lake Worth Lagoon South
MDL	Method Detection Limit

MFL	Minimum Flows & Levels
MGD	Million Gallons Per Day
MLW	Mean Low Water
MP	Management Plan
MRC	Marine Resource Council
NGVD	National Geodetic Vertical Datum
NOAA	National Oceanic & Atmospheric Administration
NOAA FACE	National Oceanic & Atmospheric Administration Florida Area Coastal Environment
NOAA NMFS	National Oceanic & Atmospheric Administration National Marine Fisheries Service
NPBC-CERP	North Palm Beach County Comprehensive Everglades Restoration Plan
NPDES	National Pollutant Discharge Elimination System
NSM	Natural Systems Model
OAC	Outreach Advisory Committee
PBC	Palm Beach County
PBCERM	Palm Beach County Environmental Resources Management Department
PBCMPP	Palm Beach County Manatee Protection Plan
PBCSWD	Palm Beach Soil & Water Conservation District
PBH	Port of Palm Beach Harbor
PBSO	Palm Beach Sheriff Office
PEL	Probable Exposure Level
PIR	Project Implementation Report
PPB	Port of Palm Beach
PLRG	Pollutant Load Reduction Goals
PSU	Practical Salinity Unit
RECOVER	Restoration Coordination & Verification
SAV	Submerged Aquatic Vegetation
SFWMD	South Florida Water Management District
SFWQPP	South Florida Water Quality Protection Program
SIRWCD	South Indian River Water Control District
SOW	Scope of Work
SSC	Suspended Sediment Concentrations
STA	Storm-Water Treatment Areas
SWIM	Surface Water Improvement and Management (Act)
SWP	State Warning Point
TAC	Technical Advisory Committee
TEL	Threshold Effects Level
TDC	Tourist Development Council
TIN	Triangulated Irregular Network
TMDL	Total Maximum Daily Load
TSS	Total Suspended Sediments
UF/IFAS	University of Florida / Institute of Food and Agricultural Sciences
ULDC	Unified Land Development Code

USACE	United States Army Corps of Engineers
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VEC	Valued Ecosystem Components
WQ	Water Quality

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APPENDICES

