Indian River Lagoon System

Management Plan

Including Banana River, Indian River – Malabar to Vero Beach, Indian River – Vero Beach to Ft. Pierce, and Jensen Beach to Jupiter Inlet Aquatic Preserves

DRAFT JUNE 2014

Florida Department of Environmental Protection
Florida Coastal Office
3900 Commonwealth Blvd., MS #235, Tallahassee, FL 32399
www.aquaticpreserves.org

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June 2014

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Mission Statement

The Florida Coastal Office's mission statement is: Conserving and restoring Florida's coastal and aquatic resources for the benefit of people and the environment.

The four long-term goals of the Florida Coastal Office's Aquatic Preserve Program are to:

1. protect and enhance the ecological integrity of the aquatic preserves;
2. restore areas to their natural condition;
3. encourage sustainable use and foster active stewardship by engaging local communities in the protection of aquatic preserves; and
4. improve management effectiveness through a process based on sound science, consistent evaluation, and continual reassessment.

Executive Summary

Indian River Lagoon System Management Plan, including Banana River, Indian River – Malabar to Vero Beach, Indian River – Vero Beach to Ft. Pierce, and Jensen to Jupiter Inlet aquatic preserves.	
Lead Agency:	Florida Department of Environmental Protection's (DEP) Florida Coastal Office (FCO)
Common Name of Property:	Banana River, Indian River – Malabar to Vero Beach, Indian River – Vero Beach to Ft. Pierce, and Jensen to Jupiter Inlet Aquatic Preserves
Location:	Brevard, Indian River, St. Lucie, Martin and Palm Beach counties, Florida
Acreage Total:	91,000 Acres
Acreage Breakdown for FCO Management Units According to Florida Natural Areas Inventory (FNAI) Natural Community Types	
FNAI Natural Communities	*Acreage according to GIS*
Seagrass Bed	35,898 acres
Tidal Marsh	60 acres
Tidal Swamp	1,857 acres
Freshwater Tidal Swamp	59 acres
Consolidated Substrate	Unknown
Unconsolidated Substrate	Unknown
Composite Substrate	Unknown
Algal Bed	Unknown
Management Agency:	DEP's FCO
Unique Features:	In addition to its environmental importance, the Indian River Lagoon is attributed to providing over $3.7 billion in benefits to citizens and visitors of counties bordering the lagoon.
Archaeological/ Historical Sites:	The Florida Department of State's Division of Historical Resources Master Site File indicates there are three archaeological and eleven historical sites adjacent to the Indian River Lagoon System. Archaeological sites date from 4,000 to 2,500 BC and include Moccasin Island, Persimmon Trail and Mount Elizabeth. Historical sites include architectural, military, social, transportation, commerce and conservation sites.
Management Needs	
Ecosystem Science:	There is a very large and committed group of research institutions and agencies that conduct extensive monitoring, research, and modelling in the Indian River Lagoon. The aquatic preserve fosters strong working partnerships with these research institutions and agencies, and assists with equipment and staff as needed to support research and monitoring projects. These programs provide the basis for making sound resource management decisions.
Resource Management:	Continue to focus on protecting natural resources by restoring altered areas that contribute to reduced water quality and implementing management practices that maintain or improve viable habitats and populations within the aquatic preserve.
Education & Outreach:	Continue volunteer island enhancement work days, Eagle scout projects, Adopt-A-Spoil Island Program, volunteer shoreline planting and oyster reef deployment events. Improve signage at boat ramps. Continue participation in the Indian River Lagoon Envirothon for middle and high school classrooms and Adopt-A-Mangrove workshops.
Public Use:	Rapid population growth is expected to return to coastal areas of Florida. Information and data contained within this Plan is intended to assist aquatic preserve managers, working closely with other state entities and local governments, to make decisions that will assure a balance between sustainable resource protection and waterway management.
Public Involvement:	Public meetings will be held locally after the first draft of the management plan is developed and released. Public comments will be received at the public meetings as well as a designated period of time after the public meetings.

Coastal Zone Management Issues

The State of Florida has over 17 million residents and over 76 million visitors annually. Florida has the second longest state coastline, and nowhere else in the country are so many people so close to such an extensive and economically valuable coastline. Within these coastal communities, recreational activities such as boating and fishing shape community culture and provide positive economic growth. However, rapid coastal development, increasing public access, and changing land use patterns are complicating regulation and management efforts within valuable aquatic systems. To protect and enhance the unique coastal resources throughout Florida, a variety of issues that affect water quality, quantity, and growth management must be addressed. Challenges facing the Indian River Lagoon System include low water quality that is further degraded by unnatural water management practices, the need for hands-on resource management, rapid conversion of agricultural lands to urban developments deemed to have significant regional impact, little understanding of public use trends, and the impacts of public use on the protected resources.

Goals

The management goals and associated strategies outlined in this document provide an action plan that will be used to address these challenges over the next decade. Because of limited resources and the overlap of jurisdictional boundaries, success will depend on partnerships formed with private, local, regional, state, and federal organizations and agencies. Partnerships will be formed to promote the maintenance or improvement of the quality of water reaching the preserve to meet the needs of the natural resources. Routine assessment of water quality status is required to document change over time. Resource management goals that will improve water quality include hydrologic restoration, muck removal, and creation of oyster reef habitat. Documentation of natural resource location and extent will allow mangers to evaluate the success of large-scale watershed restoration projects. Maintenance of a safe environment for fish, wildlife, and user groups, and the promotion of low-impact recreational opportunities are also important goals that will be addressed by preserve staff.

FCO/Trustees Approval

FCO Approval: **ARC approval date:** **Trustees approval date:**

Comments:

Acronym List

Abreviation	Meaning	Abreviation	Meaning
ACOE	United States Army Corps of Engineers	**IRLO**	Indian River Lagoon Observatory
BLM	Bureau of Land Management	**IRLT**	Indian River Land Trust
BMAP	Basin Management Action Plans	**JID**	Jupiter Inlet District
BMP	Best Management Practices	**LOBO**	Land/Ocean Biogeochemical Observatory
BOD	Biochemical Oxygen Demand	**MSL**	mean sea level
BP	Before Present	**MRC**	Marine Resources Council
C	Celsius	**NASA**	National Aeronautics and Space Administration
CCMP	Comprehensive Conservation Management Plan	**NEP**	National Estuary Program
CDOM	Colored Dissolved Organic Matter	**NERR**	National Estuarine Research Reserve
CELCP	Coastal and Estuarine Land Conservation Program	**NMFS**	National Marine Fisheries Service
CERP	Comprehensive Everglades Restoration Plan	**NOAA**	National Oceanic and Atmospheric Administration
Chla	Chlorophyll a	**NRHP**	National Register of Historic Places
CSFFCP	Central and South Florida Flood Control Project	**NWR**	National Wildlife Refuge
CSO	Citizen Support Organization	**OFW**	Outstanding Florida Water
CWA	Critical Wildlife Area	**ORCA**	Ocean Research and Conservation Association
DEP	Florida Department of Environmental Protection	**ORP**	Oxidation Reduction Potential
DO	Dissolved Oxygen	**PAR**	Photosynthetically Active Radiation
EPA	United States Environmental Protection Agency	**ppt**	parts per thousand
ESA	Endangered Species Act	**PVC**	Polyvinyl-chloride
F	Fahrenheit	**RIFA**	red imported fire ants
F.A.C.	Florida Administrative Code	**SAV**	Submerged Aquatic Vegetation
F.A.R.	Florida Administrative Register	**SEAS**	Shellfish Environmental Assessment Section
F.S.	Florida Statutes	**SFWMD**	South Florida Water Management District
FCO	Florida Coastal Office	**SIP**	Spoil Island Project
FCREPA	Florida Committee on Rare and Endangered Plants and Animals	**SJRWMD**	St. Johns River Water Management District
FDACS	Florida Department of Agriculture and Consumer Services	**SMRI**	Smithsonian Marine Research Institute
FIM	Fisheries-Independent Monitoring	**SRP**	Shoreline Restoration Project
FNAI	Florida Natural Areas Inventory	**SSC**	Species of Special Concern
FOS	Florida Oceanographic Society	**SSRPSP**	St. Sebastian River Preserve State Park
FWC	Florida Fish and Wildlife Conservation Commission	**S**	State
FWRI	Fish and Wildlife Research Institute	**STORET**	STORage and RETrieval database
FY	Fiscal Year (July 1 – June 30)	**SWIM**	Surface Water Improvement and Management
G	Global	**TMDL**	Total Maximum Daily Load
HAB	Harmful Algal Bloom	**TN**	Total Nitrogen
HBOI	Harbor Branch Oceanographic Institute	**TP**	Total Phosphorus
ICW	Intra-Coastal Waterway	**USFWS**	United States Fish and Wildlife Service
IOA	Indices of Abundance	**USGS**	United States Geological Survey
IR	Indian River	**WMP**	Watershed Management Program
IRL	Indian River Lagoon	**WQMN**	Water Quality Monitoring Network
IRLAP	Indian River Lagoon Aquatic Preserves		

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The Indian blanket flower is commonly found in natural areas throughout the IRL System.

Part One

Basis for Management

Chapter One

Introduction

The Florida aquatic preserves are administered on behalf of the state by the Florida Department of Environmental Protection's (DEP) Florida Coastal Office (FCO) as part of a network that includes 41 aquatic preserves, 3 National Estuarine Research Reserves (NERRs), a National Marine Sanctuary, the Coral Reef Conservation Program and the Florida Oceans and Coastal Council. This provides for a system of significant protections to ensure that our most popular and ecologically important underwater ecosystems are cared for in perpetuity. Each of these special places is managed with strategies based on local resources, issues and conditions.

Our expansive coastline and wealth of aquatic resources have defined Florida as a subtropical oasis, attracting millions of residents and visitors, and the businesses that serve them. Florida's submerged lands play important roles in maintaining good water quality, hosting a diversity of wildlife and habitats (including economically and ecologically valuable nursery areas), and supporting a treasured quality of life for all. In the 1960s, it became apparent that the ecosystems that had attracted so many people to Florida could not support rapid growth without science-based resource protection and management. To this end, state legislators provided extra protection for certain exceptional aquatic areas by designating them as aquatic preserves.

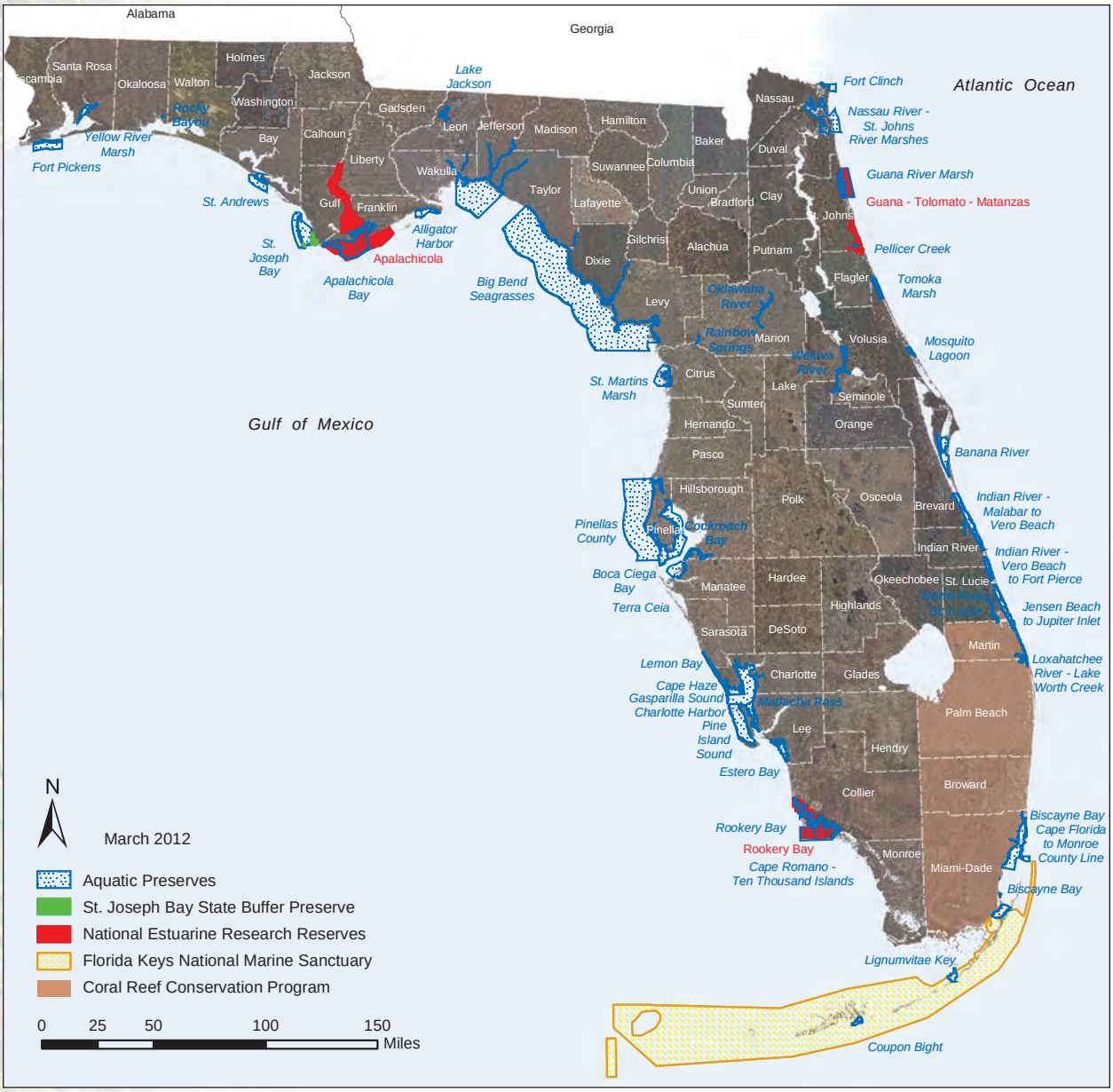
Title to submerged lands not conveyed to private landowners is held by the Board of Trustees of the Internal Improvement Trust Fund (the Trustees). The Governor and Cabinet, sitting as the Trustees, act as guardians for the people of the State of Florida (§253.03, Florida Statutes [F.S.]) and regulate the

use of these public lands. Through statute, the Trustees have the authority to adopt rules related to the management of sovereignty submerged lands (Florida Aquatic Preserve Act of 1975, §258.36, F.S.). A higher layer of protection is afforded to aquatic preserves including areas of sovereignty lands that have been "set aside forever as aquatic preserves or sanctuaries for the benefit of future generations" due to "exceptional biological, aesthetic, and scientific value" (Florida Aquatic Preserve Act of 1975, §258.36, F.S.).

This tradition of concern and protection of these exceptional areas continues, and now includes: the Rookery Bay NERR in Southwest Florida, designated in 1978; the Apalachicola NERR in Northwest Florida, designated in 1979; and the Guana Tolomato Matanzas NERR in Northeast Florida, designated in 1999. In addition, the Florida Oceans and Coastal Council was created in 2005 to develop Florida's ocean and coastal research priorities, and establish a statewide ocean research plan. The group also coordinates public and private ocean research for more effective coastal management. This dedication to the conservation of coastal and ocean resources is an investment in Florida's future.

*1.1 / **Management Plan Purpose and Scope***

With increasing development, recreation and economic pressures, our aquatic resources have the potential to be significantly impacted, either directly or indirectly. These potential impacts to resources can reduce the health and viability of the ecosystems that contain them, requiring active management to ensure the long-term health of the entire network. Effective management plans for the aquatic preserves



Map 1 / Florida Coastal Office System

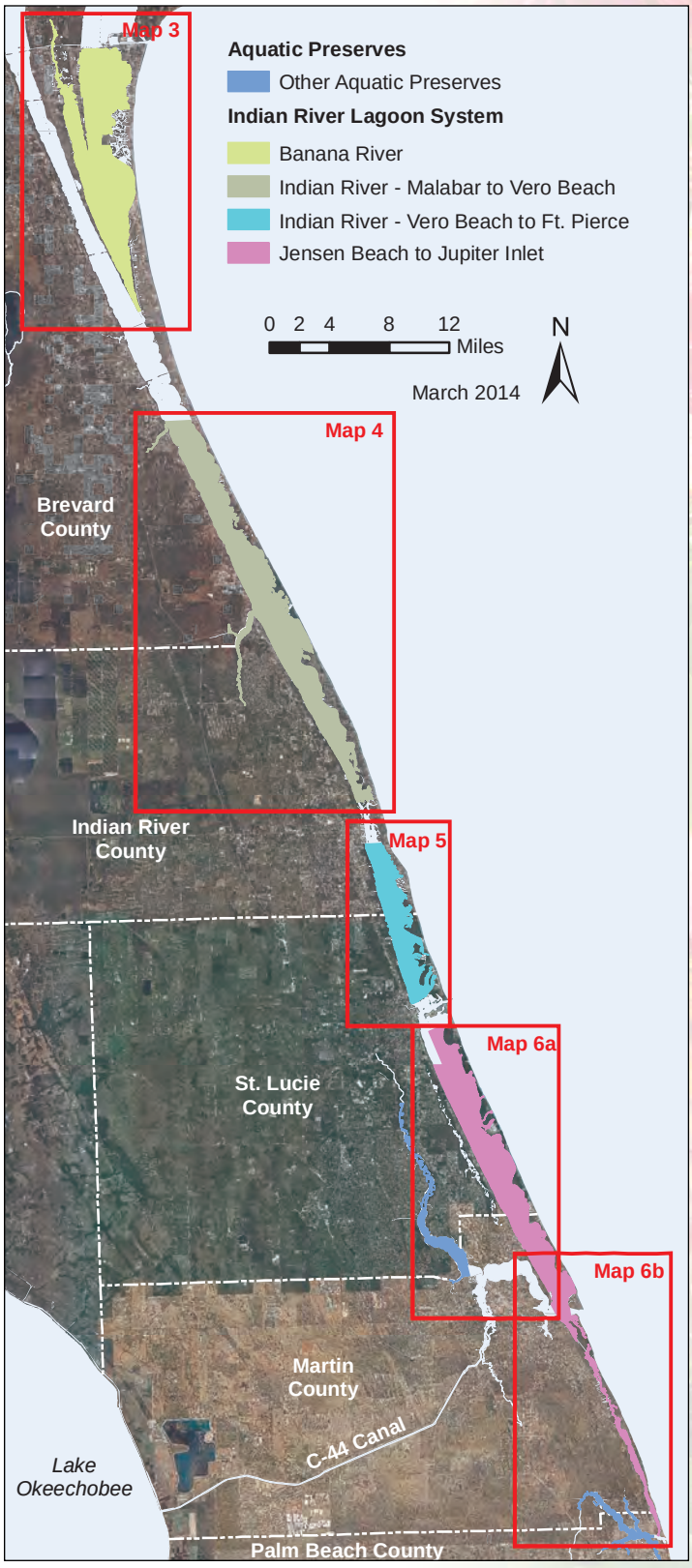
are essential to address this goal and each site's own set of unique challenges. The purpose of these plans is to incorporate, evaluate and prioritize all relevant information about the site into a cohesive management strategy, allowing for appropriate access to the managed areas while protecting the long-term health of the ecosystems and their resources.

The mandate for developing aquatic preserve management plans is outlined in Section 18-20.013 and Subsection 18-18.013(2) of the Florida Administrative Code (F.A.C.). Management plan development and review begins with the collection of resource information from historical data, research and monitoring, and includes input from individual FCO managers and staff, area stakeholders, and members of the general public. The statistical data, public comment, and cooperating agency information is then used to identify management issues and threats affecting the present and future integrity of the site, its boundaries, and adjacent areas. This information is used in the development and review of the management plan, which is examined for consistency with the statutory authority and intent of the Aquatic Preserve Program. Each management plan is evaluated periodically and revised as necessary to allow for strategic improvements. Intended to be used by site managers and other agencies or private groups involved with maintaining the natural integrity of these resources, the plan includes scientific information about the existing conditions of the site and the management strategies developed to respond to those conditions.

To aid in the analysis and development of the management strategies for the site plans, four comprehensive management programs are identified. In each of these management programs, relevant information about the specific sites is described in an effort to create a comprehensive management plan. It is expected that the specific needs or issues are unique and vary at each location, but the four management programs will remain constant. These management programs are:

- Ecosystem Science
- Resource Management
- Education and Outreach
- Public Use

In addition, unique local and regional issues are identified, and goals, objectives and strategies are established to address these issues. Finally, the program and facility needs required to meet these goals as identified. These components are all key elements in an effective coastal management program and for achieving the mission of the sites.



Map 2 / Indian River Lagoon System

For the purpose of this management plan, the Indian River Lagoon (IRL) System encompasses four aquatic preserves (see Map 2). These include the IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce, Jensen Beach to Jupiter Inlet, and Banana River aquatic preserves. While it is recognized that the Mosquito Lagoon, Loxahatchee River-Lake Worth Creek, and North Fork, St. Lucie River aquatic preserves are critical components of the IRL System, each of these aquatic preserves is addressed by separate individual management plans. This is the first update to the IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce and Banana River aquatic preserve management plans and the second update to the Jensen Beach to Jupiter Inlet Aquatic Preserve management plan. The initial management plans for the IR-Vero Beach to Ft. Pierce, Jensen Beach to Jupiter Inlet, and Banana River aquatic preserves were adopted in 1985. The initial plan for the IR-Malabar to Vero Beach Aquatic Preserve was adopted in 1986. The Jensen Beach to Jupiter Inlet Aquatic Preserve management plan was last revised in 1990.

*1.2 / **Public Involvement***

FCO recognizes the importance of stakeholder participation and encourages their involvement in the management plan development process. FCO is also committed to meeting the requirements of the Sunshine Law (§286.011, F.S.):

- meetings of public boards or commissions must be open to the public;
- reasonable notice of such meetings must be given; and
- minutes of the meetings must be recorded.

Several key steps are to be taken during management plan development. First, staff compose a draft plan after gathering information of current and historic uses and resource, cultural and historic sites, and other valuable information regarding the property and surrounding area. Staff then organize an advisory committee comprised of key stakeholders and conduct, in conjunction with the advisory committee, public meetings to engage the stakeholders for feedback on the draft plan and the development of the final draft of the management plan. Additional public meetings are held when the plan is reviewed by the Acquisition and Restoration Council and the Trustees for final approval. For additional information about the advisory committee and the public meetings refer to Appendix C - Public Involvement.

Ospreys are seen frequently throughout the IRL System nesting or catching fish.

Chapter Two

The Florida Department of Environmental Protection's Florida Coastal Office

2.1 / ***Introduction***

The Florida Department of Environmental Protection (DEP) protects, conserves and manages Florida's natural resources and enforces the state's environmental laws. DEP is the lead agency in state government for environmental management and stewardship and commands one of the broadest charges of all the state agencies, protecting Florida's air, water and land. DEP is divided into three primary areas: Regulatory Programs, Land and Recreation, and Water Policy and Ecosystem Restoration. Florida's environmental priorities include restoring America's Everglades; improving air quality; restoring and protecting the water quality in our springs, lakes, rivers and coastal waters; conserving environmentally-sensitive lands; and providing citizens and visitors with recreational opportunities, now and in the future.

The Florida Coastal Office (FCO) is the unit within DEP that manages more than four million acres of submerged lands and select coastal uplands. This includes 41 aquatic preserves, three National Estuarine Research Reserves (NERRs), the Florida Keys National Marine Sanctuary and the Coral Reef Conservation Program. All are managed in cooperation with the National Oceanic and Atmospheric Administration (NOAA).

FCO manages sites in Florida for the conservation and protection of natural and historical resources and resource-based public use that is compatible with the conservation and protection of these lands. FCO is a strong supporter of the NERR system and its approach to coastal ecosystem management. The State of Florida has three designated NERR sites, each encompassing at least one aquatic preserve within its boundaries. Rookery Bay NERR includes Rookery Bay Aquatic Preserve and Cape Romano - Ten

Thousand Islands Aquatic Preserve; Apalachicola NERR includes Apalachicola Bay Aquatic Preserve; and Guana Tolomato Matanzas NERR includes Guana River Marsh Aquatic Preserve and Pellicer Creek Aquatic Preserve. These aquatic preserves provide discrete areas designated for additional protection beyond that of the surrounding NERR and may afford a foundation for additional protective zoning in the future.

Each of the Florida NERR managers serves as a regional manager overseeing multiple other aquatic preserves in their region. This management structure advances FCO's ability to manage its sites as part of the larger statewide system.

*2.2 / **Management Authority***

Established by law, aquatic preserves are submerged lands of exceptional beauty that are to be maintained in their natural or existing conditions. The intent was to forever set aside submerged lands with exceptional biological, aesthetic, and scientific values as sanctuaries, called aquatic preserves, for the benefit of future generations.

The laws supporting aquatic preserve management are the direct result of the public's awareness of and interest in protecting Florida's aquatic environment. The extensive dredge and fill activities that occurred in the late 1960s spawned this widespread public concern. In 1966, the Board of Trustees of the Internal Improvement Trust Fund (Trustees) created the first aquatic preserve, Estero Bay, in Lee County.

In 1967, the Florida Legislature passed the Randall Act (Chapter 67-393, Laws of Florida), which established procedures regulating previously unrestricted dredge and fill activities on state-owned submerged lands. That same year, the Legislature provided the statutory authority (§253.03, Florida Statutes [F.S.]) for the Trustees to exercise proprietary control over state-owned lands. Also in 1967, government focus on protecting Florida's productive water bodies from degradation due to development led the Trustees to establish a moratorium on the sale of submerged lands to private interests. An Interagency Advisory Committee was created to develop strategies for the protection and management of state-owned submerged lands.

In 1968, the Florida Constitution was revised to declare in Article II, Section 7, the state's policy of conserving and protecting natural resources and areas of scenic beauty. That constitutional provision also established the authority for the Legislature to enact measures for the abatement of air and water pollution. Later that same year, the Interagency Advisory Committee issued a report recommending the establishment of 26 aquatic preserves.

The Trustees acted on this recommendation in 1969 by establishing 16 aquatic preserves and adopting a resolution for a statewide system of such preserves. In 1975 the state Legislature passed the Florida Aquatic Preserve Act of 1975 (Act) that was enacted as Chapter 75-172, Laws of Florida, and later became Chapter 258, Part II, F.S. This Act codified the already existing aquatic preserves and established standards and criteria for activities within those preserves. Additional aquatic preserves were individually adopted at subsequent times up through 1989.

In 1980, the Trustees adopted the first aquatic preserve rule, Chapter 18-18, Florida Administrative Code (F.A.C.), for the administration of the Biscayne Bay Aquatic Preserve. All other aquatic preserves are administered under Chapter 18-20, F.A.C., which was originally adopted in 1981. These rules apply standards and criteria for activities in the aquatic preserves, such as dredging, filling, building docks and other structures that are stricter than those of Chapter 18-21, F.A.C., which apply to all sovereignty lands in the state.

This plan is in compliance with the Conceptual State Lands Management Plan, adopted March 17, 1981 by the Board of Trustees of the Internal Improvement Trust Fund and represents balanced public utilization, specific agency statutory authority, and other legislative or executive constraints. The Conceptual State Lands Management Plan also provides essential guidance concerning the management of sovereignty lands and aquatic preserves and their important resources, including unique natural features, seagrasses, endangered species, and archaeological and historical resources.

Through delegation of authority from the Trustees, DEP and FCO have proprietary authority to manage the sovereignty lands, the water column, spoil islands (which are merely deposits of sovereignty lands), and some of the natural islands and select coastal uplands to which the Trustees hold title.

Enforcement of state statutes and rules relating to criminal violations and non-criminal infractions rests with the Florida Fish and Wildlife Conservation Commission law enforcement and local law enforcement agencies. Enforcement of administrative remedies rests with FCO, DEP Districts, and Water Management Districts.

2.3 / *Statutory Authority*

The fundamental laws providing management authority for the aquatic preserves are contained in Chapters 258 and 253, F.S. These statutes establish the proprietary role of the Governor and Cabinet, sitting as the Board of Trustees of the Internal Improvement Trust Fund, as Trustees over all sovereignty lands. In addition, these statutes empower the Trustees to adopt and enforce rules and regulations for managing all sovereignty lands, including aquatic preserves. The Florida Aquatic Preserve Act was enacted by the Florida Legislature in 1975 and is codified in Chapter 258, F.S.

The legislative intent for establishing aquatic preserves is stated in Section 258.36, F.S.: "It is the intent of the Legislature that the state-owned submerged lands in areas which have exceptional biological, aesthetic, and scientific value, as hereinafter described, be set aside forever as aquatic preserves or sanctuaries for the benefit of future generations." This statement, along with the other applicable laws, provides a foundation for the management of aquatic preserves. Management will emphasize the preservation of natural conditions and will include lands that are specifically authorized for inclusion as part of an aquatic preserve.

Management responsibilities for aquatic preserves may be fulfilled directly by the Trustees or by staff of DEP through delegation of authority. Other governmental bodies may also participate in the management of aquatic preserves under appropriate instruments of authority issued by the Trustees. FCO staff serves as the primary managers who implement provisions of the management plans and rules applicable to the aquatic preserves. FCO does not "regulate" the lands per se; rather, that is done primarily by the DEP Districts (in addition to the Water Management Districts) which grant regulatory permits. The Florida Department of Agriculture and Consumer Services through delegated authority from the Trustees, may issue proprietary authorizations for marine aquaculture within the aquatic preserves and regulates all aquaculture activities as authorized by Chapter 597, Florida Aquaculture Policy Act, F.S. Staff evaluates proposed uses or activities in the aquatic preserve and assesses the possible impacts on the natural resources. Project reviews are primarily evaluated in accordance with the criteria in the Act, Chapter 18-20, F.A.C., and this management plan.

FCO staff comments, along with comments of other agencies and the public are submitted to the appropriate permitting staff for consideration in their issuance of any delegated authorizations in aquatic preserves or in developing recommendations to be presented to the Trustees. This mechanism provides a basis for the Trustees to evaluate public interest and the merits of any project while also considering potential environmental impacts to the aquatic preserves. Any activity located on sovereignty lands requires a letter of consent, a lease, an easement, or other approval from the Trustees.

Many provisions of the Florida Statutes that empower non-FCO programs within DEP or other agencies may be important to the management of FCO sites. For example, Chapter 403, F.S., authorizes rules concerning the designation of "Outstanding Florida Waters" (OFWs), a program that provides aquatic preserves with additional regulatory protection. Chapter 379, F.S., regulates saltwater fisheries, and provides enforcement authority and powers for law enforcement officers. Additionally, it provides similar powers relating to wildlife conservation and management. The sheer number of statutes that affect aquatic preserve management prevents an exhaustive list of all such laws from being provided here.

2.4 / *Administrative Rules*

Chapters 18-18, 18-20 and 18-21, F.A.C., are the three administrative rules directly applicable to the uses allowed in aquatic preserves specifically and sovereignty lands generally. These rules are intended to be cumulative, meaning that Chapter 18-21, F.A.C., should be read together with Chapter 18-18, F.A.C., or Chapter 18-20, F.A.C., to determine what activities are permissible within an aquatic preserve. If Chapter 18-18, F.A.C., or Chapter 18-20, F.A.C., are silent on an issue, Chapter 18-21, F.A.C., will control; if a conflict is perceived between the rules, the stricter standards of Chapter 18-18, F.A.C., or Chapter 18-20, F.A.C., supersede those of Chapter 18-21, F.A.C. Because Chapter 18-21, F.A.C. concerns all sovereignty lands, it is logical to discuss its provisions first.

Originally codified in 1982, Chapter 18-21, F.A.C., is meant "to aid in fulfilling the trust and fiduciary responsibilities of the Board of Trustees of the Internal Improvement Trust Fund for the administration, management and disposition of sovereignty lands; to insure maximum benefit and use of sovereignty lands for all the citizens of Florida; to manage, protect and enhance sovereignty lands so that the public may continue to enjoy traditional uses including, but not limited to, navigation, fishing and swimming; to manage and provide maximum protection for all sovereignty lands, especially those important to public drinking water supply, shellfish harvesting, public recreation, and fish and wildlife propagation

and management; to insure that all public and private activities on sovereignty lands which generate revenues or exclude traditional public uses provide just compensation for such privileges; and to aid in the implementation of the State Lands Management Plan."

To that end, Chapter 18-21, F.A.C., contains provisions on general management policies, forms of authorization for activities on sovereignty lands, and fees applicable for those activities. "Activity," in the context of the rule, includes "construction of docks, piers, boat ramps, boardwalks, mooring pilings, dredging of channels, filling, removal of logs, sand, silt, clay, gravel or shell, and the removal or planting of vegetation" (Rule 18-21.003, F.A.C.). To be authorized on sovereignty lands, activities must be not contrary to the public interest (Rule 18-21.004, F.A.C.).

Chapter 18-21, F.A.C., also sets policies on aquaculture, geophysical testing (using gravity, shock wave and other geological techniques to obtain data on oil, gas or other mineral resources), and special events related to boat shows and boat displays. Of particular importance to FCO site management, it additionally addresses spoil islands, preventing their development in most cases.

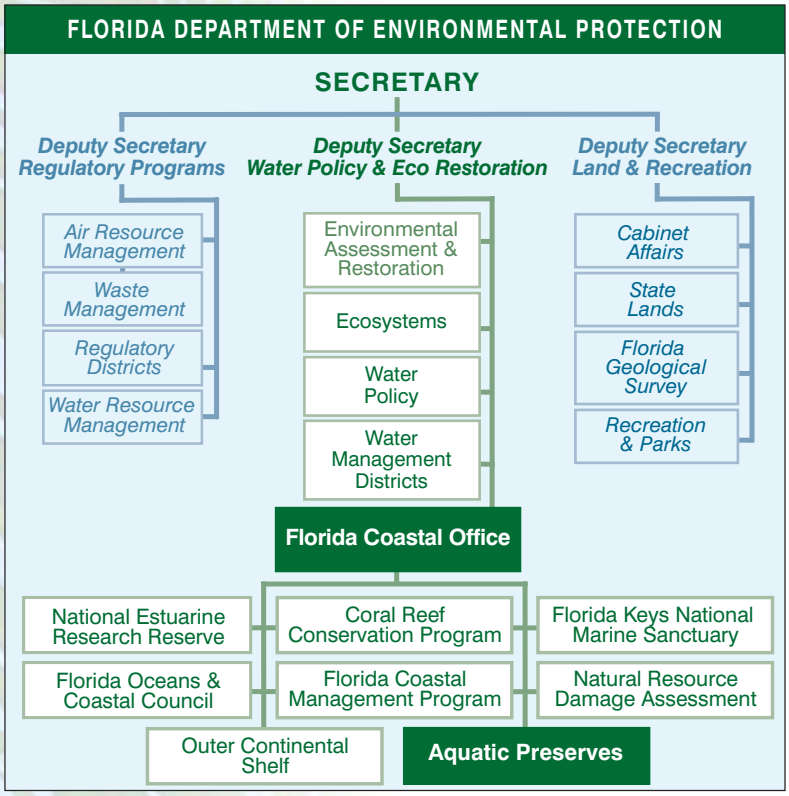


Figure 1 / State structure for managing Aquatic Preserves.

Chapters 18-18 and 18-20, F.A.C., apply standards and criteria for activities in the aquatic preserves that are stricter than those of Chapter 18-21, F.A.C. Chapter 18-18, F.A.C., is specific to the Biscayne Bay Aquatic Preserve and is more extensively described in that site's management plan. Chapter 18-20, F.A.C., is applicable to all other aquatic preserves. It further restricts the type of activities for which authorizations may be granted for use of sovereignty lands and requires that structures that are authorized be limited to those necessary to conduct water dependent activities. Moreover, for certain activities to be authorized, "it must be demonstrated that no other reasonable alternative exists which would allow the proposed activity to be constructed or undertaken outside the preserve" (Paragraph 18-20.004(1)(g), F.A.C.).

Chapter 18-20, F.A.C., expands on the definition of "public interest" by outlining a balancing test that is to be used to determine whether benefits exceed costs in the evaluation of requests for sale, lease, or transfer of interest of sovereignty lands within an aquatic preserve. The rule also provides for the analysis of the cumulative impacts of a request in the context of prior, existing, and pending uses within the aquatic preserve, including both direct and indirect effects.

Chapter 18-20, F.A.C., directs management plans and resource inventories to be developed for every aquatic preserve. Further, the rule provides provisions specific to certain aquatic preserves and indicates the means by which the Trustees can establish new or expand existing aquatic preserves.

As with statutes, aquatic preserve management relies on the application of many other DEP and outside agency rules. Perhaps most notably, Chapter 62-302, F.A.C., concerns the classification of surface waters, including criteria for OFW, a designation that provides for the state's highest level of protection for water quality. All aquatic preserves contain OFW designations. No activity may be permitted within an OFW that degrades ambient water quality unless the activity is determined to be in the public interest. Once again, the list of other administrative rules that do not directly address FCO's responsibilities but do affect FCO-managed areas is so long as to be impractical to create within the context of this management plan.

The St. Sebastian River is part of the IRL System and offers great opportunities to view undisturbed freshwater ecosystems.

Chapter Three

The Indian River Lagoon System

*3.1 / **Description of Representative Ecosystem Region***

*3.1.1 / **Historical Background***

The Indian River Lagoon (IRL) has always existed in a state of fluctuation. Historically, the IRL has been characterized by shifting barrier islands, cyclically varying freshwater watershed discharge, and dramatically varying salinity levels due to ocean water mixing following the opening and closing of natural inlets. Hurricanes and other severe storms were the primary cause of inlet formation, migration and closure, which in turn determined the morphology of the barrier islands and lagoon. At various times, the IRL has been either conducive or hostile to biophysical health, both before and after human settlement (Osborn, 2012). Indeed, as far back as 1894, a fish kill was described that "killed tens of thousands of fish in such quantities that local residents shoveled them into wagons for fertilizer. The stench from the fish kill lingered for more than one year" (Newman, 1953). Over the last century, humans have attempted to stabilize the fluid nature of the IRL. During this time the IRL has been drastically altered by the construction of five permanent inlets and sixteen causeways. In order to drain the region's agricultural lands, canals were constructed which, in turn, flooded the most biologically diverse estuarine ecosystem in the United States with freshwater. Freshwater discharge was regulated through dams and locks. Additionally, dredging of the Atlantic Intracoastal Waterway (ICW) changed water movement. Spoil from the dredging was used for the creation of spoil islands and heavy boat traffic significantly changed the IRL's biophysical processes. These changes have forever altered the IRL.

It is believed that humans lived in the IRL watershed as early as 15,000 B.C. Many of this period's coastal village sites are now underwater due to rising sea levels. For some 7,000 years before European settlers arrived, indigenous Ais and Jeaga peoples had inhabited the IRL region. While most of North American Indian groups progressed to an agrarian society, the IRL's Indians remained hunters and gatherers into the 18th century. During the 200 years following Ponce de Leon's 1513 Florida arrival, the IRL was part of an outpost of the Spanish Empire, during which time nearly all indigenous people were extirpated. It is estimated 100,000 people lived in Florida at the time of Ponce de Leon's landing, 2,000 of which lived in the IRL basin (Derr, 1989).

Florida was ceded to England from Spain in 1763. The northern section of the IRL was inhabited by more than one thousand Europeans in a failed British colony during the late 1760s. At the end of the Second Seminole War (1835-1842), the U.S. Congress encouraged settlement of their newly acquired territory by offering free land in the region. The area remained depopulated, however, due to geographic isolation and continued tensions with the Seminoles. It was not until after the Civil War, that thousands of northerners began relocating to the IRL region attracted by newspaper accounts of "warm fish-choked waters with near-magical healing properties" (Osborn, 2012).

Anthropogenic impacts to the natural IRL ecosystem began with the occupation by indigenous people through the construction of large shell middens. During Spanish control, upper reaches of the IRL were impacted by drainage and establishment of orange groves. In the late 1760s, British settlers drained 3,107 acres of wetland in the northern IRL for planting indigo and cleared mangroves from seven miles of shoreline for waterfront housing which later would become New Smyrna (Landers, 2000). This set the precedent which would characterize cultural impacts to the IRL for the next two hundred years.

An 1825 census counted 317 people living in the historic IRL basin. By 1910, the population along the IRL increased to nearly 9,000 persons (Adams, Ainsley, Busby, Day, Recore, & Rice, 1996). Rapid growth during this time was largely a result of railroad expansion and construction of the Dixie Highway (now U.S. Highway 1). The first significant dredging project in the IRL occurred in the early 1880s and was overseen by the Florida Coast Line and Transportation Company. A 50 foot wide canal, five feet deep, was dug for a length of 134 miles, from Haulover Canal to Jupiter. A single, reliably deep waterway running the length of Florida's east coast was completed shortly thereafter when the Florida Coast Line and Transportation Company finished cutting a canal between Jupiter and Lake Worth (Crawford, 1997). The first commercial citrus grove was established in the region in 1828. Other early agricultural activities included pineapple and coconut groves and palmetto fruit harvesting (Adams et al., 1996). Bananas, guavas, mangoes and sugar cane were also successfully transplanted to the IRL's sandy soils. Agriculture quickly became a profitable commercial enterprise with the advent of reliable steam and rail transportation. In 1900, the annual export of IRL pineapples was nearly 700,000 and oranges was 70,000 crates. By 1906 the annual export of IRL citrus had reached 1,000,000 crates (Osborn, 2012). A freeze in 1910 devastated the pineapple industry from which it never recovered.

In an effort to promote agricultural development, the 1916 Drainage Act was passed which established taxing districts to provide drainage, flood control, and mosquito control throughout the IRL. These activities resulted in continued population growth between 1910 and 1950. Wetlands outside the IRL basin were drained into the IRL for agriculture and development purposes. By the late twentieth century, the IRL watershed increased from approximately 550,000 acres to 1,500,000 acres and became interconnected with the Okeechobee and St. Johns River basins. Discharge from the enlarged watershed has created conditions of dramatically varying salinity and increased nutrient input.

One of the more ambitious water control projects was the creation of the St. Lucie Canal. The purpose of the canal was to drain vast areas west of the IRL, allow water level management of Lake Okeechobee through discharge into the St. Lucie River and provide a navigable route across Florida. Construction of the enormous canal began in 1915. By 1923, water from Lake Okeechobee began flowing through the canal into the St. Lucie River. The opening of the St. Lucie Canal dramatically altered the salinity of the southern IRL by introducing much larger and more regular infusions of freshwater than naturally occurred through the lagoon's tributaries. Within several years of the opening of the St. Lucie Canal, muck soil from Lake Okeechobee began to enter the St. Lucie Estuary (Osborn, 2012).

During World War II, extensive military infrastructure was developed in the IRL region to support the war effort. By the end of WWII, Florida was home to 172 military installations and two million servicemen and women (Wynne & Moorhead, 2010). Many of the personnel based in the region remained or returned following their service. Beginning in the 1940s, bridges and causeways were built across the lagoon for improved access to the barrier island. Beginning in 1950, the establishment of the space program at Cape Canaveral fueled growth in the region. By the 1960s, hostile environmental conditions which had previously hampered development were well under control. Air conditioning, mosquito control, inlet stabilization, dredged waterways and a system of highways and bridges resulted in rapid population growth which still continues today. More than two million people currently live in the five-county region (Brevard, Indian River, St. Lucie, Martin and Palm Beach) of the IRL System (University of Florida, 2013).

The first documented commercial fishing in the IRL was a cannery for sea turtles, fish and oysters in 1866 Woodward-Clyde, 1994). It was not until improved rail transportation, improved navigation through the opening of new inlets and a growing population during the 1890s that commercial fishing became a significant industry in the IRL region. By 1895, two and a half million pounds of seafood

were being shipped annually from Ft. Pierce (Brice, 1987). In 1896, the U.S. Commission on Fish and Fisheries investigated fisheries in the IRL. It determined that overfishing had already resulted in dramatic decreases in fish stocks in the IRL. As a result, it recommended that Congress enact laws to ban certain nets and place closures on commercially valuable fish species during spawning seasons (Brice, 1897). Total commercial seafood landings increased to eight million pounds in 1958 and peaked in 1977 at nearly 20 million pounds. The significant inshore fisheries have declined to such an extent that by the late twentieth century inshore commercial fishing had ceased to be a major industry in the IRL (Woodward-Clyde, 1994). Today, the IRL region accounts for 14 percent (12 million pounds) of the state's commercial seafood landings (Florida Fish and Wildlife Conservation Commission [FWC], 2013b).

Historically, the IRL naturally had sufficient energy from intertidal oceanic exchange and freshwater flow to keep between three and five inlets open at any time (South Florida Ecosystem Restoration Task Force, 1996). Inlets migrated through the region. Although many natural inlets have opened and closed through the effects of storm, tide and wind over the centuries in the IRL, there were only three open inlets (Jupiter, Indian River and Ponce) connecting the IRL to the Atlantic Ocean prior to the turn of the 20th century. In 1892, the St. Lucie Inlet was opened twenty miles south of the Indian River Inlet. The opening of the St. Lucie Inlet introduced saltwater into what at the time had been a freshwater environment. After numerous failed attempts, an inlet was successfully opened in the vicinity of the current Sebastian Inlet in 1905 only to be closed by a storm the following year (Robinson, 2005). Construction of manmade inlets reduced hydrologic energy allowing sand to accumulate and close in other inlets. In 1916, failed attempts to open and maintain the Sebastian Inlet began. By 1920, both Jupiter Inlet and Indian River Inlet had been naturally closed for some time, and the Ponce Inlet at the extreme northern edge of the system was nearly closed as well. The man-made St. Lucie Inlet was the only connection between the IRL and the Atlantic Ocean (Fineren, 1938).

A ten year span, beginning in 1920, saw the creation of the Fort Pierce Inlet and its deep water port, significant expansion of the St. Lucie Inlet, the dredging of a major anchoring field near the mouth of the St. Lucie Estuary, and the improvement of the Sebastian Inlet (Osborn, 2012). In 1941, routine dredging of the Sebastian and Jupiter Inlets was suspended in order to allow the inlets to close due to their potential use by German submarines. In the 1950s, more than one hundred new spoil islands were created along the lagoon with the dredging of the ICW to a new depth of twelve feet. The Canaveral Inlet and associated lock were completed in 1954. These new inlets have created a permanent hydrological flushing effect in the IRL System that had historically existed only during periods when storm-based tidal surge had over washed the barrier islands, creating natural inlets (Woodward-Clyde, 1994).

Historically, the IRL's naturally small watershed was separated from areas to the west by the Atlantic Ridge. Rain was the primary source of water entering the IRL System. Runoff was of very limited volume and entered the lagoon after slowly filtering through sloughs and wetlands. Water control efforts have resulted in an intensively managed system in which water has been diverted from a very large area of land west of the IRL basin's natural watershed and immediately deposited into the lagoon. Storm events now discharge huge volumes of polluted land-based freshwater into the IRL which have greatly decreased water quality in all sections of the lagoon. Man's desire to turn the IRL from an ever-transitional environment (characterized primarily by its instable inlets, shifting coastlines, and fluctuating salinity) into a stable environment forever altered the lagoon. Indeed, public work projects have converted the perennially shifting IRL into a fixed managed system of canals, pumps, dikes, seawalls and fill.

*3.1.2 / **General Description***

For the purpose of this management plan, the IRL System encompasses four aquatic preserves. These include the IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce, Jensen Beach to Jupiter Inlet, and Banana River aquatic preserves. While it is recognized that the Mosquito Lagoon, Loxahatchee River-Lake Worth Creek, and North Fork, St. Lucie River aquatic preserves are critical components of the overall IRL, each of these aquatic preserves is addressed by separate individual management plans.

International/National/State/Regional Significance

Indian River-Malabar to Vero Beach, Indian River-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet were designated by the Florida Legislature as aquatic preserves in 1969. Banana River Aquatic Preserve was designated in 1970. All four aquatic preserves were included in the Aquatic Preserves Act of 1975 passed by the Florida Legislature, and were designated as Outstanding Florida Waters (OFW) in 1979 (Rule 62-302.700 (9), F.A.C.). The Florida Department of Environmental Protection (DEP) affords the highest level of protection to these waters. In addition, areas within Banana River and Indian River-Malabar to Vero Beach aquatic preserves are also classified as Class II, Shellfish Harvesting

waterbodies (approved for shellfish propagation or harvesting). The four aquatic preserves addressed by this management plan are part of the overall IRL. The IRL is one of the most biodiverse estuaries in North America (Swain, Breininger, Busby, Clark, Cook, & Day, 1995) and has been integrated into the IRL National Estuary Program, a partnership between water management districts and the U.S. Environmental Protection Agency (EPA). The IRL connection to Lake Okeechobee (via the C-44 Canal) makes the restoration projects in the Jensen Beach to Jupiter Inlet Aquatic Preserve watershed the northernmost component of the Comprehensive Everglades Restoration Plan.

Map 3 / Banana River Aquatic Preserve.

The IRL provides relatively contiguous habitat for fish and wildlife. The IRL simultaneously supports multi-million dollar recreational and commercial fisheries while providing habitat for 17 federally-protected species and 59 state- or federally-designated endangered or threatened species or state Species of Special Concern (see Appendix B.3) and numerous nationally-registered cultural resource sites (FWC, 2013f). Adjacent state and county-owned public lands with natural shorelines provide a wildlife corridor which connects a variety of natural communities and facilitates a wilderness experience that is easily accessible to residents in a five county area (Brevard to Palm Beach counties).

Location/Boundaries

The four aquatic preserves (Banana River, IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet) addressed by this management plan are part of the IRL, a long, wide shallow estuarine lagoon bounded on the west by the Florida mainland, and on the east by a chain of barrier islands. For the purpose of this management plan, these four aquatic preserves are referred to as the IRL System. The aquatic preserve boundaries are generally defined by state-owned sovereign submerged lands located waterward of the mean high water line. The location and boundaries of each of the four aquatic preserves, listed from north to south, are as follows:

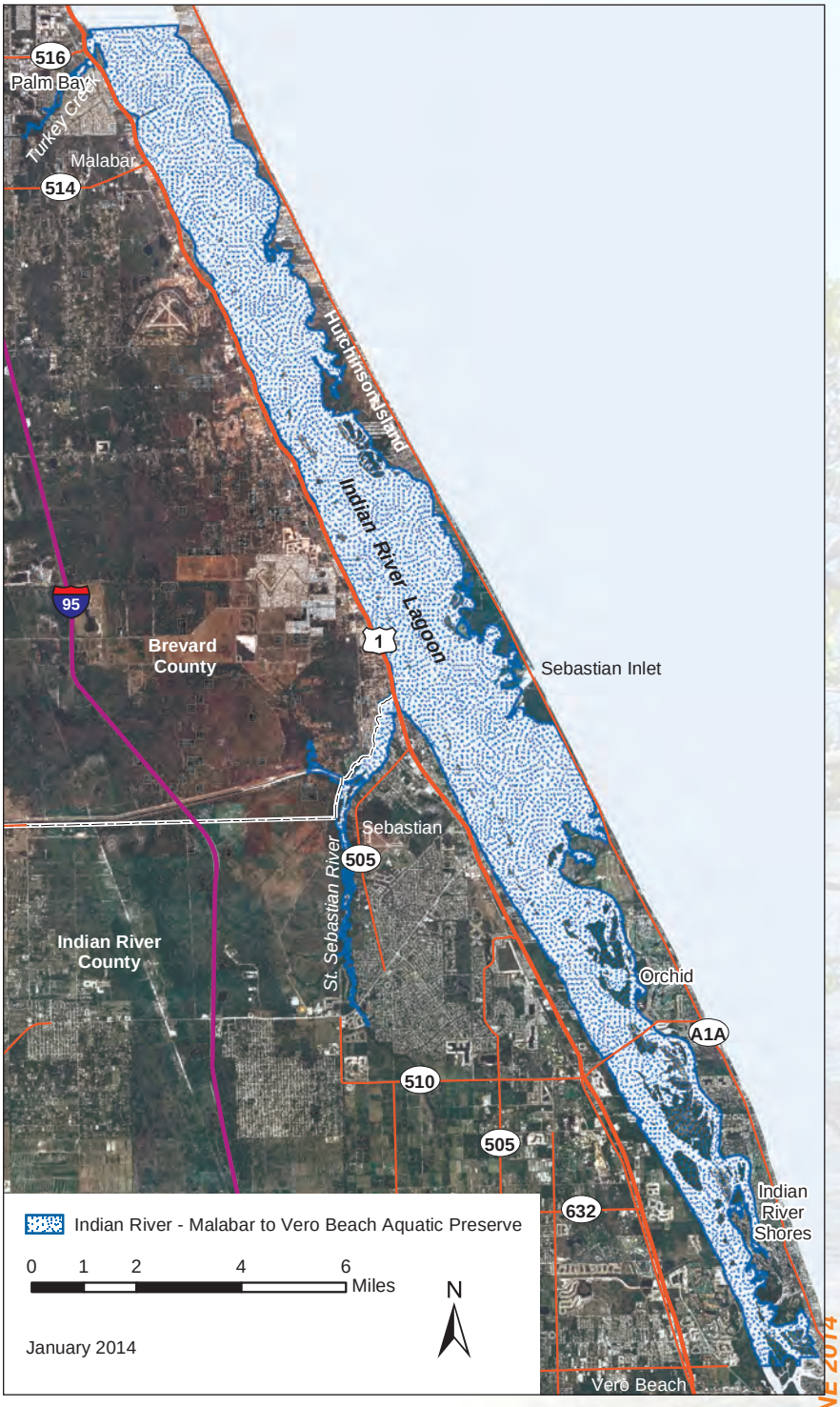
Banana River Aquatic Preserve - Banana River Aquatic Preserve is located in north central Brevard County, separating Merritt Island on the west and the beach barrier island on the east (see Map 3). The surface water area of the aquatic preserve is approximately 30,000 acres. The aquatic preserve begins at State Road 528 (Bennett Causeway), extends almost to the southern tip of Merritt Island, and includes Newfound Harbor and Sykes Creek as far north as Hall Road. The incorporated cities bordering the aquatic preserve are Cape Canaveral, Cocoa Beach, Satellite Beach and Indian Harbor Beach, north to south respectively. In addition, Patrick Air Force Base lies along the Banana River Lagoon between Cocoa Beach and Satellite Beach. The aquatic preserve is accessible from the east by U.S. Highway A1A and from the west by State Road 3. Numerous parks and boat ramps provide direct public access to the aquatic preserve.

Indian River-Malabar to Vero Beach Aquatic Preserve - Located in Brevard and Indian River counties, IR-Malabar to Vero Beach Aquatic Preserve encompasses 28 miles, totaling 28,000 acres of the IRL (see

Map 4). The aquatic preserve begins just north of Turkey Creek at Castaway Point in Palm Bay, extends south to northern Vero Beach corporate limit and includes waters of Turkey Creek and St. Sebastian River. Palm Bay, Malabar, Sebastian, Vero Beach, Orchid, and Indian River Shores are incorporated cities which lie along the aquatic preserve boundary. Unincorporated cities include Floridana Beach, Melbourne Shores, Grant, Micco, Wabasso, Roseland, and Gifford. The aquatic preserve is accessible from the east by U.S. Highway A1A and from the west by U.S. Highway 1. Numerous parks and boat ramps provide direct public access to the preserve.

Indian River- Vero Beach to Ft. Pierce Aquatic Preserve - Located in Indian River and St. Lucie counties, IR-Vero Beach to Ft. Pierce Aquatic Preserve is 12 miles long and encompasses 11,000 acres (see Map 5). The aquatic preserve extends from the southern Vero Beach corporate limit south to the north U.S. Highway A1A bridge in Ft. Pierce and includes Big Starvation Cove, Wildcat Cove and Ft. Pierce Cut. The aquatic preserve is bordered by the cities of Vero Beach and Ft. Pierce. The aquatic preserve is accessible from the east by U.S. Highway A1A and from the west by U.S. Highway 1. Numerous parks and boat ramps provide direct public access to the aquatic preserve.

Jensen Beach to Jupiter Inlet Aquatic Preserve - Located in St. Lucie, Martin and extreme northern Palm Beach counties, Jensen Beach to Jupiter Inlet Aquatic Preserve is 37 miles long and encompasses 22,000 acres (see Maps 6a and 6b). Despite its official name, the aquatic preserve extends from the southern corporate limits of Ft. Pierce, south to Jupiter Inlet, including the Peck Lake and Hobe Sound area. Stuart is the only incorporated city bordering the aquatic preserve. Unincorporated cities include Jensen Beach, Hobe Sound and Tequesta. The aquatic preserve is accessible from the east by U.S. Highway A1A and from the west by Indian River Drive or U.S. Highway 1. Despite the length of the aquatic preserve, there are a limited number of parks and boat ramps which provide direct public access to the aquatic preserve.



Map 4 / Indian River-Malabar to Vero Beach Aquatic Preserve.

Historically, aquatic preserve boundaries were designated based primarily on water quality. Many cities discharged wastewater with only primary treatment during the 1960s through the 1970s. This practice resulted in poor water quality surrounding many population centers. Other consideration was given to the habitat function, economic value of resources and beauty of areas proposed for inclusion as aquatic preserves. Commercial interests and private inholdings within proposed aquatic preserves were also given consideration as dredge and fill were still not heavily

regulated. These designations were established prior to the common usage of geographic information systems for mapping. For ease of reference, boundaries were chosen where there were landmarks, bridges, ditches or city boundaries that were already established. Today, it is recognized that sometimes these boundaries do not make ecological sense due to previous mapping constraints or because conditions have changed.

The headquarters for the IRL Aquatic Preserves (IRLAP) Field Office is located at 3300 Lewis Street in Ft. Pierce, Florida 34981. The office is situated on public land managed by the Savannas Preserve State Park and is located at the confluence of Five Mile and Ten Mile creeks, tributaries to North Fork St. Lucie River Aquatic Preserve. The office is centrally located with respect to the IRL System. A satellite field office is located at the St. Sebastian River Preserve State Park in Fellsmere and has been occupied by IRLAP staff since summer 2008.

Map 5 / Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.

*3.1.3 / **Resource Description***

Surrounding Population Data and Future Projected Changes

Growth in the IRL basin has been rapid since the 1950s. Expansion of tourism, a space industry and agriculture coupled with improvements in access to the basin and control of mosquitoes helped fuel that growth (Wynne and Moorhead, 2010; Woodward-Clyde, 1994). Between 2000 and 2007, Florida's population growth (17 percent) more than doubled that of the country (7 percent) (U.S. Census Bureau, n.d.). During that same time period the total population of the five counties (Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties) that contain the IRL System grew at the same rate as the state from approximately 2,040,000 to 2,383,000 people (University of Florida, 2013). St. Lucie County grew at a much faster rate (37 percent) than surrounding counties. The exponential growth of St. Lucie County was supported by the conversion of natural and agricultural lands located west of Interstate 95 to large-scale developments of regional impact. Beginning in 2007, Florida's population growth dropped to its lowest levels since the 1940s as result of the country's worst economic recession since the Great Depression of the 1930s. Beginning in 2011, growth in the state has begun to increase and is estimated to accelerate over the next few years (Smith & Cody, 2013).

The populations of Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties have nearly doubled since the adoption of the original aquatic preserve management plans comprising the IRL System. Total population of the five counties grew from 1,330,000 to 2,468,000 people (an 86 percent increase) (University of Florida, 2013). The increasing local population affects the IRL System in complex ways, and long-term population predictions must be taken into consideration for the protection of local natural resources. Rapid population growth and development in coastal regions of Florida, and the resultant impacts on natural resources, are cause for concern. Loss of habitat has affected many species including those of economic and recreational importance. Shortages in groundwater supply, caused by expanding infrastructure developments, are stressing natural systems throughout the region. Stormwater runoff and associated nutrient discharges into the IRL System negatively affect local water quality. These subjects are discussed throughout this plan, but are more specifically addressed in Chapter 5. By 2024, when the next IRL System management plan revision is scheduled, the population for the five-county area is expected to increase 15 percent to

2,846,000 people. St. Lucie County is expected to continue growing at a faster rate (30 percent) than the other counties encompassing the IRL System (University of Florida 2013). For all counties, future population growth will continue to be primarily a result of net migration (Smith & Cody, 2013).

Topography and Geomorphology

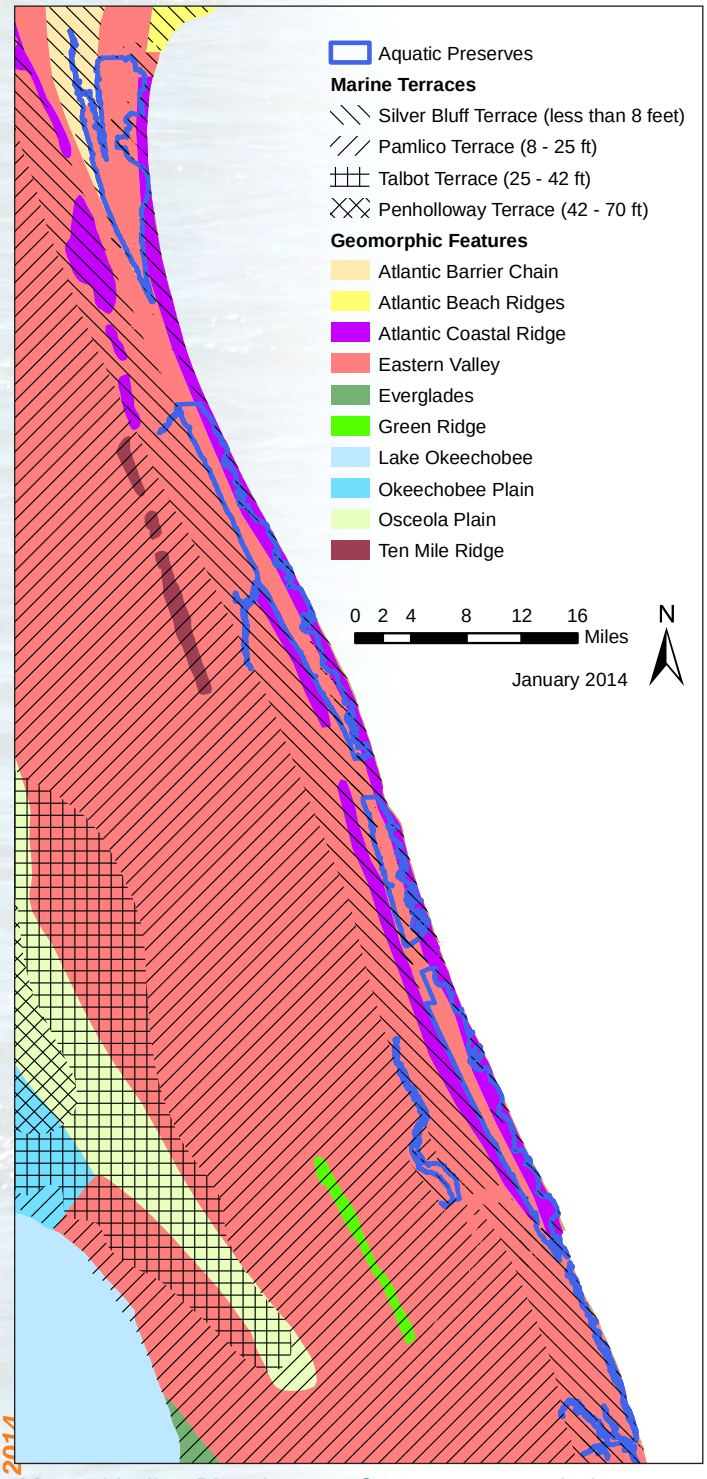
The IRL System is a prominent geomorphic feature on Florida's east coast, with land formations dating back 420,000 years. Land and water features of the IRL System have been formed by the rise and fall of the sea. The IRL System has been alternately covered by water and exposed as dry land many times, resulting in the creation of barrier islands, dunes and marine terraces. When water levels were higher, plains were formed from erosion by waves and currents. These plains became terraces or flatlands when the water exceeded. Terraces in the IRL System basin in order of descending elevation are Pamlico and Silver Bluff. Dunes formed on these terraces and were parallel and west of the basin. Higher ridges formed on the dunes. The Atlantic Coastal Ridge formed on the Silver Bluff Terrace. The Atlantic Coastal Ridge lies to the west of the lagoon on the mainland and runs parallel to the Atlantic Ocean coastline. The Green Ridge extends from western Port St. Lucie along Interstate 95 to the C-44 Canal.

The eastern side of the IRL System consists of barrier islands that extend south of two unique

Map 6a / Jensen Beach to Jupiter Inlet Aquatic Preserve (north section).

Map 6b / Jensen Beach to Jupiter Inlet Aquatic Preserve (south section).

land features, Cape Canaveral and Merritt Island. West Merritt Island formed first, when sea levels were low. About 10,000 years ago, rising sea levels eroded the Merritt Island beach, forming a sand bar to the east. As sea levels began to recede, the sand bar was reshaped into Cape Canaveral, thereby forming the Banana River Lagoon. Over time, the IRL was formed as barrier islands developed from the southward migration of sand from Cape Canaveral (Rouse, 1981).



Map 7 / Indian River Lagoon System geomorphology.

Historically, narrow points of the barrier islands have been breached during storms. The temporary shallow inlets, which formed, later closed due to siltation. Man's intervention through dredging and stabilization has allowed saline water from the Atlantic Ocean to mix with fresh water creating the lagoon environment that is found today. The Canaveral Lock, Sebastian Inlet, Ft. Pierce Inlet, St. Lucie Inlet and Jupiter Inlet are the only connections between the IRL System and the Atlantic Ocean. Of these, only the Jupiter Inlet is a natural connection to the ocean. IR-Malabar to Vero Beach Aquatic Preserve is connected to the Atlantic Ocean by the Sebastian Inlet. IR-Vero Beach to Ft. Pierce Aquatic Preserve is influenced by its connections to the Atlantic Ocean by both the Sebastian Inlet and the Ft. Pierce Inlet. Jensen Beach to Jupiter Inlet Aquatic Preserve is connected to the Atlantic Ocean by the St. Lucie Inlet and the Jupiter Inlet. Finally, Banana River Aquatic Preserve is connected to the Atlantic Ocean by the Canaveral Lock. Because these inlets are the only connection to the Atlantic Ocean, the IRL System is microtidal and generally protected from coastal storms.

Geology

The landforms just described were either created or carved from four surface geologic formations contained in the IRL System. From most recent to oldest, these formed during the Holocene, Pleistocene/Holocene, Pleistocene, and Pliocene/Pleistocene epochs. Holocene sediments formed over 10,000 years ago and consist of sedimentary sand, clay and organics. The exposure of these sediments is generally restricted to Merritt Island and the southwest and eastern shorelines of Banana River Aquatic Preserve. They occur near the coastline at elevations less than five feet. The Holocene/Pleistocene formation consists of unconsolidated quartz sands. These form the Atlantic Coastal Ridge as well as ridges and dunes along the barrier islands throughout the IRL System. The Anastasia formation, which formed during the Pleistocene over 1.8 million years ago, is composed of limestone, coquina and sand. The Anastasia formation serves as the major conduit for the regional surficial aquifer. This formation lies under the entire IRL System. It can be exposed along the shore and extends up to 20 miles inland. In the IRL System, the Anastasia formation is mostly exposed along the western side of the lagoon throughout Brevard County including all of IR-Malabar to Vero Beach Aquatic Preserve. Small outcroppings of the Anastasia formation also occur along isolated sections of the western shore of the Jensen Beach to Jupiter Inlet Aquatic Preserve. The Pliocene/Pleistocene formation dates back to over 5.3 million years and contains some of the most abundant and diverse fossils in the world (Brech, 2004). These complex sediments, composed of sand, shell and clay confound the origin of

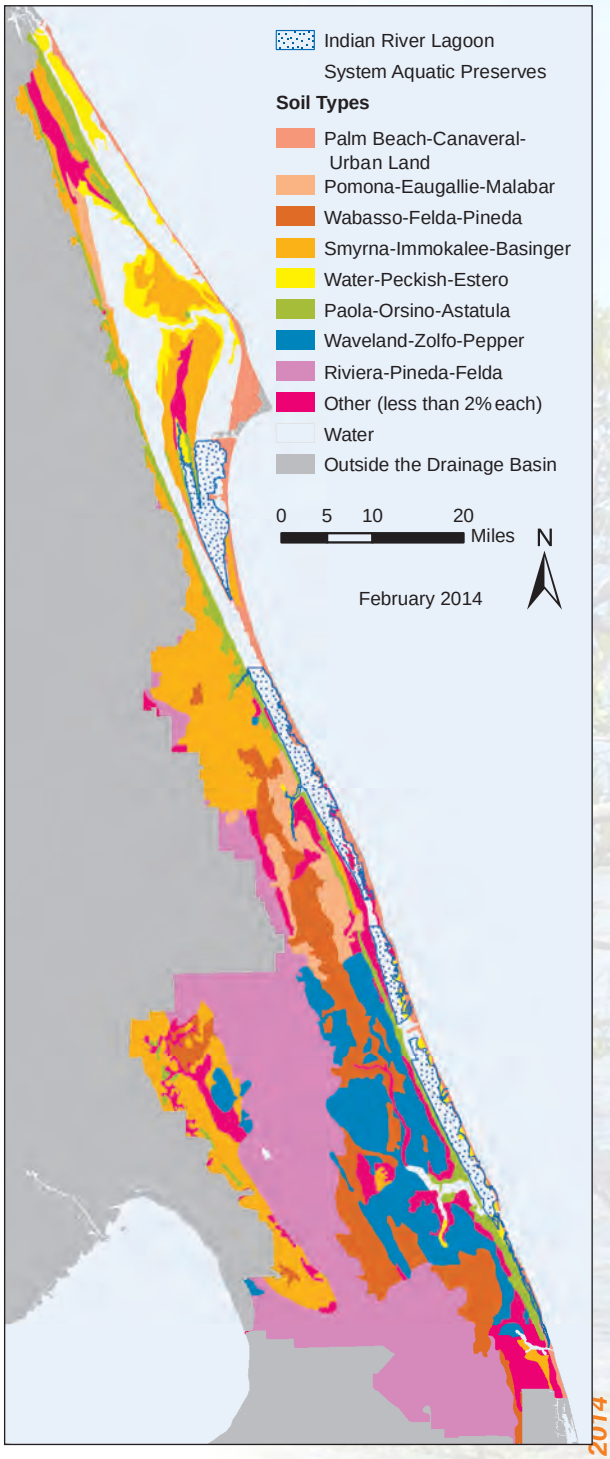
this formation. Formerly categorized as the Caloosahatchee formation, it is now referred to as the Tertiary-Quaternary shell unit. This shell unit is exposed landward of the IRL System throughout much of its associated drainage basin. These four geologic formations overlie basement rocks of the Florida Platform, including Precambrian-Cambrian igneous rocks, Ordovician-Devonian sedimentary rocks, and Triassic-Jurassic volcanic rocks (Scott, 2001).

Hydrology and Watershed

The shape and geographic setting of the IRL System influences its hydrologic behavior. All four aquatic preserves have long narrow shapes with shallow water depths. The result is a generally sluggish circulation pattern within the IRL System. Tidal exchange and flushing with the Atlantic Ocean are limited so most circulation is wind driven. The hydrodynamic characteristics of the IRL System make it particularly susceptible to influxes of pollutants (Adams et al., 1996). Each of the four aquatic preserves contained within the IRL System differ somewhat in their hydrodynamics and geographic features.

Meteorological (wind and changes in barometric pressure) currents are thought to be the only significant currents capable of moving water in the Banana River Lagoon (Woodward-Clyde, 1994). Under certain conditions, there is virtually no mass flow of water and consequently no flushing. It takes an estimated two years for a complete flush of Banana River Lagoon (DEP, 2013). This means the Banana River Aquatic Preserve is highly susceptible to inputs or loading of pollutants and may not be able to withstand significant loadings without degradation of water quality. The northern boundary of Banana River Aquatic Preserve is located immediately south of the Canaveral Lock. The lock is the only connection between the Banana River Aquatic Preserve and the Atlantic Ocean. Historically, Banana Creek connected the north IRL and the Banana River Lagoon, but this connection was severed when National Aeronautics and Space Administration (NASA) constructed the Crawlerway to transport rockets (DEP, 2006).

The average flushing rate in IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves is 10 times higher than in the north IRL and 15 times higher than in the Banana River Aquatic Preserve (DEP, 2009). IR-Malabar to Vero Beach Aquatic Preserve includes areas within the tidal influence of the Sebastian Inlet. From Malabar to Vero Beach, tidal flow and potential flushing increase steadily and persist south to the Indian River Narrows near the southern border of IR-Malabar to Vero Beach Aquatic Preserve. Tidal flow primarily from the Ft. Pierce Inlet is present throughout the IR-Vero Beach to Ft. Pierce Inlet, with tidal action most pronounced up to five miles north and south of the Ft. Pierce Inlet. Tidal flow is present everywhere in Jensen Beach to Jupiter Inlet Aquatic Preserve, with tidal action most pronounced within three to five miles of the Ft. Pierce, St. Lucie and Jupiter inlets.



Map 8 / Indian River Lagoon System soils.

The IRL System watershed has become highly altered within the last 75 years to accommodate growth and development in the area. As a result, the timing and volume of freshwater flows to the lagoon have dramatically changed from historical conditions. The combination of drainage modifications, along with land use development in the watershed, has dramatically increased wet-season flows and reduced dry-season flows to the IRL System. These activities affect habitats and organisms dependent on brackish

or freshwater areas during their life cycle. In addition, high-volume stormwater discharges produce rapid salinity fluctuation as well as sedimentation and nitrification. The increase in nutrient and sediment loading has contributed to the build-up of fine-grained muck and elevated nutrients in the IRL System. The resultant changes in the health of the estuary are evidenced through a reduction in submerged aquatic vegetation and benthic organisms (SFWMD, 2011).

Map 9 / Indian River Lagoon Shellfish Harvest Areas.

Water Quality Classifications - Each of the four aquatic preserves comprising the IRL System were classified as OFWs in 1979 (Rule 62-302.700 (9) F.A.C.). The boundary of the OFW in IR-Malabar to Vero Beach Aquatic Preserve was amended in 1988 to exclude portions of the Sebastian Creek upstream of U.S. Highway 1. This is a state designation implementing a provision of the federal Clean Water Act, intended to afford the highest level of protection to existing high quality waters. The OFW designation is for "special protection due to their natural attributes" (Section 403.061, F.S.). Designated waters are to be preserved in a non-degraded state and protected in perpetuity for the benefit of the public. No degradation of water quality, other than that allowed in Rule 62-4.232(2) is to be authorized. Most OFWs are associated with managed areas in the state or federal park system, such as aquatic preserves, national seashores or wildlife refuges.

Several large sections of the IRL System are designated as Class II Shellfish (clam and oyster) Propagation and Harvest Areas (see Map 9, Table 1). The Florida Department of Agriculture and Consumer Services (FDACS) manages and classifies shellfish harvest areas and establishes regulations implementing the national Shellfish Sanitation Program standards concerning shellfish harvesting. Most of these standards are based on water quality pertaining to public health concerns. Boundaries and daily status of the harvest areas can be accessed at http://shellfish.floridaaquaculture.com/seas/seas_statusmap.htm. Historically, the IRL System had a highly productive clam fishing industry. Due to declines in wild stocks, current shellfish harvesting in the IRL System is primarily limited to clam aquaculture. Clam aquaculture is conducted on sovereignty submerged lands leased from the state through the FDACS Division of Aquaculture. Within the IRL System, aquaculture leases are only located in IR-Malabar to Vero Beach Aquatic Preserve. These leases include two high density aquaculture lease areas named Body F and Indian River. The Body F High Density Aquaculture Lease Area comprises 137 acres of sovereignty submerged lands and is located approximately four miles north of the Sebastian Inlet. The Indian River High Density Aquaculture Lease Area comprises 97 acres of sovereignty submerged lands and is located approximately two miles south of the Sebastian Inlet. An additional 36 individual shellfish leases are located throughout IR-Malabar to Vero Beach Aquatic Preserve totaling 262 acres of sovereignty submerged lands (personal communication, Wanda Prentis, May 2013).

When a proposed lease site is located within an aquatic preserve, staff from the aquatic preserve is asked to participate in the resource survey and to make recommendations pertinent to the management of the affected aquatic preserve. The aquatic preserve managers review the proposed activities and make determinations pertinent to the aquatic preserve's management plan and local resource issues. Additionally, DEP may draw upon expertise from the Florida Fish and Wildlife Conservation Commission (FWC) and the Fish and Wildlife Research Institute to assess and evaluate specific resource management issues.

Shellfish Area 2: 70 Indian River/St. Lucie

Aquatic Preserve: IR-Vero Beach to Ft. Pierce

Brief description of extents: All waters of the Indian River north of the U.S. Highway A1A (Seaway Drive) bridge at the Fort Pierce Inlet and south of the State Road 60 bridge at Vero Beach.

Description of Management for Closures and Acres
- **7001 Indian River/St. Lucie approved:** Closed during emergency conditions, including hurricanes, tropical storms, sewage discharges, red tides, and illnesses. 2,025 acres.
- **7005 Indian River/St. Lucie restricted:** Closed by FDACS at all times except during supervised shellfish relay operations with approved participants. Closed during emergency conditions, including hurricanes, tropical storms, sewage discharges, red tides, and illnesses. 4,055 acres.

Shellfish Area 2: 72 North Indian River

Aquatic Preserve: IR-Malabar to Vero Beach

Brief description of extents: All waters of the Indian River north of the State Road 510 bridge at Wabasso and south of ICW marker 59 at the Sebastian Inlet.

Description of Management for Closures and Acres
- **7202 North Indian River conditionally approved:** Closed when four-day cumulative rainfall measured at the Sebastian Inlet State Recreation Area exceeds 4.37 inches. 3,623 acres.
- **7206 North Indian River conditionally restricted:** Closed by FDACS at all times except during supervised shellfish relay operations with approved participants. When open for relay operations, the area will be closed when four-day cumulative rainfall measured at the Sebastian Inlet State Recreation Area exceeds 4.37 inches. 1,886 acres.

Shellfish Area 2: 74 Body F

Aquatic Preserve: IR-Malabar to Vero Beach

Brief description of extents: All waters of the Indian River north of ICW marker 59 at the Sebastian Inlet and south of ICW marker 16 at Cape Malabar.

Description of Management for Closures and Acres
- **7412 Body F conditionally approved:** Closed when six-day cumulative rainfall measured at the DEP Sebastian Inlet Recreation Area exceeds 4.93 inches. 6,037 acres.
- **7416 Body F conditionally restricted:** Closed by FDACS at all times except during supervised shellfish relay operations with approved participants. When open for relay operations, the area will be closed when six-day cumulative rainfall measured at the DEP Sebastian Inlet Recreation Area exceeds 5.7 inches. 4,325 acres.

Shellfish Area 2: 79 South Banana River

Aquatic Preserve: Banana River

Brief description of extents: All waters of the Banana River and Newfound Harbor north of the State Road 518 bridge near Dragon Point and south of the federal No Motor Zone (Port Canaveral).

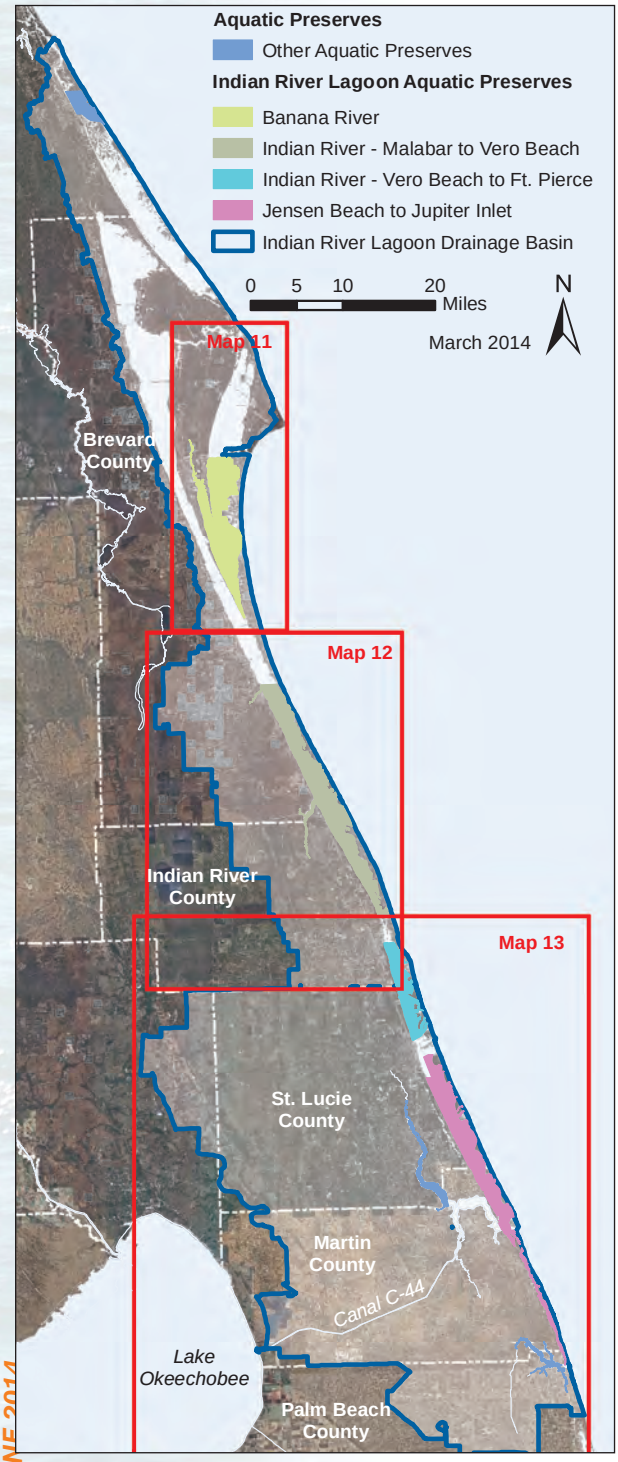
Description of Management for Closures and Acres
- **7902 South Banana River conditionally approved:** Closed when one-day cumulative rainfall measured at the Cape Canaveral Wastewater Treatment Plant exceeds 1.55 inches. 13,805 acres.
- **7906 South Banana River conditionally restricted:** Closed by FDACS at all times except during supervised shellfish relay operations with approved participants. When open for relay operations, the area will be closed when one-day cumulative rainfall measured at the Cape Canaveral Wastewater Treatment Plant exceeds 1.57 inches. 9,795 acres.

Table obtained from FDACS website:www.floridaaquaculture.com/seas/seas_sums

Table 1 | Description of Shellfish Harvest Areas.

Surface Water and Drainage Patterns

The IRL is divided between St. Johns River Water Management District (SJRWMD) and the South Florida Water Management District (SFWMD). The boundary between the two water management districts occurs roughly at the Indian River/St. Lucie County line. As a result, the Banana River and IR-Malabar to Vero Beach aquatic preserves fall under the jurisdiction of SJRWMD. Jensen Beach to Jupiter Inlet Aquatic Preserve falls under the jurisdiction of SFWMD. IR-Vero Beach to Ft. Pierce Aquatic Preserve straddles the boundary between the two districts with approximately half of the aquatic preserve under each jurisdiction.



Map 10 / Indian River Lagoon drainage basin.

The Florida Legislature enacted the Surface Water Improvement and Management (SWIM) Act in 1987 and revised it in 1991 (Chapter 373.451-373.4595, F.S.). The act declared that the IRL was becoming degraded as a result of point and non-point sources of pollution and the destruction of natural habitats. The SJRWMD and SFWMD jointly developed the 1989 SWIM Plan for the IRL in an effort to comply with the SWIM mandate. The IRL SWIM Plan was updated in 1994 and again in 2003. Each update addressed the current status on the state of the lagoon, a summary of progress on projects undertaken since the previous update and recommendations for future projects and actions. Consequently, the IRL SWIM Plan contains an exhaustive description of the IRL watershed and individual sub-basins (see Map 10). A summary of key surface water and drainage patterns for each of the four aquatic preserves in the IRL System follows.

Banana River Aquatic Preserve - Banana River Aquatic Preserve is characterized by large areas of open water affected by a relatively small watershed drainage area (see Map 11). The watershed area and the area of open water are roughly equal. The northern boundary of Banana River Aquatic Preserve is located immediately south of the Canaveral Lock. The lock is the only connection between Banana River Aquatic Preserve and the Atlantic Ocean. The small watershed associated with the Banana River limits the amount of fresh water entering the lagoon. During most of the year, evaporation in the Banana River exceeds freshwater input. As a result, an input of surface water from the adjacent IRL must make up the difference. This pattern tends to prevent flow of water out of the Banana River Lagoon and severely limits potential flushing action. The surface drainage divide between the Banana River Lagoon and the IRL follows Kennedy Parkway on Merritt Island south until the Parkway turns west and then south along a dune ridge. Sykes Creek and Newfound Harbor are the primary tributaries to the Banana River (DEP, 2006). Other drainage is contributed from Merritt Island.

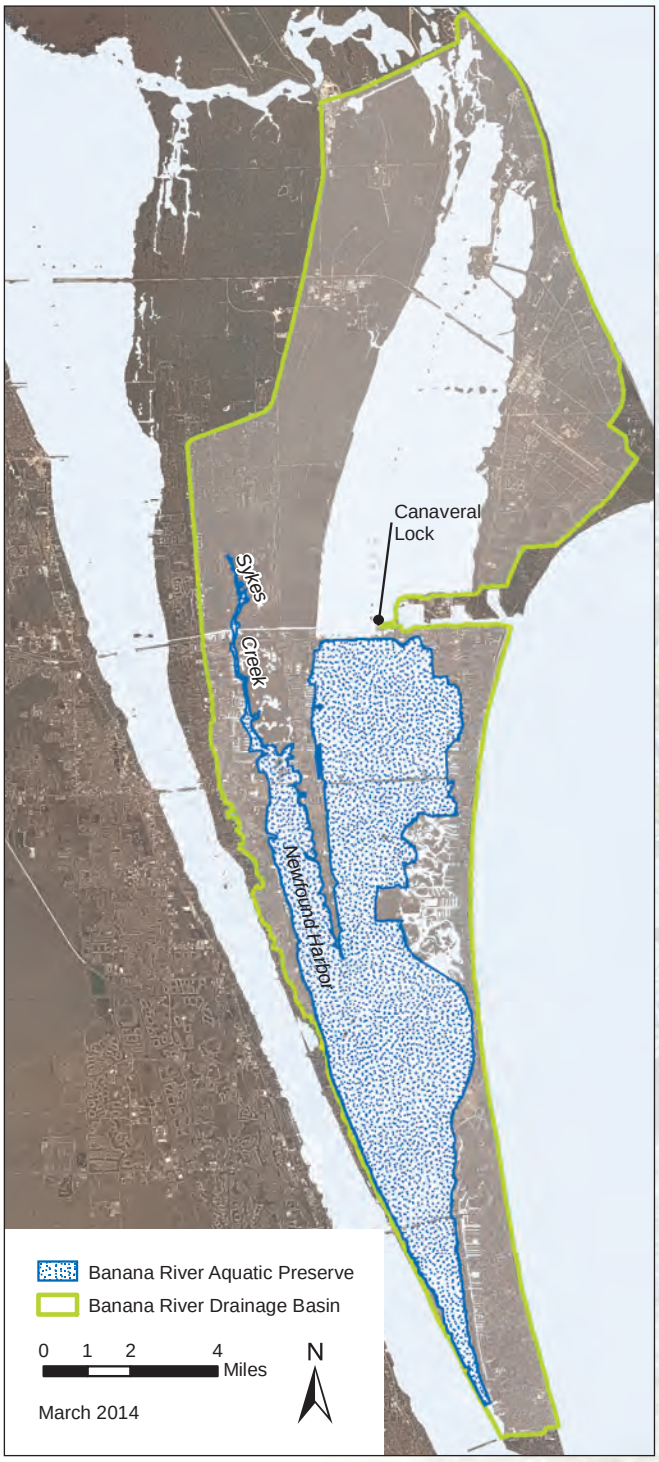
Indian River-Malabar to Vero Beach Aquatic Preserve - The IR-Malabar to Vero Beach Aquatic Preserve watershed boundary extends eastward to the barrier island dune line (see Map 12). Historically, the location of the Atlantic Coastal Ridge west of the lagoon determined the western limits of the aquatic preserve's natural watershed basin. This ridge is less than three miles from the lagoon in Brevard County. In Indian River County, the St. Sebastian River naturally drains some of the area west of the Atlantic Coastal Ridge to the lagoon by flowing through a break in the coastal ridge. Much of the historical basin boundary has been expanded westward by drainage projects that allow water from the Upper St. Johns River Basin to be diverted to the IR-Malabar to Vero Beach

Aquatic Preserve. Major cities and towns in IR-Malabar to Vero Beach Aquatic Preserve include Palm Bay, Sebastian and Vero Beach.

Turkey Creek enters the IRL south of Melbourne. It collects drainage from urbanized and agricultural areas of Palm Bay. Starting in the 1920s the watershed for Turkey Creek was greatly expanded by the Melbourne-Tillman Water Control District to include about 98 square miles of the Upper St. Johns River Basin – nearly a sevenfold increase in drainage area (Steward, Brockmeyer, Gostel, Sime, & Van Arman, 2003). The C-1 Canal is the primary drainage canal connecting the Upper St. Johns River Basin to IR-Malabar to Vero Beach Aquatic Preserve. Goat, Kid and Trout Creek sub-basins are south of Turkey Creek.

The St. Sebastian River sub-basin extends from Grant south to Wabasso and covers approximately 172 square miles. Drainage canals within the St. Sebastian River Water Control District and Fellsmere Water Control District drainage areas have resulted in significant westward expansion of the St. Sebastian River sub-basin (Steward, Brockmyer, Gostel, Sime, & Arman, 2003). The C-54 Canal diverts water from the Upper St. Johns River Basin to IR-Malabar to Vero Beach Aquatic Preserve through its connection with the St. Sebastian River. The C-54 Canal contributes approximately 25 percent of the St. Sebastian River flow.

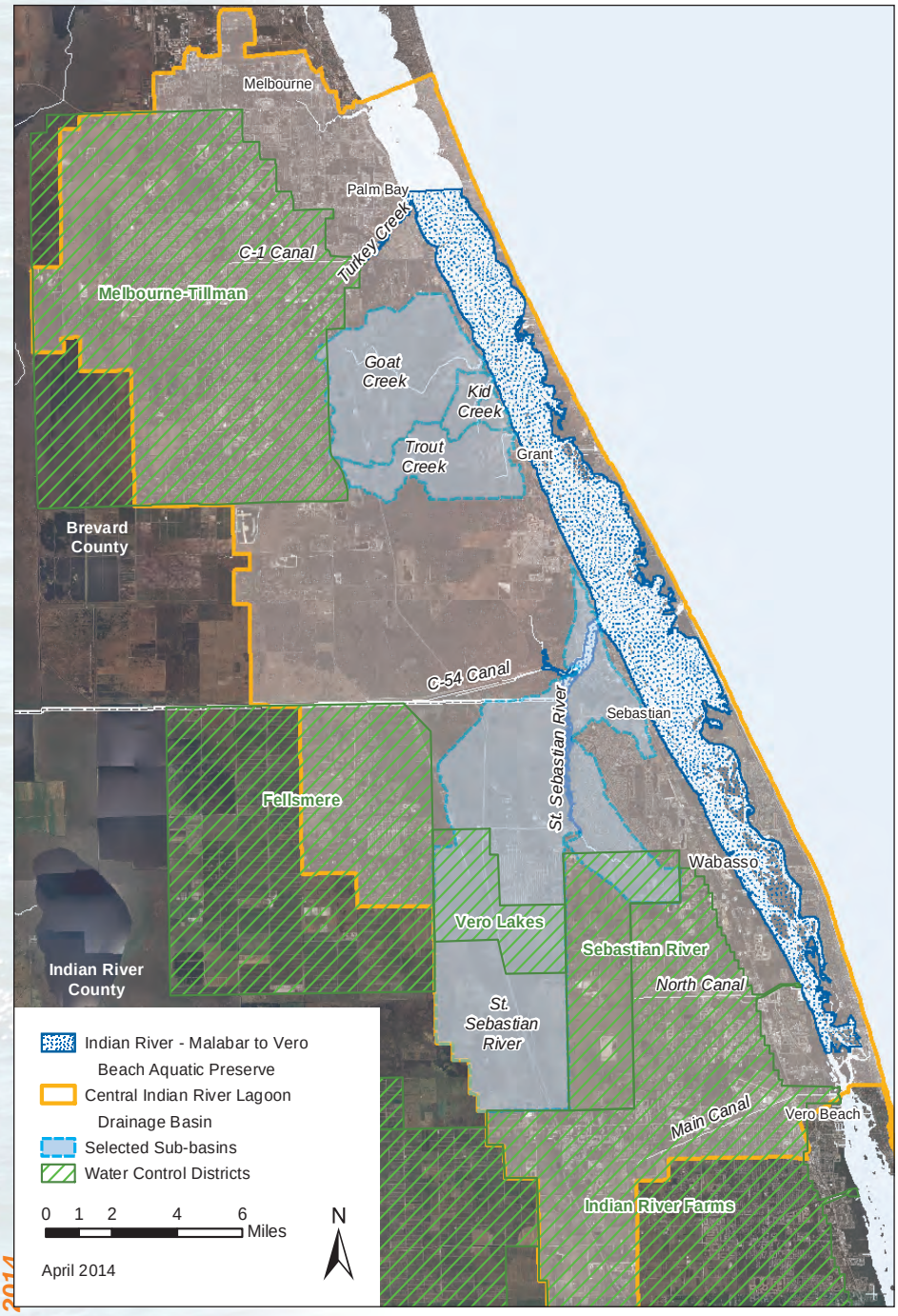
Indian River-Vero Beach to Ft. Pierce Aquatic Preserve - The IR-Vero Beach to Ft. Pierce Aquatic Preserve watershed boundary extends eastward to the barrier island dune line (see Map 13). The western boundaries are less easily defined. The southern boundary of IR-Malabar to Vero Beach Aquatic Preserve and the northern boundary of IR-Vero Beach to Ft. Pierce Aquatic Preserve are based on political boundaries rather than distinct physiographic regions. As a result, both aquatic preserves share the Indian River Farms Water Control District sub-basin. The District is located in southeastern Indian River County and drains approximately 80 square miles. This sub-basin is a 50/50 mix of agriculture and urban growth within and surrounding Vero Beach (Woodward-Clyde, 1994). Discharges from this District are directed to the IRL through three primary canals. The North Canal drains into the southern end of IR-Malabar to Vero Beach Aquatic Preserve four miles south of the Wabasso Causeway. The Main Canal empties into the IRL near the Merrill P. Barber Bridge midway between the two aquatic preserves. The South Canal is the primary source of freshwater into IR-Vero Beach to Ft. Pierce Aquatic Preserve and drains into the IRL at the northern end of the aquatic preserve. Major cities and towns in IR-Vero Beach to Ft. Pierce Aquatic Preserve include Ft. Pierce and Vero Beach.



Map 11 / Banana River Lagoon drainage basin.

Jensen Beach to Jupiter Inlet Aquatic Preserve - Jensen Beach to Jupiter Inlet Aquatic Preserve comprises the 1,050-square-mile St. Lucie River watershed and the C-25 Canal watershed to the north (see Map 13). The adjacent Loxahatchee watershed, to the south, is 278 square miles in size (see Map 13). The watershed boundary extends eastward to the barrier island dune line. The western boundaries

are less easily defined. The watershed's western boundary has been altered and surface waters that once flowed into the Lake Okeechobee basin are now diverted into Jensen Beach to Jupiter Inlet Aquatic Preserve. Within this region, the Green Ridge becomes discontinuous and moves away from the coast to the west. This allows the St. Lucie and Loxahatchee rivers to drain broad low-lying areas up to 20 miles west from the coast. The IRL's drainage basin now extends up to 30 miles to the west and includes portions of St. Lucie, Martin, Palm Beach and Okeechobee counties. It has been estimated that approximately 60 percent of the Jensen Beach to Jupiter Inlet watershed is now comprised of artificially expanded watershed (Woodward-Clyde, 1994).



Map 12 / Central Indian River Lagoon drainage basin.

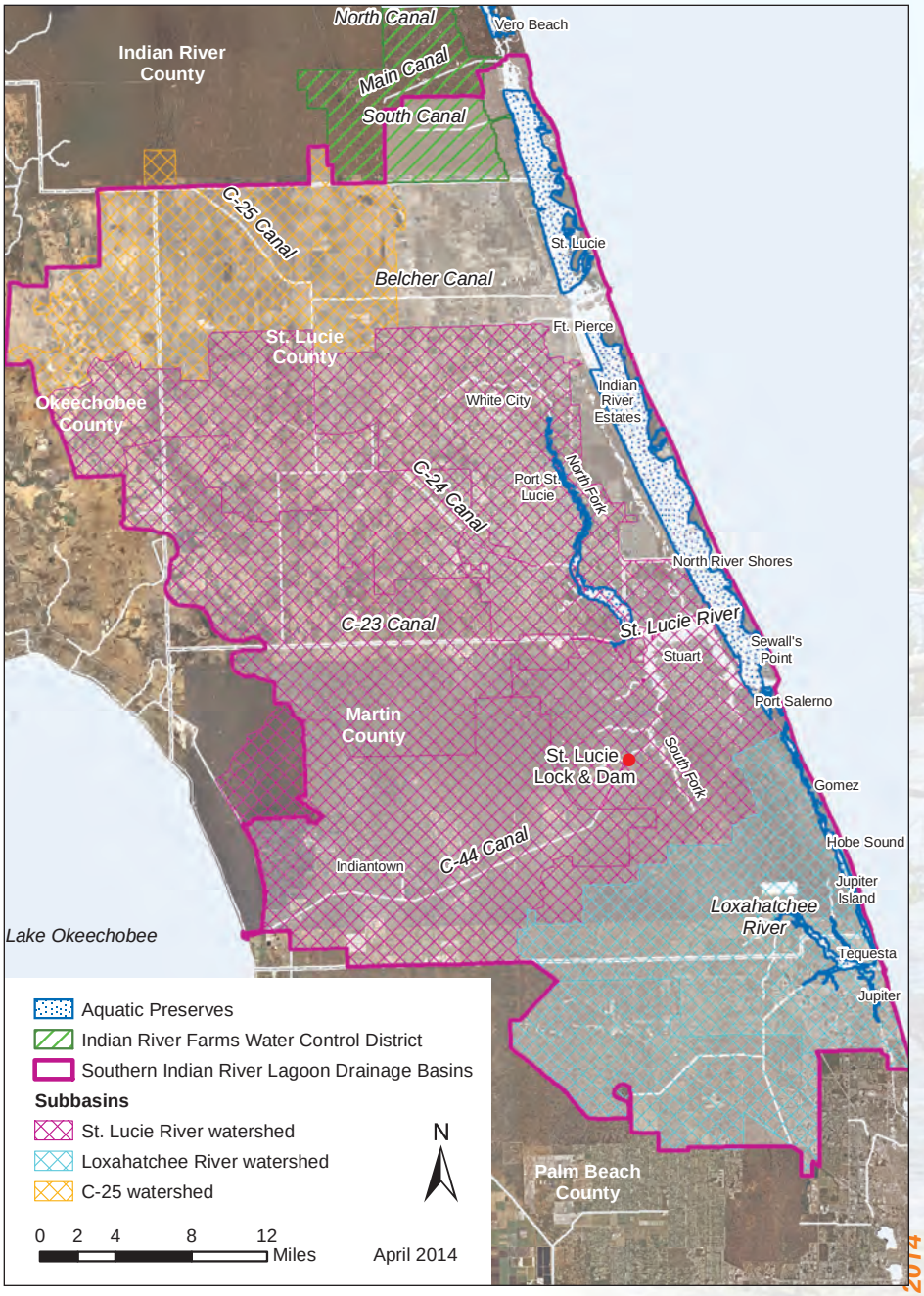
Extending as far as the Lake Okeechobee watershed, the St. Lucie River watershed consists of former wetlands that have been extensively drained for agriculture. The inner St. Lucie Estuary is composed of the South Fork and North Fork of the St. Lucie River. These converge to form a single middle estuary that extends eastward to the IRL. Historically, this area included a much smaller natural watershed that directly contributed to the river system. Interior areas of Martin and St. Lucie counties contained large expanses of poorly drained wetlands that did not directly feed to the river and estuary.

Beef cattle and citrus production are the largest agricultural activities in the St. Lucie River watershed, with rangeland and improved pasture covering more than 25 percent of the area. In contrast to the St. Lucie River watershed, wetlands remain the predominant land cover in the Loxahatchee watershed, and a much lower percentage of the watershed is used for agriculture, primarily citrus. Urban sprawl and new residential development are increasing, both within the watershed and in the rapidly developing region to the south. Many areas of the Loxahatchee watershed that are not developed for residential purposes have been purchased or are being purchased for conservation. Major cities and towns in Jensen Beach to Jupiter Inlet Aquatic Preserve include Ft. Pierce, Gomez, Hobe Sound, Indian River Estates, Indiantown, Jupiter, Jupiter Island, North River Shores, Palm City, Port St. Lucie, Port Salerno, River Park, St. Lucie, Sewall's Point, Stuart, Tequesta, Viking and White City.

A major ditch and canal system is associated with the Central and South Florida Flood Control Project (CSFFCP) and includes large portions of St. Lucie and Martin counties. Begun in the 1950s by the U.S.

Army Corps of Engineers (ACOE), the CSFFCP was designed to control flooding in south Florida. The primary conveyance canals of this system are the C-25, C-24, and C-23 canals which discharge to the Belcher Canal as well as to the North Fork St. Lucie River. The North Fork St. Lucie River discharges through the middle and lower St. Lucie Estuary to Jensen Beach to Jupiter Inlet Aquatic Preserve.

The C-44 Canal (a.k.a. St. Lucie Canal or Okeechobee Waterway) is the largest drainage channel in the IRL System. Constructed between 1916 and 1924, the C-44 Canal connects Lake Okeechobee to the South Fork St. Lucie River through a control structure. The canal's purpose was to prevent additional flooding around Lake Okeechobee, create a navigation channel and convert swampland into developable land. The C-44 Canal has been managed by ACOE since the 1930s and is now viewed as a conduit of unwanted releases of large volumes of freshwater and pollutants from Lake Okeechobee into Jensen Beach to Jupiter Inlet Aquatic Preserve (DEP, 2013a). Regulatory releases through the main control structure on the C-44 Canal occur if lake levels become high enough that the integrity of the surrounding dike is threatened. These releases are known to quickly reduce salinity to near freshwater levels in Jensen Beach to Jupiter Inlet Aquatic Preserve, and can distress and kill estuarine flora and fauna. Other discretionary releases are made for the ecological health of the lake or to avoid larger regulatory releases when large amounts of regional rainfall are expected (SFWMD, 2011).



Map 13 | Southern Indian River Lagoon drainage basins.

Drainage Districts, formed in the 1910s through 1930s under Chapter 298 of the Florida Statues, were established for the purposes of controlling flooding and removing ground and surface water. A summary of principal Drainage Districts in the IRL System include:

- Melbourne-Tillman Drainage District (a.k.a. Water Control District of South Brevard) which discharges to Turkey Creek in Brevard County. Turkey Creek drains to the northern end to IR-Malabar to Vero Beach Aquatic Preserve.
- Fellsmere Farms and St. Sebastian River Water Control Districts in Indian River County which both discharge to the St. Sebastian River. The St. Sebastian River drains to the central portion of the IR-Malabar to Vero Beach Aquatic Preserve.
- Indian River Farms Water Control District in Indian River County which discharges through the Vero North, Main and South Canals to the lagoon. The Vero North Canal discharges to the southern end of IR-Malabar to Vero Beach Aquatic Preserve. The Vero Main Canal discharges to the IRL near the base of the Merrill Barber Causeway located midway between IR-Malabar to Vero Beach and IR-Vero

Beach to Ft. Pierce aquatic preserves. The Vero South Canal discharges to the northern end of IR-Vero Beach to Ft. Pierce Aquatic Preserve.

- Ft. Pierce Farms and North St. Lucie Water Control Districts in St. Lucie County, which discharge to the Belcher Canal. The Belcher Canal discharges to the IRL in Ft. Pierce in between IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves.

Point Source and Non-Point Source Pollution - Potential pollution sources affecting water quality in the IRL System can either be classified as point sources or non-point sources. Point sources are those where the discharge is usually through a discrete and identifiable point such as wastewater treatment plants. Non-point sources are generally a result of stormwater runoff entering the IRL System through either overland flow or stream flow. Point and non-point sources of pollution impacting the IRL System have been extensively documented by sub-basin and are detailed in individual Basin Management Action Plans (BMAPs) published by DEP, Division of Environmental Assessment and Restoration, Bureau of Watershed Restoration.

Paragraph 403.067(7)(a)1, F.S., authorizes DEP to adopt BMAPs that provide for phased implementation of the strategies necessary to ultimately achieve the associated total maximum daily loads (TMDLs). TMDLs are water quality targets, based on state water quality standards, for specific pollutants (including nutrients such as nitrogen and phosphorus). DEP adopted nutrient TMDLs for the IRL Basin in March 2009. The TMDLs focus on the water quality conditions necessary for seagrass growth at water depth limits where seagrass previously grew in the basin, based on a multiyear composite of seagrass coverage. The median depth limits of seagrass coverage in the IRL Basin have decreased over the years due to decreased water quality resulting from human (anthropogenic) influences. As polluted runoff reaches the lagoon, it creates conditions that prevent the seagrass from growing in deeper water.

To determine the amount of nutrient reductions needed to improve lagoon water quality in each sub-basin, the TMDL analysis regressed three years of loading levels against the same years' seagrass coverage to calculate the restoration target of 10 percent less than the multiyear composite of historical seagrass depth limit coverage. This target is based on historical seagrass data from 1943 to 1999 to determine at what depths the deep edge of the seagrass beds previously grew. Since changes in the IRL Basin will likely prevent 100 percent restoration of seagrass at these depths, the TMDL allowed for a 10 percent reduction in the target seagrass depth. The 10 percent reduction was selected to be consistent with the water quality criteria in Rule 62-302, Florida Administrative Code, which allows up to a 10 percent reduction in the photo-compensation point. This target should result in nutrient reductions that allow seagrass to grow almost to the depths previously seen in the area.

Due to the large geographic extent of the IRL Basin and the hydrologic differences throughout the basin, DEP determined the best way to address the TMDLs for the IRL Basin would be to divide it into four sub-basins: (1) Banana River Lagoon, (2) North IRL, (3) Central IRL, and (4) St. Lucie River and Estuary. Separate BMAPs were developed for each of these four sub-basins. The entire Banana River Aquatic Preserve is included in the Banana River Lagoon BMAP. The North IRL BMAP includes areas outside of the AP boundaries. The Central IRL BMAP includes all of the IR-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce aquatic preserves. The St. Lucie River and Estuary BMAP addresses the majority of the Jensen Beach to Jupiter Inlet Aquatic Preserve (northern boundary to just south of the St. Lucie River). To date, TMDLs have not been developed for the Loxahatchee River Basin. Consequently there is no BMAP in place which addresses the extreme southern portion of Jensen Beach to Jupiter Inlet Aquatic Preserve.

Groundwater and Wells - There are three basic units of the hydrogeologic framework underlying Florida and the IRL System: the Floridan Aquifer, the intermediate aquifer and the surficial aquifer. The Floridan Aquifer is a system of limestone and dolomite beds and is the main source of potable water in the five counties that contain the IRL System. The top of the Floridan Aquifer quickly descends in elevation (north to south) from 200 feet below mean sea level to 700 feet below mean sea level in the IRL System (Causey & Leve, 1976). The surficial aquifer is a system of sand and shell deposits with uppermost layers contiguous with the land surface. Groundwater from the surficial aquifer is an important freshwater input to the IRL System. Surficial aquifer seepage to the IRL System accounts for approximately 10 percent of all freshwater input to the lagoon (Pandit & El-Khazen, 1990). Confining layers (clay) in the intermediate aquifer separate the surficial aquifer from the Floridan Aquifer.

Within the five-county region, public water supplies are obtained from both the Floridan Aquifer and the surficial aquifer via wells. In the southern portions of the IRL System, the Floridan Aquifer becomes brackish. Consequently, St. Lucie, Martin and Palm Beach counties have historically relied on the surficial aquifer system for public water supply. Recognizing the potential impacts to wetlands, as well

as the increased potential for saltwater intrusion, the SJRWMD and SFWMD have reduced permitted withdrawals from the surficial aquifer. Water use for agricultural irrigation far exceeds that for public supply. In Brevard and Indian River counties, over half of the water used for agriculture consists of groundwater extracted from the surficial aquifer via shallow wells. Surface water continues to be the primary source of water supply for the agricultural industry in St. Lucie, Martin and Palm Beach counties (Bader, 2012; SFWMD, 2011).

Surface Water Quality and Monitoring - Water quality monitoring is necessary to determine that water bodies meet public health standards, will support fisheries and maintain standards to meet their specific designations such as OFW and Shellfish Propagation and Harvesting (Class II Waters). Besides providing a general summary of the condition of water quality, monitoring can identify seasonal, as well as shorter and longer-term trends, specific pollution sources or events, freshwater inflows and pollutant loadings, and is essential for state TMDL determinations. Parameters, such as water temperature, are measured to gauge the effect of the solubility of oxygen, the rate of photosynthesis, and the metabolic rates of numerous aquatic organisms. Dissolved oxygen is essential for the survival of fish and other aquatic organisms and indicates the amount of oxygen dissolved in a body of water. pH is a measure of acidity of a water body. Knowledge of pH is important because most aquatic organisms are adapted to live in water with a pH between 5.0 and 9.0. Biological activity, however, may significantly alter pH in an estuary. An overabundance of algae may cause pH levels in an estuary to rise significantly, which can be lethal to aquatic animals. Turbidity provides a measure of water clarity, as it is affected by the amount of suspended solids in the water column. Suspended solids range from clay, silt, topsoils and plankton to industrial and agricultural wastes and sewage. Turbidity increases when suspended solids are carried into water bodies by wind, rain and runoff. These sediments can severely limit the amount of sunlight penetrating the water column, thus affecting seagrasses. Salinity values specify the total concentration of salts in the water. Salinity values fluctuate according to volumes of seawater entering through inlets and freshwater inputs from tributaries, rain, stormwater and groundwater seepage. Oxidation-Reduction Potential (ORP) is a measure of water's tendency to support oxidizing or reducing chemical reactions. In other words, ORP measures the amount of oxidizers, those wanting to take oxygen from the environment. ORP measurements provide qualitative information about many chemical reactions that affect aqueous biota. In addition, ORP is a good indicator of the presence of industrial oxidizing chemicals such as chlorine used to disinfect drinking and waste water. Changes in long-term ORP trends can signal the need for more detailed chemical study of the water and its contamination sources. Long-term analysis of each water quality parameter helps to establish a clear picture of the status and trends in water quality within the IRL System (see Section 4.2.1 for information on the historical water quality data set).

The Florida STORage and RETrieval (STORET) database serves as the primary repository of ambient water quality data for the state of Florida. DEP pulls water quality data used for water evaluations directly from the STORET database. SJRWMD, SFWMD, DEP, and numerous local stakeholders currently upload water quality data for the IRL System into STORET. All data providers have agreed to upload ambient water quality data to STORET at least once every six months, upon completion of the appropriate quality assurance/quality control checks.

IRL System water quality monitoring stations in the STORET database include the following parameters:

- Total Phosphorous
- Orthophosphate as Phosphorous
- Nitrate/Nitrite as Nitrogen
- Nitrogen, Ammonia
- Total Kjeldahl Nitrogen
- Dissolved Oxygen
- Biochemical Oxygen Demand
- Chlorophyll-a
- pH
- Temperature
- Specific Conductance
- Total Suspended Solids
- Turbidity
- Alkalinity

The monitoring network includes stations throughout the IRL System which are sampled by federal, state, and local entities. The SJRWMD monitors monthly stations throughout the Banana River, IR-Malabar to Vero Beach and northern half of the IR-Vero Beach to Ft. Pierce aquatic preserves. In addition, long-term stations are monitored by the Indian River Farms Water Control District and St. Sebastian River

Improvement District for water quality and U.S. Geological Survey (USGS) for flow in the IR-Malabar to Vero Beach and northern half of IR-Vero Beach to Ft. Pierce aquatic preserves.

SFWMD monitors monthly stations throughout the southern half of the IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves. Within Jensen Beach to Jupiter Inlet Aquatic Preserve, long term stations are also monitored by Fort Pierce Farms and North St. Lucie River water control districts, Hobe St. Lucie Conservancy District, Port St. Lucie, St. Lucie County, St. Lucie West Services District and USGS.

Harbor Branch Oceanographic Institute (HBOI) at Florida Atlantic University is focusing on the relationship of water quality in the IRL with seagrasses, macroalgae, and phytoplankton through the IRL Research Initiative. Since May 2005, scientists have been conducting high-frequency water quality monitoring in IR-Vero Beach to Ft. Pierce Aquatic Preserve. Monitoring is being conducted in order to identify water quality gradients related to freshwater discharges and significant climate-related interannual variability in water quality. Monitoring efforts are focusing on salinity, water clarity, nutrients and suspended solids.

The Smithsonian Marine Station at Ft. Pierce maintains a water quality sensor and continuous datalogger on their research vessel dock. Measured water quality parameters include conductivity, salinity, dissolved oxygen, pH, chlorophyll and total dissolved solids. Current water quality data can be viewed on the Marine Station's website (www.sms.si.edu/Research.htm).

The Ocean Research and Conservation Association (ORCA), located in Ft. Pierce, has developed and is testing the ORCA Kilroy Network. The ORCA Kilroy Network consists of a wireless network of remote semiautonomous sensor systems. The network is coordinated by a central supervisory system that directs operations of the remote systems, collects data, and relays them via the internet through a standard web service interface to a geospatial database in near real time. Kilroy sensors have the capacity to measure flow direction/velocity, depth, temperature, salinity, dissolved oxygen, nitrate levels and prevalence of key microorganisms. ORCA has established a long term monitoring network of six stations in the vicinity of the Ft. Pierce Inlet. Near real time and historical data for this network can be accessed at the ORCA Kilroy website (api.kilroydata.org/public/).

The Marine Resources Council (MRC) manages the Indian River Lagoonwatch Program, a volunteer based water quality program in the IRL. The Lagoon Watch Program is supported by the IRL National Estuary Program and EPA. Eighty citizen volunteers, trained and equipped by MRC, test water quality parameters as indicators of the health of the IRL. Every week salinity, dissolved oxygen, pH, and water clarity are tested at approximately 80 sites. Fecal coliform and nutrients are also tested at selected sites. MRC staff then processes the data into a color-coded map for each of the key water quality parameters. The collection of data reflects the history of the IRL water quality progress or degradation. Data is available to the public on the MRC website (www.mrcirl.org/water/watch.html).

The Shellfish Environmental Assessment Section in the Bureau of Aquaculture Environmental Services, FDACS, is responsible for classifying and managing Florida shellfish harvesting areas. The goal of shellfish harvesting area classification and management is to provide maximum utilization of shellfish resources and to reduce the risk of shellfish-borne illness. FDACS routinely monitors fecal coliform and water quality parameters at established stations in each of Florida's shellfish harvesting areas. Subsurface water samples are collected, placed in ice-filled coolers and shipped overnight to a certified laboratory. The analysis for fecal coliform takes 24 hours, and numbers of bacteria are expressed in the units of Most Probable Number per 100 milliliters (ml). Shellfish harvesting area locations, described previously in this chapter, are located in the Banana River, IR-Malabar to Vero Beach, and IR-Vero Beach to Ft. Pierce aquatic preserves.

Historic Hydrologic Alterations - The hydrology of the IRL System has been altered by the construction and dredging of inlets and channels, the construction of causeways, and the impoundment of wetlands for mosquito control.

Inlets - The barrier island chain separating the IRL System from the Atlantic Ocean is currently intersected by five inlets which have been either stabilized or man-made. The Canaveral Lock, Sebastian Inlet, Ft. Pierce Inlet, St. Lucie Inlet and Jupiter Inlet are the only connections between the IRL System and the Atlantic Ocean. Of these, the Jupiter Inlet is the only historically natural connection to the ocean. Inlets in the IRL System act as a total littoral sink to sediment transport along the adjacent shorelines. Regular dredging of the inlets is necessary to maintain adequate depth and renourish the downdrift beach to counter erosion.

Port Canaveral **-** Port Canaveral is a man-made inlet and deep water port located on the Atlantic Ocean in Brevard County, immediately north of the Banana River Aquatic Preserve boundary. Constructed as

a federal navigation project between 1951 and 1954, the port is connected to the ICW via barge canal and a navigation lock. Protected by dual rock jetties, the entrance channel is maintained to a depth of approximately 46 feet mean low water. Tidal flow through the inlet is limited due to the presence of the Canaveral Lock. The Canaveral Lock is the largest navigation lock in Florida. Located between Port Canaveral's west turning basin and the Banana River, Canaveral Lock was constructed by ACOE in 1965 to secure safe passage of vessels from the Banana River to Port Canaveral and the Atlantic Ocean. The lock reduces tidal-current velocities in Canaveral Harbor, prevents entry of hurricane tides into the Banana River and prevents salt water intrusion (CH2M Hill, 2007).

Sebastian Inlet **-** The Sebastian Inlet is a man-made inlet which connects the Atlantic Ocean with IR-Malabar to Vero Beach Aquatic Preserve. It is situated on the county line between Brevard and Indian River counties. The Sebastian Inlet District was created in 1919 by special act of the Legislature of the State of Florida thereby providing for a governing body to oversee construction and maintenance of the inlet through the levy of taxes. In 1924, the Sebastian Inlet was opened at its current location and small jetties were completed. In 1941 the Inlet closed due to a nor'easter. For safety reasons, it was left closed during World War II, then permanently blasted open in 1947 and has remained open since. It wasn't until 2006 that the Sebastian Inlet District received state and federal permits to dredge the connection from the Inlet to the ICW. The dredging was completed and navigation markers were installed July 2007. Dredging was most recently conducted in 2010 and 2012. The Commission of the Sebastian Inlet District, in coordination with the State of Florida, authorizes programs and projects for beach renourishment, erosion control, environmental protection, navigation, boating, recreation and public safety (Sebastian Inlet District, 2013).

Ft. Pierce Inlet **-** The Ft. Pierce Inlet and port separates the IR-Vero Beach to Ft. Pierce Aquatic Preserve and the Jensen Beach to Jupiter Inlet. Initial dredging of the Fort Pierce Inlet and construction of the associated port began in 1920. In 1995 ACOE modified the Fort Pierce Harbor and enlarged the inlet channel to 30 feet by 400 feet, the interior channel to 28 feet by 250 feet, and dredging of the turning basin to a depth of 28 feet. In early 2013, St. Lucie County received emergency funding to dredge the inlet. Reduced commercial traffic due to the downturn in the economy has lowered the priority for ACOE-funded dredging (ACOE, 2013).

St. Lucie Inlet **-** The St. Lucie Inlet is a navigation channel located at the southern tip of South Hutchinson Island that has provided ocean access for the shipping of goods and for commercial, charter and fishing activities since the 1800s. Private local interests created the artificial inlet in 1892, with a channel five feet deep over a bottom width of 30 feet. By 1922, the inlet had widened to 2,600 feet through natural processes. In an attempt to stabilize a navigation channel through the inlet, a 3,325-foot stone jetty was constructed along the northern side of the inlet between 1926 and 1929. The St. Lucie Inlet was established as a federally authorized project in 1945. Maintenance dredging and stabilization projects have been periodically conducted by ACOE. Structural improvements made by ACOE were partially completed in 1982, including: extensions of the north and south jetties, construction of a 450-foot detached breakwater to shelter the navigation channel, and partial excavation of an impoundment basin inside the inlet adjacent to the north jetty. Federal improvements were continued in 2002, with the expansion and deepening of the impoundment basin to a 20-foot depth. In 2009, the seaward section of the north jetty was raised to an elevation of eight feet above sea level to better protect boats navigating the inlet, improve the efficiency of the impoundment basin and allow better access for the dredges that maintain the inlet (ACOE, 2013).

In January 2012, the Martin County Board of County Commissioners unanimously approved the award of a 6.4 million dollar contract to dredge the St. Lucie Inlet. The dredging was completed on April 21, 2012. During the project, 472,000 cubic yards of sand were dredged from the Inlet and used to renourish the beach on Jupiter Island (Martin County, 2013).

Jupiter Inlet **-** The Jupiter Inlet is the only naturally occurring inlet affecting the IRL System. The inlet is located immediately south of the Jensen Beach to Jupiter Inlet Aquatic Preserve. According to historical accounts, the Jupiter Inlet was first shown on explorers' maps in 1671 and other contemporary navigation charts (Jupiter Inlet District [JID], 2013a). Originally, this was the only outlet for the Loxahatchee River, Lake Worth Creek and Jupiter Sound. Part of the discharge from St. Lucie River and the southern part of Indian River was also diverted to the ocean through Jupiter Inlet. The total flow was sufficient to maintain adequate depth through the inlet except during severe storms when the inlet closed for short periods.

In 1920, the Jupiter Inlet District (JID), a special taxing district for the continued management and maintenance of the Jupiter Inlet and portions of the Loxahatchee River was formed. In 1922, the JID built two parallel jetties about 300 feet apart at the inlet. In 1929, the north and south jetties were

There are more than 120 spoil islands within the IRL System, most of which are owned by the state and managed by the IRLAP Office.

extended 200 feet and 80 feet, respectively. In 1940, JID built an angular groin at the seaward end of the south jetty. The intended purpose was to increase current velocities and induce scouring between the jetties, where closure of the inlet had recurred. In 1941, a 6-foot deep and 60-foot wide channel was dredged close to the south jetty. However, the inlet again closed in 1942 and remained as such until 1947. Since JID reopened the inlet in 1947, biennial maintenance dredging has kept the inlet open for small-craft navigation. In 1956, a 250-foot long concrete-capped sheet pile jetty was constructed 85 feet north of the existing north jetty. In 1966, JID working with a consulting engineering firm, initiated a 15-year improvement program. The present channel, about 165 feet wide, requires regular maintenance dredging. The frequency of dredging has increased from once every two to three years to once a year. In order to minimize erosion downdrift of the inlet, the JID seeks to place a minimum of 60,000 cubic yards on the south beach on an average annual basis (JID, 2013b).

Channels - The ICW was dredged to create a deep water channel for navigation. The channel is maintained at a depth of 12 feet north of Ft. Pierce and 10 feet south of Ft. Pierce in an otherwise shallow system. The ICW runs through the IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce, and Jensen Beach to Jupiter Inlet aquatic preserves. Dredged material from the ICW resulted in numerous spoil islands throughout the three aquatic preserves.

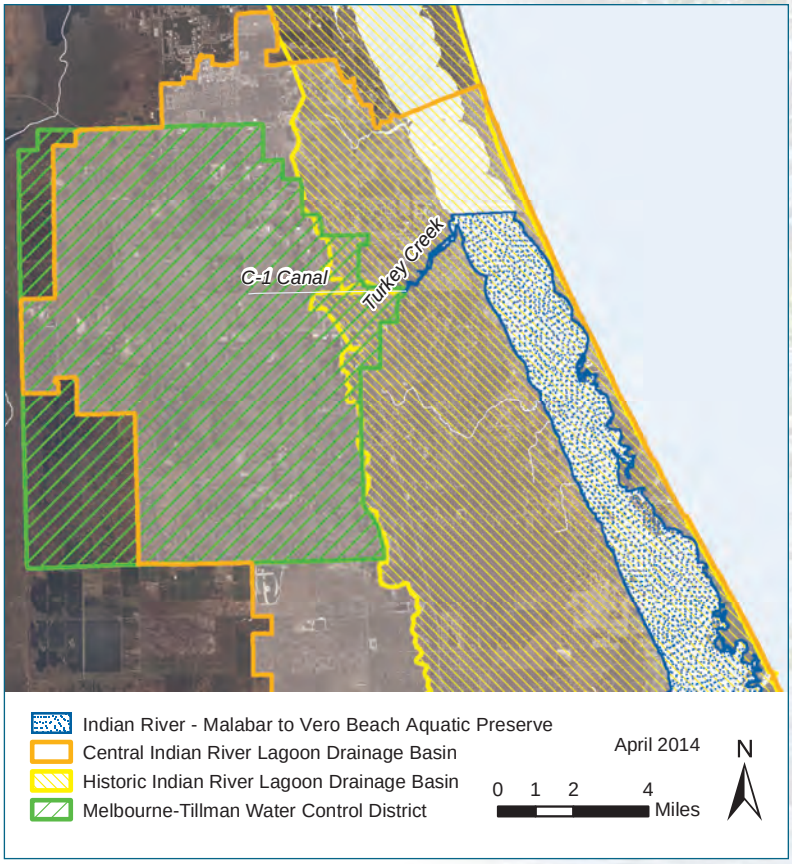
The Banana River Channel runs south to north, bisecting Banana River Aquatic Preserve. The Banana River Channel connects to the Saturn Barge Canal to the north and crosses the Canaveral Harbor Barge Canal just north of Banana River Aquatic Preserve.

The Canaveral Harbor Barge Canal was constructed at the same time as the lock to allow the transport of crude oil by barge to the two power plants south of Titusville. The canal provides an east/west link between the Atlantic Ocean and the IRL through a dredged cut across northern Merritt Island. The barge canal consists of two segments separated by Banana River Aquatic Preserve. The canal is 12 feet deep and bisects Sykes Creek, a major tributary of Banana River Aquatic Preserve. The Canaveral Inlet, Port, Lock and Harbor Canal are managed by ACOE in conjunction with the Canaveral Port Authority.

Causeways - Causeways built to connect the barrier islands to the mainland alter hydrology patterns at a more localized scale. Near shore portions of the IRL System have been filled to accommodate the construction of causeways, altering overall hydrologic connections in the IRL System by compartmentalization. Causeways reduce the width of open water at bridge crossings creating a bottleneck between each part (Woodward-Clyde, 1994).

Mosquito Impoundments - In the late 1950s and early 1960s mosquito control districts within the IRL System began building impoundments to control saltmarsh mosquitoes. This activity, allowing flooding during warmer months to prevent mosquito oviposition, was so intensive that fully 90 percent of mangrove and saltmarsh in the IRL System was impounded (Taylor, 2012). Impoundments are earthen dikes built around high marsh (salt marsh, mangrove forest). Interior borrow material is used, resulting in a perimeter ditch inside the impoundment. Approximately 40,000 acres of wetlands were impounded for mosquito control by the early 1970s, essentially severing their function from the estuary (Brockmeyer, Rey, Virnstein, Gilmore, & Earnest, 1997). Recently, however, there have been efforts to mitigate the effects of impounding by installing culverts through the dikes or removing sections of dikes to allow seasonal reconnection to the estuary, while still maintaining mosquito control flood elevations during the majority of the year (Taylor, 2012).

Canals - Historically, the IRL drainage basin was less than half the size it is today. Its natural boundary followed the Atlantic Coast Ridge. The 1916 Drainage Acts of Florida created a special taxing district to lower ground water levels, promote agriculture, and protect against flooding. From 1916 into the 1950s, canal systems were constructed, modifying streams and natural drainage patterns. During this time, the land area draining into the lagoon increased from approximately 572,000 acres to 1,400,000 acres (Adams et al., 1996). These activities altered both the volume and timing of water entering the lagoon. Upland rainwater in urbanized areas is discharged to the lagoon within hours of a storm event, a process which under natural conditions would take days or even weeks. Map 14 provides a good demonstration of the western expansion of the IRL watershed. Using the Melbourne-Tillman Water Control district as an example, Map 14 illustrates how flood control projects expand watershed acreage while at the same time creating point source discharges into the IRL. In the case of the Melbourne-Tillman Water Control district, approximately 60,000 acres of land which historically drained into the Upper St. Johns River have been drained by a series of canals which empty directly into Turkey Creek through the C-1 Canal,



Map 14 / Melbourne-Tillman Water Control District and Indian River Lagoon watershed expansion.

Hydrologic Restoration Projects

Mosquito Impoundment Reconnection - Research beginning in the 1960s proved the detriment of mosquito impoundments to the lagoon ecosystem both within and adjacent to the impoundments (Rey, Shaffer, & Crossman, 1990a; Rey, Shaffer, & Crossman, 1982; Harrington & Harrington, 1982). In order to provide for flushing and create pathways for faunal movement while still managing for mosquitoes, a technique known as Rotational Impoundment Management was developed (Clements & Rogers, 1964). Through this process, impoundments are flooded via pumps only during the key mosquito breeding months, typically May to October. Culverts installed in the impoundment dikes are left open for the remainder of the year to allow water levels to adjust naturally with the tides. A spillway prevents water from exceeding levels that would damage vegetation within the impoundment. The benefits of this management regime are well documented and include improved water quality (Rey, Shaffer, Kain, & Crossman, 1992), increased plant diversity (Rey et al., 1990b), and the creation of pathways for transient fish species (Brockmeyer et al., 1997).

In some areas it was deemed appropriate to go beyond the standard Rotational Impoundment Management design to further enhance impounded marshes. Select impoundments had their dikes either breached or backfilled into the perimeter ditch they were created from, allowing for year round,

permanent flushing of marshes. These types of restoration were done in areas where mosquitoes were no longer an issue or could be managed through alternative means.

In the 1990s, due much in part to the SWIM Plan and IRL National Estuary Program, Water Management Districts and county governments began a push to reconnect impoundments throughout the IRL. Of the almost 40,000 acres of impounded marsh, approximately 80 percent are reconnected in some fashion as of 2013 (personal communication, Ron Brockmeyer, May 2013). Much of the remaining targeted wetlands are private or federally owned areas of Brevard and Indian River counties.

Stormwater Retention - Issues with non-point nutrient pollution, estuarine habitat degradation, and a need for freshwater recharge of aquifers have pushed federal, state, and local governments to create ways of reducing stormwater discharges. Some of the largest projects being undertaken are by the Water Management and Water Control districts and aim at retaining or re-diverting freshwater flow from canals to mimic historic, natural flow patterns.

One such example, which encompasses both diversion and retention of stormwater, is the C-1 Canal re-diversion in the Melbourne/Palm Bay area. The canal system is managed by the Melbourne-Tillman Water Control District and drains freshwater from the region into Turkey Creek, part of IR-Malabar to Vero Aquatic Preserve. Historically, freshwater in this area ran west to the marshes of the upper St. Johns River. The influx of freshwater through the C-1 Canal increases nutrient loadings, reduces salinities, adds to muck deposition, and limits seagrass coverage of up to a 20 mile portion of the lagoon (SJRWMD, 2008). The C-1 Canal re-diversion project aims to reduce these impacts by limiting stormwater flow from canals into Turkey Creek.

Initial phases of this re-diversion project were completed in 2011, including improving local drainage infrastructure and revising operation of the associated control structure. Stormwater now flows into the C-1 retention area before being pumped into Sawgrass Lakes Water Management Area. Water in Sawgrass Lakes is treated and then released into the marshes of the upper St. Johns River. The final phases of construction will involve similar methods within the basin, pumping water from canals into the C-10 retention area. Water in the retention area will be treated and released into the Three Forks Marsh Conservation Area. Construction of final phases is scheduled to begin in 2014. Once completed, discharge volumes into the IRL are expected to be reduced up to 46 percent (SJRWMD, 2011) while nutrient loading (nitrogen and phosphorus) will be reduced by up to 59 percent annually (SJRWMD, 2012a).

Similar projects are being conducted throughout the lagoon. The list below identifies projects and links to up to date online information if available. Much of the information on hydrologic restoration projects is available online from the lead organizations listed below.

- The IRL BMAPs which were adopted in February 2013 also contain comprehensive information on hydrologic restoration projects done lagoon-wide. (www.dep.state.fl.us/central/Home/Watershed/BMAP.htm)
- SJRWMD project information updates for their region from Nassau to Indian River counties. (www.sjrwmd.com/upperstjohnsriver/)
- The Comprehensive Everglades Restoration Plan is the joint effort of federal and state agencies to restore historic water flow to the Everglades. The south IRL portion is sponsored by the South Florida Water Management District. (www.evergladesplan.org/pm/projects/proj_07_irl_south.aspx)

Climate

Climate plays a critical role in natural community structure and composition within the IRL System. The IRL straddles the boundary between two biotic provinces, the temperate Carolinian Province and the tropical/subtropical Caribbean Province. As a result, the IRL System represents a latitudinal ecotone where flora and fauna from each province overlap. Many tropical and temperate species reach their north/south distribution limit within the IRL System (Taylor, 1993). Due to its central location in the state, cyclic climatic fluctuations can affect the floral and faunal compositions of the IRL System through changes in salinity regimes, temperatures or catastrophic events such as hurricanes. Rainfall and temperature extremes in this shallow system directly modify salinity levels. For example, global weather events such as La Niña and El Niño can rapidly change the salinity regime of this semi-closed estuarine system. In summer and fall months, tropical depressions, tropical storms and hurricanes can impact the IRL System. During the past decade, several strong hurricanes have struck the east coast of Florida, including in 1999, hurricanes Dennis, Floyd, and Irene. Between August 14 and September 26, 2004, four tropical weather systems (Charley, Frances, Ivan, and Jeanne) affected the IRL System. The central IRL System received a prodigious amount of rainfall for the two months, between 28 and 33 inches (which is a once-in-50-year rainfall event). High stream discharges were generated that, combined with wind-suspended sediments, significantly reduced salinities and water transparency (Steward et al., 2006).

The climate in the IRL System is typically characterized by long, warm, humid summers and mild winters. Average yearly temperature is 73° Fahrenheit (F) (23° Celsius (C)). Average summertime temperatures may range between 91° F (32° C) and 72° F (22° C). Average winter temperatures may range between 70° F (21° C) and 48° F (8° C). Winter minimum temperatures increase 4° F (2° C) from north to south in the IRL System (Weather Underground, 2013). Total annual rainfall in the IRL System averages between 55 and 60 inches and is unevenly distributed throughout the year with approximately 62 percent occurring from June through October and about 21 percent during March, April and May (Adams et al., 1996).

The IRL System straddles the 10-year freeze line (Walters, Roman, Stiner, & Weeks, 2001). Since the time weather has been recorded in Florida (1890), at least one extreme cold event has been recorded per decade with the exception of the 1920s (National Weather Service, 2013). In the region of the IRL System, extended cold events affecting the flora and fauna have been reported approximately once a decade with statewide freezes occurring in 1835, 1895, 1958, 1966, 1977, 1984 1989 and 2003, resulting in impacts to the biota and economy of Florida (National Weather Service, 2013). More recently, the IRL System experienced extended cold events in 2010 and 2011. The unseasonably cold temperatures are believed to have contributed to the superbloom of 2011 and resulted in widespread fish kills throughout the IRL System. Low temperature events can have drastic impacts on aquatic organisms (Taylor, 1993). Abrupt temperature changes producing frost or freezing temperatures often result in the cold stress and death of West Indian manatees *(Trichechus manatus),* fish species, sting rays, sea turtles, mangroves and seagrasses (Provancha, Scmalzer, & Hall, 1986; Gilmore, Bullock & Berry, 1978). In particular, four freeze events during the winters of 1985, 1990, 2010 and 2011 caused extensive damage to crops, fish and animal populations in the IRL System and killed mangroves in Banana River Aquatic Preserve.

The IRL System is generally shallow with an average depth of four feet. Therefore, its capacity to store heat over time is relatively small. The water temperature of the lagoon will rise sharply during the summer and decrease markedly during the winter. Wind action serves as the most important mixing phenomenon in the lagoon because it is so shallow. As a consequence, temperatures at the surface and at the bottom tend to be very similar. However, the variance from winter to summer has a profound effect on biological processes in the lagoon. Extremely high water temperatures suppress dissolved oxygen levels and accelerate the rate at which sediments become anoxic (lack oxygen) or anaerobic (related to chemical processes that occur with little oxygen) (Windsor, 1988). This, in turn, kills many organisms, especially sessile invertebrates (animals that have limited mobility such as sea squirts and oysters) and submerged aquatic vegetation. Increased temperature also affects salinity levels through evaporation. During an extended drought in the spring and early summer of 2011, salinity levels in much of the lagoon exceeded that of the ocean. Salinity levels in Banana River Aquatic Preserve reached 45 parts per thousand (ppt), nearly 50 percent greater than the ocean (33 ppt).

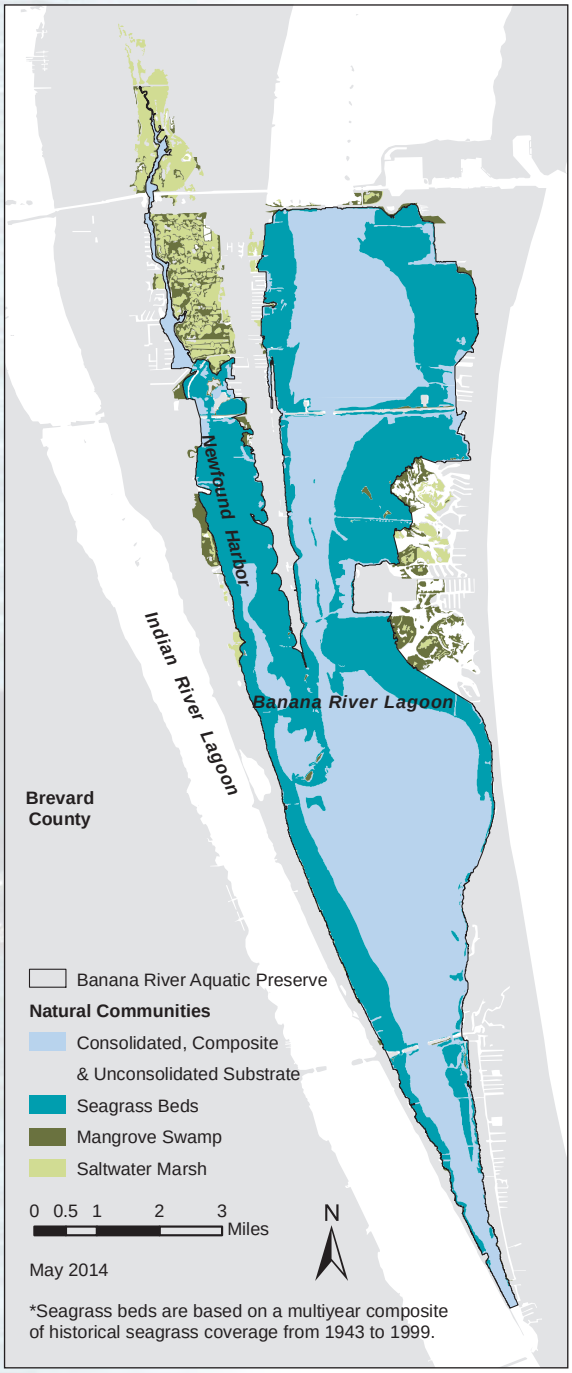
Due to the low elevations of the mangrove and marsh systems (100-year floodplain) of the IRL System, predicted trends such as global warming or increasing ocean water levels, will influence the habitat structure and species distribution in the lagoon. As part of an ongoing program evaluating global climate change, the EPA conducted a study of sea level rise throughout Florida (Titus & Narayanan, 1995). By 2025, sea level is predicted to rise from 2.8 inches (90 percent probability) to 10.7 inches (1 percent probability) in the IRL region. Sea level rise threatens to inundate many coastal wetlands, with little room to move inland because of coastal development. Rising sea level would allow saltwater to penetrate farther inland and upstream. Increasing salinity could cause an up-estuary advance of marine and estuarine species and a retreat of freshwater species. Some species now thriving in the waters of the lower estuary would migrate into the upper estuary (Merritt, 2010). New inlet formations could also lead to changes within the system. These potential events could flood low mangrove and marsh habitat and shellfish beds, drastically changing species composition. The potential effects on surrounding developed areas in low lying barrier islands could substantially alter the man-made landscape.

Natural Communities

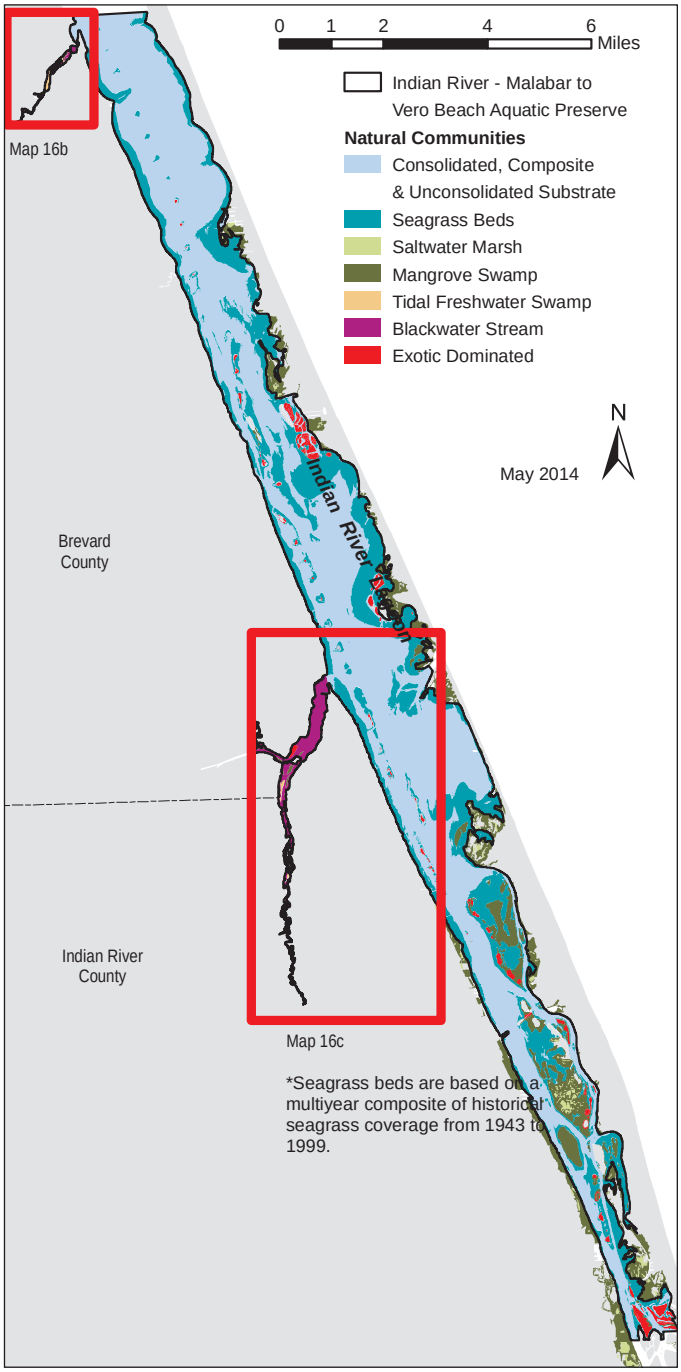
The natural community classification system used in this plan was developed by the Florida Natural Areas Inventory (FNAI) and the Florida Department of Natural Resources, now DEP, and updated in 2010. The community types are defined by a variety of factors, such as vegetation structure and composition, hydrology, fire regime, topography and soil type. The community types are named for the most characteristic biological or physical feature (FNAI, 2010). FNAI also assigns Global (G) and State (S) ranks to each natural community and species that FNAI tracks. These ranks reflect the status of the natural community or species worldwide (G) and in Florida (S). Lower numbers reflect a higher degree of imperilment (e.g., G1 represents the most imperiled natural communities worldwide, S1 represents the most imperiled natural communities in Florida).

Data used to produce a map delineating the major natural community types found in the IRL System were developed by FNAI using multiple sources that include, but were not limited to: SJRWMD, 2009; and SFWMD, 2008; Florida Land Cover Classifications System, 2009; Digital Ortho-photographs; black and white aerial photographs (1:25,000 scale), FNAI data on Element Occurrences, Potential Natural Areas and Areas of Conservation Interest. These data are not always based on comprehensive or site-specific field surveys, and no additional fieldwork was conducted for purposes of producing these maps. The descriptions of the natural community types found in the IRL System have been adapted from the Guide to the Natural Communities of Florida (FNAI, 2010).

Consolidated Substrate - (synonyms: hard bottom, coquina bottom). Consolidated substrates are mineral-based natural communities generally characterized as expansive, relatively open areas of subtidal (areas below mean low water), intertidal (transitional zone bounded by high tide line and low tide line), and supratidal zones (above the mean high tide and mean wrack line) which lack dense populations of sessile plant and animal species. Consolidated substrates are solidified rock or shell



Map 15 / Banana River Aquatic Preserve Florida Natural Areas Inventory natural communities.



Map 16a / Indian River - Malabar to Vero Beach Aquatic Preserve Florida Natural Areas Inventory natural communities.

FNAI Natural Community Type	# Acres	% of Area	Federal Rank	State Rank	Comments
Consolidated Substrate	Unknown	Unknown	G3	S5	
Unconsolidated Substrate	Unknown	Unknown	G5	S5	
Composite Substrate	Unknown	Unknown	G3	S3	
Mollusk Reef	Unknown	Unknown	G3	S3	Live & dead oyster reef
Algal Bed	Unknown	Unknown	G2	S2	
Seagrass Bed*	10,620	41	G4	S4	
Tidal Marsh	17	<1	G3	S3	Salt marsh
Tidal Swamp	64	<1	G3	S3	Mangrove swamp

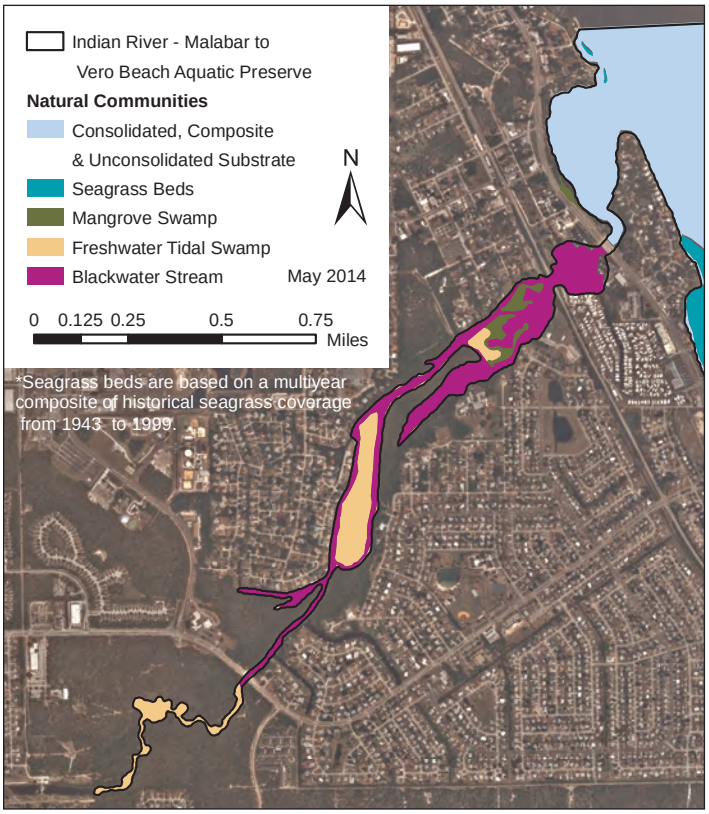
**Note: Acres of seagrass beds represents limits of where seagrass has historically grown based on a multiyear composite of seagrass coverage from 1943 to 1999.*

Table 2 / Summary of natural communities in Banana River Aquatic Preserve.

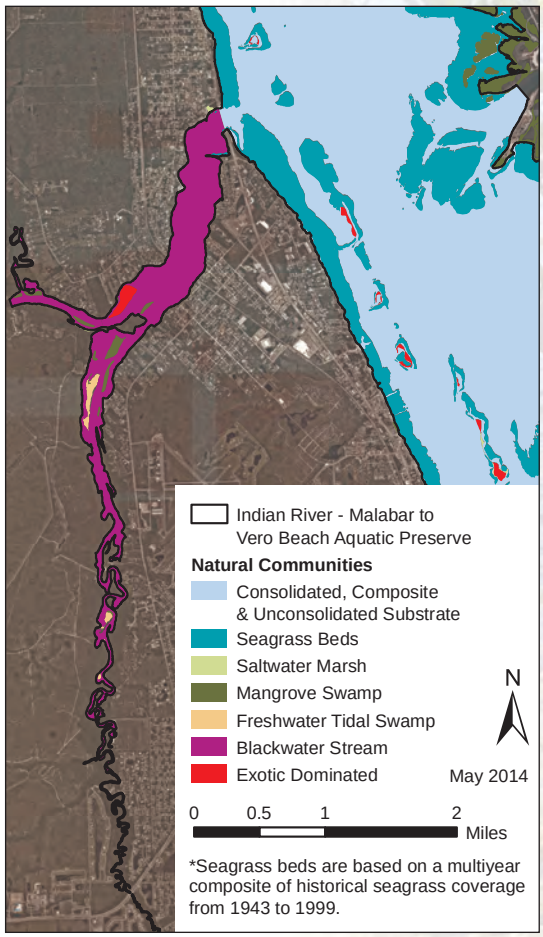
conglomerates and include coquina, limerock or relic mollusk reef materials. These communities may be sparsely inhabited by sessile, planktonic, epifaunal and pelagic plants and animals but house few infaunal organisms (i.e., animals living within the substrate).

Unconsolidated Substrate - (synonyms: sand bottom, sand bar, mud flat, tidal flat). Unconsolidated substrates are important in that they form the foundation for the development of other marine and estuarine natural communities when environmental conditions become appropriate. Unconsolidated substrate supports salt marshes, seagrasses and mollusk beds and other communities that are rich in estuarine invertebrates. While these areas can be relatively barren, the densities of infaunal organisms in subtidal zones can reach the tens of thousands per square meter, making these areas important feeding grounds for many bottom-feeding fish.

Disturbances directly affecting unconsolidated substrates within the IRL System may result from unmanaged anchorages, sunken/abandoned boats and propeller scarring from boats in shallow waters. In addition, runoff from roads, stormwater discharges and leachate from septic tanks may all contribute to sediment contamination. Significant amounts of these compounds in the sediments may kill infaunal organisms, eliminating a major food source for a variety of fish, birds and other organisms.



Map 16b / Turkey Creek Florida Natural Areas Inventory natural communities.



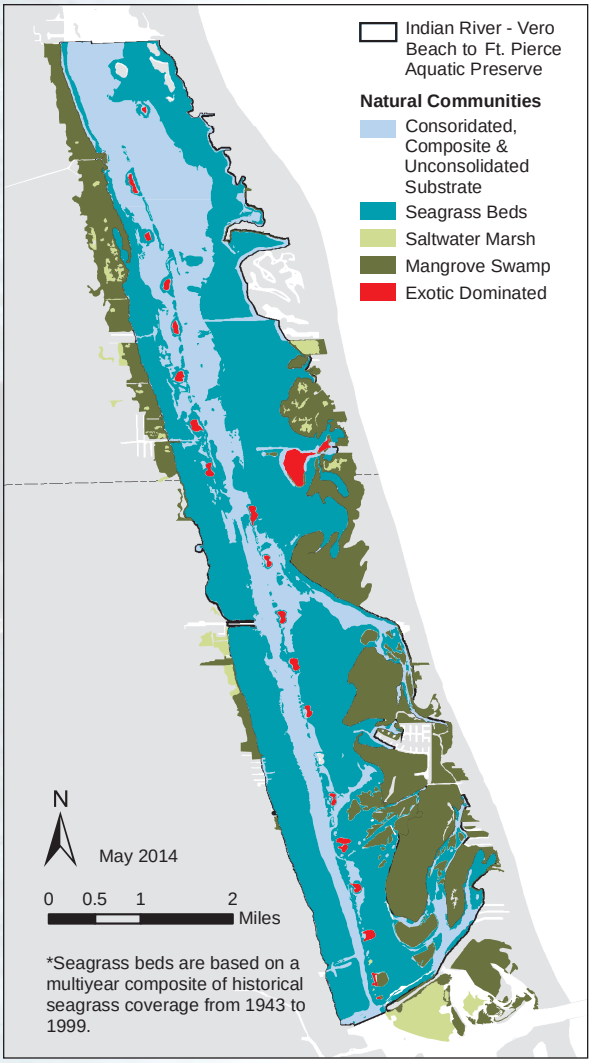
Map 16c / St. Sebastian River Florida Natural Areas Inventory natural communities.

FNAI Natural Community Type	# Acres	% of Area	Federal Rank	State Rank	Comments
Consolidated Substrate	Unknown	Unknown	G3	S5	
Unconsolidated Substrate	Unknown	Unknown	G5	S5	
Composite Substrate	Unknown	Unknown	G3	S3	
Mollusk Reef	Unknown	Unknown	G3	S3	Live & dead oyster reef
Algal Bed	Unknown	Unknown	G2	S2	
Seagrass Bed*	8,309	29	G4	S4	
Tidal Marsh	34	<1	G3	S3	Salt marsh
Tidal Swamp	1,312	5	G3	S3	Mangrove swamp
Freshwater Tidal Swamp	59	<1	G3	S3	Freshwater species
Blackwater Stream	339	1	G4	S2	

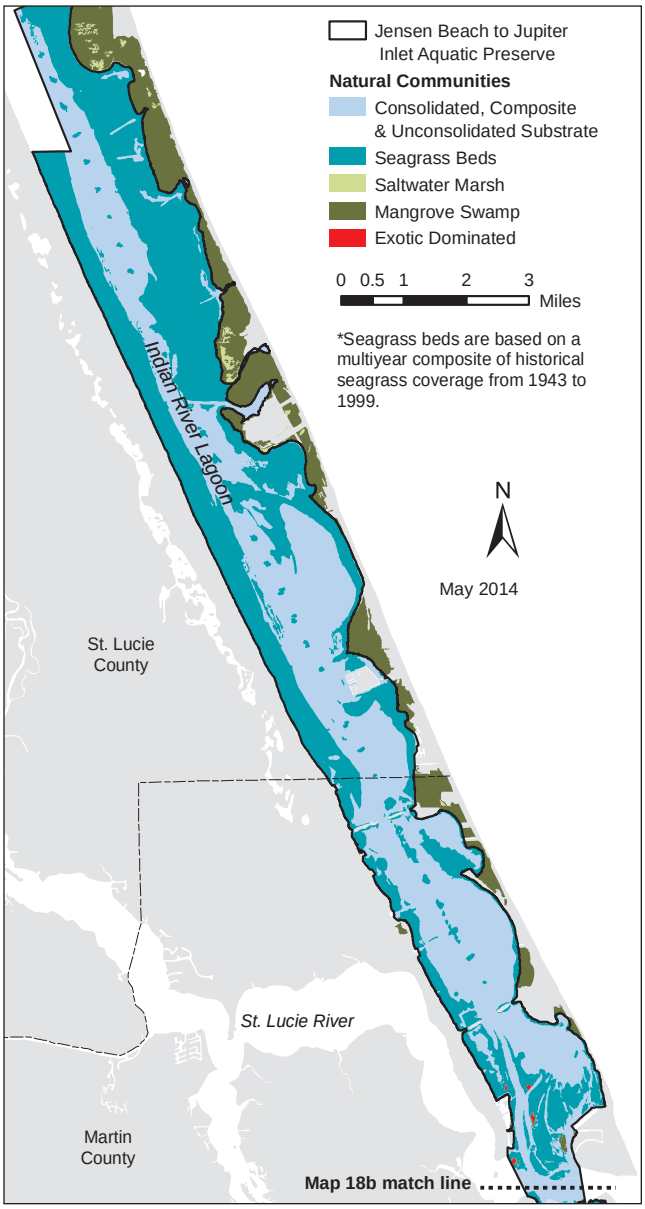
**Note: Acres of seagrass beds represents limits of where seagrass has historically grown based on a multiyear composite of seagrass coverage from 1943 to 1999.*

Table 3 / Summary of natural communities in Indian River-Malabar to Vero Beach Aquatic Preserve.

Mollusk Reef - (synonyms: oyster bar, oyster reef, mussel reef). Mollusk reefs are faunal-based natural communities typically characterized as expansive concentrations of sessile mollusks/bivalves occurring in intertidal and subtidal zones. In Florida, the most developed mollusk reefs are generally restricted to estuarine areas dominated by the American or Eastern oyster (*Crassostrea virginica)*,



Map 17 / Indian River - Vero Beach to Ft. Pierce Aquatic Preserve Florida Natural Areas Inventory natural communities.



Map 18a / Jensen Beach to Jupiter Inlet Aquatic Preserve (north section) Florida Natural Areas Inventory natural communities.

FNAI Natural Community Type	# Acres	% of Area	Federal Rank	State Rank	Comments
Consolidated Substrate	Unknown	Unknown	G3	S5	
Unconsolidated Substrate	Unknown	Unknown	G5	S5	
Composite Substrate	Unknown	Unknown	G3	S3	
Mollusk Reef	Unknown	Unknown	G3	S3	Live & dead oyster reef
Algal Bed	Unknown	Unknown	G2	S2	
Seagrass Bed*	8,309	29	G4	S4	
Tidal Marsh	34	<1	G3	S3	Salt marsh
Tidal Swamp	1,312	5	G3	S3	Mangrove swamp
Freshwater Tidal Swamp	59	<1	G3	S3	Freshwater species
Blackwater Stream	339	1	G4	S2	

**Note: Acres of seagrass beds represents limits of where seagrass has historically grown based on a multiyear composite of seagrass coverage from 1943 to 1999.*

Table 4 / Summary of natural communities in Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.

typically found growing in clusters attached to hard bottom (consolidated substrates), while hard clams are generally found burrowed into soft bottoms (unconsolidated sediments).

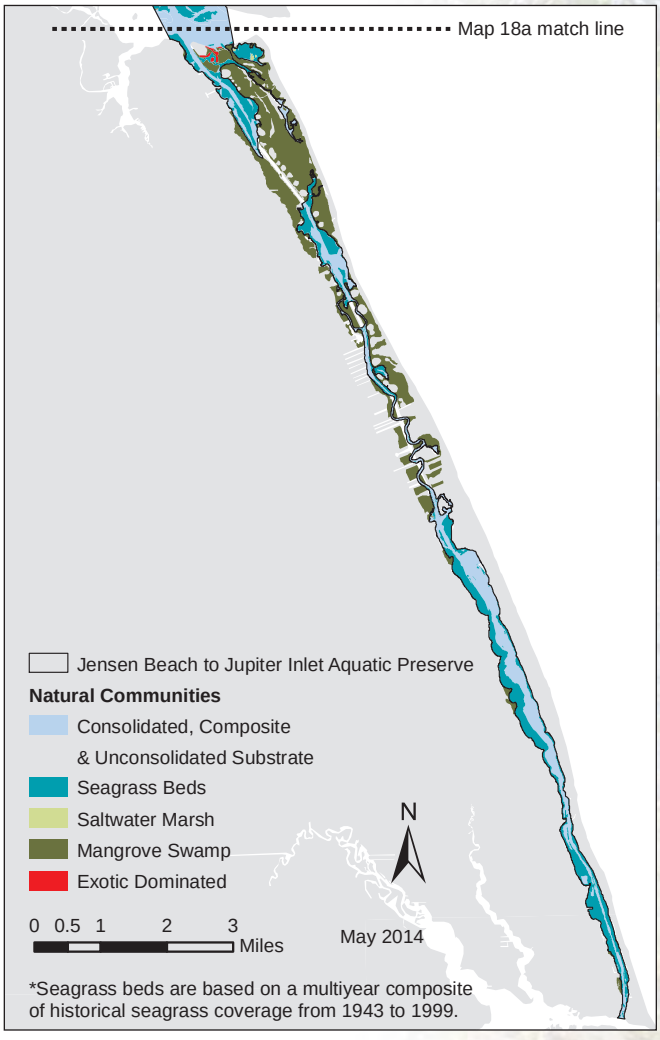
Mollusk reefs occur throughout the IRL. The IRL System has large expanses of mollusk reefs along its shorelines and surrounding islands. The American oyster is a recreationally and commercially important species that occupies bottom substrates in brackish and saltwater environments.

Mollusk reefs occupy a unique position among estuarine invertebrates and have been an important human food source since prehistoric times as evidenced by numerous shell middens found throughout the IRL System. Mollusk reefs present a dynamic community within estuarine ecology, providing refuges, nursery grounds and feeding areas for a myriad of other estuarine organisms.

Mollusks are filter feeders, filtering up to 50 gallons of water a day. During this process they can accumulate toxins from polluted waters and harmful algal blooms. Sources of these pollutants can be from considerably distant areas, but are often more damaging when nearby (runoff, stormwater inputs and sewage). Substrate degradation and erosion can also negatively impact mollusk reef formations and occurs when silts, sludge and dredge spoils cover and bury the mollusk reefs. Declining mollusk reef populations can be expected in coastal waters that are being dredged or are receiving chemicals mixed with rainwater flowing off the land or from drainage of untreated residential or industrial sewage systems.

Natural predators impacting mollusk reefs within the IRL System include stone crab (*Minippe mercenaria),* blue crab (*Callinectes sapidus*), oyster drills (*Thais haemastoma*), sheepshead (*Archosargus probatocephalus),* black drum (*Pogonias cromis*), American oystercatcher (*Haematopus palliatus*) and others.

Algal Bed - (synonyms: algal mats, periphyton mats). Estuarine algal beds are floral-based natural communities characterized as large populations of macro- or micro-algae. The dominant algal species include red, green,



Map 18b / Jensen Beach to Jupiter Inlet Aquatic Preserve (south section) Florida Natural Areas Inventory natural communities.

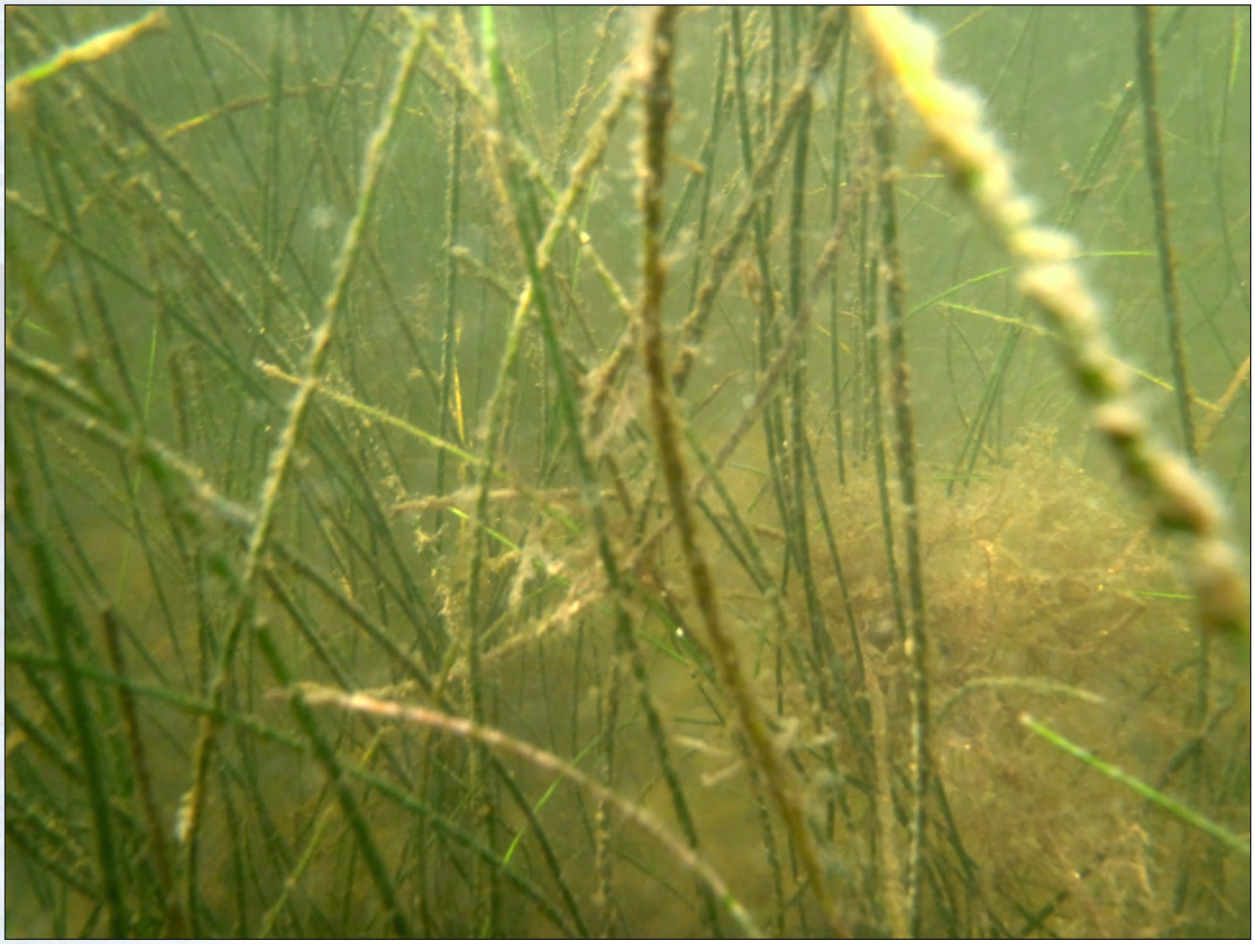
FNAI Natural Community Type	# Acres	% of Area	Federal Rank	State Rank	Comments
Consolidated Substrate	Unknown	Unknown	G3	S5	
Unconsolidated Substrate	Unknown	Unknown	G5	S5	
Composite Substrate	Unknown	Unknown	G3	S3	
Mollusk Reef	Unknown	Unknown	G3	S3	Live & dead oyster reef
Algal Bed	Unknown	Unknown	G2	S2	
Seagrass Bed*	11,176	49	G4	S4	
Tidal Marsh	6	<1	G3	S3	Salt marsh
Tidal Swamp	122	<1	G3	S3	Mangrove swamp

**Note: Acres of seagrass beds represents limits of where seagrass has historically grown based on a multiyear composite of seagrass coverage from 1943 to 1999.*

Table 5 | Summary of natural communities in Jensen Beach to Jupiter Inlet Aquatic Preserve.

blue-green and brown algae. This community may occur in subtidal and intertidal zones on soft and hard bottom substrates. Vascular plants (e.g. seagrasses) may occur in algal beds associated with soft bottoms. Sessile animals (describes marine animals with limited mobility) associated with algal beds will vary based on bottom type. Harmful algal blooms (*Aureoumbra lagunensis*, *Karenia brevis* and *Pyrodinium bahamense*) and cyanobacteria (blue green algae) have been reported in the IRL System. More information on recent algal bloom occurrences and monitoring efforts can be found in Chapter 4.1.2.

Seagrass Bed - (synonyms: submerged aquatic vegetation (SAV), seagrasses). The FNAI definition of seagrass bed describes expansive stands of submerged vascular flowering plants occurring primarily in subtidal zones. Seagrasses are not true grasses. Unlike algae and seaweed, seagrasses are angiosperms (flowering plants). SAV species found in the IRL System include shoal grass (*Halodule wrightii*), paddle grass (*Halophila decipiens*), star grass (*H. engelmannii*), Johnson's seagrass (*H.*



Seagrasses are hosts to a myriad of epiphytes that serve as a food source for a variety of invertebrate fauna. The IRL System is a seagrass based ecosystem. Many organisms, at some stage of their development, depend on seagrass beds for food or shelter.

The IRL System is a seagrass-based ecosystem. Many organisms depend on seagrass beds for food or shelter at some stage of their life cycle.

johnsonii), widgeon grass (*Ruppia maritima*), manatee grass (*Syringodium filiforme*) and turtle grass (*Thallassia testudinum).* Often, numerous species of epiphytic algae, egg casings and invertebrates attach to the seagrass leaf blades. Together, seagrasses and their epiphytes serve as important food sources as well as nursery areas to a myriad of species.

Seagrass beds occur most frequently on unconsolidated substrates of marl, muck or sand, although they may also occur on other unconsolidated substrates or consolidated substrates. The blanket of leaf blades and rhizomes (root system) holds sediment particles in place and reduces the wave-energy on the bottom to promote settling of suspended particulates. The settled particles become stabilized by the dense rhizomes of the seagrasses. Thus, marine and estuarine seagrass beds are generally areas of soil accumulation. Other factors affecting the establishment and growth of seagrass beds include water temperature, salinity, wave-energy, tidal activity and available light. Seagrasses occur most frequently in areas with moderate currents, as opposed to little or no currents. Seagrasses require some active current or flushing, so the terminal ends of narrow tidal creeks are generally devoid of SAV cover. Although marine and estuarine seagrass beds are most commonly submerged in shallow subtidal zones, they may be exposed for brief periods of time during low tides and are typically comprised of shoal grass.

One of the more important factors influencing the seagrass community is the amount of solar radiation/ sunlight reaching the plants. Adequate light must reach the plant for proper photosynthesis. Turbid or muddy water restricts photosynthesis. Seagrass beds are extremely vulnerable to human impacts. Many seagrass beds have been destroyed by dredging or filling activities while others have been impacted by pollutant discharges from wastewater treatment plants, industrial discharges or other sources. Seagrasses may also be severely impacted by oil spills. Low concentrations of oils and greases are known to significantly affect the photosynthetic capability of seagrasses. Seagrasses are susceptible to scarring from boat propellers, anchors and trawls. While seagrasses will recolonize areas when water quality is good and disturbances are removed, revegetation of scarred areas may require many years. Construction of traditional wooden boat docks through seagrass areas may result in a “halo” effect (area

devoid of seagrass) around the dock as the result of shading by the dock or boats moored at the dock. Newer technologies, such as light-penetrating grated material, have shown promise in reducing shading effects. Boat traffic to and from the dock may contribute to the halo effect as well. Seagrass beds and their associated fish and invertebrate communities, which typically grow along the shoreline in a linear fashion, can be fragmented by dock construction and formation of halos. This fragmentation inhibits vegetative (spread through shoot growth) recolonization by seagrasses.

The IRL SWIM Plan directs the SJRWMD and SFWMD to map seagrasses in the IRL at two- to three-year intervals. Accordingly, in addition to the original 1943 maps, IRL seagrass maps have been prepared for the following years: 1986, 1989, 1992, 1994, 1996, 1999, 2001, 2003, 2005, 2006, 2007, 2009 and 2010. Seagrass coverage on the FNAI maps (Maps 15 through 18b) represent the union of seagrass coverages from seven mapping years (1943, 1986, 1989, 1992, 1994, 1996, and 1999) to delineate wherever seagrass had been mapped (Steward, Virnstein, Morris, & Lowe, 2005). Through the late 1990s, seagrass coverage in the IRL System had generally declined since 1943, the earliest year for mapped seagrass coverage (Steward et al., 2003). A 1999 survey of seagrass coverage showed the highest acreage loss since 1943, up to 60 percent, was immediately north of IR-Malabar to Vero Beach Aquatic Preserve. According to the SJRWMD SWIM Plan, 2002 Update, findings from the 1999 resource assessment revealed that the Banana River Lagoon had exhibited stable seagrass coverage through the 1990s and remarkable improvement in 1999. Unfortunately, an exception to this was portions of Banana River Aquatic Preserve. The Newfound Harbor/Sykes Creek area and the southern portion of the aquatic preserve experienced nearly 50 percent loss of seagrass between 1943 and 1996. Within IR-Malabar to Vero Beach Aquatic Preserve, seagrass condition had remained stable. At the time of the 1999 survey, areas in the vicinity of Sebastian Inlet were in good condition, with more extensive coverage in the 1990s than in 1943. Seagrass cover near Vero Beach, however, had remained quite low possibly due to the fact that the Vero Beach sub-basin contributes one of the largest annual loads of nitrogen and phosphorus in the IRL. Seagrass coverage in IR-Vero Beach to Ft. Pierce Aquatic Preserve in 1999 was near that in 1943. Prior to the 1999 survey, however, seagrass coverage remained near 60 percent of 1943 total acreage. With the exception of the area south of the confluence of the St. Lucie Estuary, seagrass coverage in the Jensen Beach to Jupiter Inlet during 1943 was similar to the acreage mapped in 1999. Seagrass immediately south of the confluence of the St. Lucie Estuary is regularly impacted by large discharges from Lake Okeechobee through the St. Lucie River. Seagrass acreage had increased dramatically since the 1940s in the Hobe Sound area.

Beginning in 2001, however, seagrass coverage began increasing steadily in areas which had been previously experiencing losses. The increases were attributed to depth-limit expansion of seagrasses, which appeared to be in response to modest increases in light availability (Robbins, Howard, Bachmann, & Penny, 2011). By 2007, seagrass coverage in Banana River Aquatic Preserve had exceeded the acreages recorded in 1943. Seagrass coverage in the aquatic preserve (including Newfound Harbor/ Sykes Creek) was meeting or exceeding target goals. Within IR-Malabar to Vero Beach Aquatic Preserve, 2007 seagrass coverage in the vicinity of Sebastian had almost tripled compared to 1943 acreage, primarily a consequence of the permanent opening of Sebastian Inlet in 1947. 2007 coverage in the vicinity of Vero Beach exceeded 1943 acreage and was double that recorded in 1996 (Morris, 2011). By 2007, seagrass coverage in IR-Vero Beach to Ft. Pierce Aquatic Preserve and Jensen Beach to Jupiter Inlet Aquatic Preserve had reached maximum coverage since the first mapping effort in the early 1940s (Robbins et al., 2011). One exception was in the area of the St. Lucie Inlet which experienced significant impacts from hurricanes and associated freshwater discharges in 2004 and 2005. Impacts included decreases in cover and density and, to a lesser extent, burial by shifting bottom sediments. Seagrass status was improving, as documented by increases in mapped acreage and recruitment into areas left bare following the hurricanes (Robbins et al., 2011).

In some cases, drastic seagrass loss and subsequent recovery can be part of a natural cycle. Scientists documented an event where over 247 acres of seagrass in northern IRL completely disappeared from 1996 to 1997 and then recovered by 2000. It was concluded that the demise was a natural event caused by a long-term build-up of seagrass biomass and a thick layer of detritus (Morris & Virnstein, 2004). In other cases, explanation for seagrass loss can be much more complicated. From early spring through late fall of 2011, two different, yet concurrent phytoplankton blooms and loss of seagrass occurred throughout much of the IRL. As described in the IRL 2011 Superbloom Plan of Investigation (SJRWMD et al., 2012b), these blooms and seagrass declines far exceeded any past documented events in regards to geographic scale, bloom intensity and duration, and rate and magnitude of seagrass loss. The lesser of the two blooms was generally restricted to the IR-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce aquatic preserves and was considered moderately intense, as measured by chlorophyll a (Chla) concentration. The other bloom reached immense proportions, earning its own label “superbloom.”

The superbloom covered approximately 130,960 acres of open water including the Mosquito Lagoon, the IRL north of IR-Malabar to Vero Beach Aquatic Preserve, and the Banana River Lagoon including all of Banana River Aquatic Preserve. This bloom surpassed all previous documented blooms in intensity (often exceeding 100 micrograms per liter Chla). As a result of the persistent superbloom, there was a marked decline in water transparency. By the end of June 2011, the loss of seagrass was substantial. Relative to the summer of 2010, seagrass coverage was reduced by approximately 45 percent overall in the Banana River Lagoon (including Banana River Aquatic Preserve), northern IRL, and IR-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce aquatic preserves. By the end of 2011, overall seagrass bed coverage reduced by 60 percent. In some areas such as Banana River Aquatic Preserve, seagrass losses were much greater than 60 percent.

The unprecedented bloom and seagrass die-off was surprising given the long-term drought conditions from 2009 to 2011. As discussed previously in this chapter, a very large percentage of annual external nutrient loading is conveyed to the IRL via runoff and stream drainage. A drought means comparatively little runoff and associated nutrient loading. Similarly, drought conditions imply reduced atmospheric and groundwater nutrient loading as well. Therefore, an internal flux of nutrients may be the primary mechanism that fueled the bloom. Plausible internal sources and triggers identified to date are the unusual disappearance of drift macroalgae and the sequence of extreme cold weather events concurrent with the drought. Because of the complex nature of the superbloom, a select group of state agency and academic experts are working together investigating its cause. This collaborative group of scientists has been named the IRL 2011 Consortium. Refer to the monitoring results section in 4.1.2, Current Status of Ecosystem Science for more detailed information.

Tidal Marsh - (synonyms: saltmarsh, coastal wetlands, tidal wetlands). Tidal marshes are floral based natural communities generally characterized as expanses of grasses, rushes and sedges along coastlines of low wave energy and river mouths. They are most abundant and most extensive in Florida north of the normal freeze line, being largely displaced by and interspersed among tidal swamps below this line. Consequently, the prevalence of tidal marsh diminishes in a southerly direction through the IRL System. Furthermore, the disruption of hydric regimes associated with mosquito impoundments has

A black mangrove utilizes pneumatophores to survive in a harsh environment.

Red mangroves are a key part of Indian River Lagoon shorelines, stabilizing sediments and providing food and habitat for many organisms.

resulted in large areas of salt marsh having been developed into monospecific tidal swamps as a result of succession. In northern IRL, including Banana River Aquatic Preserve, black needlerush (*Juncus roemerianus*) and smooth cordgrass (*Spartina alterniflora*) are the dominant species which usually form dense, uniform stands. The stands may be arranged in well-defined zones according to tide levels or may grade subtly over a broad area, with elevation as the primary determining factor.

Tidal fluctuation is the most important ecological factor in tidal marsh communities, cycling nutrients and allowing marine and estuarine fauna access to the marsh. This exchange helps to make tidal marshes one of the most biologically productive natural communities in the world. Numerous invertebrates and fishes, including most of the commercially and recreationally important species such as shrimp (*Penaeus* spp.), blue crab, oysters, bull shark (*Carcharhinus leucas*), grouper (*Epinephelus* spp.), snapper (*Lutjanus* spp.) and mullet (*Mugil* spp.), also use tidal marshes throughout part or all of their life-cycles.

Tidal Swamps - (synonyms: mangrove forest, mangrove swamp). Tidal swamps are floral-based natural communities characterized as dense, low forests occurring along relatively flat, intertidal and supratidal shorelines of low wave energy along central and south Florida. The northern extent of tidal swamps is limited to the 10-year freeze line, located in Brevard County. Freeze events during the winters of 1985, 1990, 2010 and 2011 killed mangroves in Banana River Aquatic Preserve. The dominant plants of tidal swamp natural communities in Florida are red mangrove (*Rhizophora mangle*), black mangrove (*Avicennia germinans*), white mangrove (*Laguncularia racemosa*) and buttonwood (*Conocarpus erectus*). Generally in south Florida these four species can be distributed by elevation or zones defined by varying water levels, with red mangrove occupying the lowest zone, black mangrove the intermediate zone, and white mangrove and buttonwood the highest zone. In the IRL System, zonation of mangrove species is rare in part because sections of the IRL System are microtidal. Buttonwoods are the species generally found at slightly higher elevations.

The prop roots of red mangroves, the extensive pneumatophores (aerial roots) of black mangroves and the dense root mats of the white mangrove serve to trap sediments and recycle nutrients from upland areas and from tidal import. This process serves in “island formation” and is a part of the successional process involved in land formation in central and southern Florida. These root structures also provide substrate for the attachment of and shelter for numerous marine and estuarine organisms.

Temperature, salinity, tidal fluctuation, substrate and wave energy are five physical factors influencing the size and extent of tidal swamps. Red mangroves require an annual average water temperature

above 66o F (19o C) to survive. They do not tolerate temperatures below freezing or temperatures which fluctuate widely over the course of a year. Saltwater is a key element in reducing competition from other plants and allowing mangroves to flourish. In addition, mangroves have adapted to the saltwater environment by either excluding or excreting salt from plant tissues. Mangroves can survive in fresh water but are usually not found in large stands under such conditions in nature because they succumb to competition. Tidal swamps are closely associated with and often grade into seagrass beds, unconsolidated substrates, tidal marshes, shell mounds, coastal berms, maritime hammocks and other coastal communities. Seagrass beds and unconsolidated substrates are usually found in the subtidal regions surrounding tidal swamps.

The tidal swamp communities are very productive systems because they function as nursery grounds for most of the state's commercially and recreationally important fishes and shellfish. These natural communities are also the breeding grounds for substantial populations of wading birds, shorebirds and other animals. The continuous shedding of mangrove leaves and other plant components produce as much as 80 percent of the total organic material available in the aquatic food web (Odum & McIvor, 1990). Additionally, tidal swamps help protect other inland communities by absorbing the brunt of tropical storms and hurricanes. Tidal swamps within the IRL System continue to be areas of environmental concern. Between 75 and 90 percent of the original mangrove and saltmarsh acreage historically bordering the IRL has been lost or impacted through diking and flooding, ditching for mosquito control, and dredging and filling activities for coastal development (Taylor, 2012).

Composite Substrate - Composite substrates consist of a combination of natural communities such as "beds" of algae and seagrasses or areas with small patches of consolidated and unconsolidated bottom with or without sessile floral and faunal populations. Composite substrates may be dominated by any combination of marine and estuarine sessile flora or fauna or mineral substrate type. Typical combinations of plants, animals and substrates representing composite substrates include soft and stony corals with sponges on a hard bottom such as coquina outcrops (limited to the southern end of Jensen Beach to Jupiter Inlet); psammophytic (grows in sand or sandy soil) algae and seagrasses scattered over a sand bottom; and patch reefs throughout a coralline algal bottom. Any of the remaining natural communities can grade into composite substrate communities. Although composite substrates can occur in any marine or estuarine area in Florida, some combinations are common while others are extremely rare. Combinations of consolidated and unconsolidated substrate components offer the greatest opportunity for diversity, and should be high priority areas for protection. Management requirements are negligible, providing the composite community is adequately protected. Protection efforts will vary slightly based on components of the composite substrate community. Generally, degradation of physical and chemical water quality parameters should be prevented, as well as mechanical disturbance from anchoring, dredging, trawling and similar activities.

Freshwater Tidal Swamp - A small portion of the IRL System is classified as freshwater tidal swamp. This habitat type occurs along floodplains just inland (upstream) from the mangrove tidal swamps in Turkey Creek and the St. Sebastian River, both located in IR-Malabar to Vero Beach Aquatic Preserve. These areas contain numerous species including an overstory of pop ash (Fraxinus *caroliniana*), laurel oak (*Quercus laurifolia*), red maple (*Acer rubrum*), pond apple (*Annona glabra*), dahoon holly (*Ilex cassine*) and cabbage palm (*Sabal palmetto*) with a ground cover of saltbush (*Baccharis* spp.), wild coffee (*Psychotria* spp.), giant leather fern (*Acrostichum danaeifolium)*, pimpernel (*Samolus* sp.), buttonbush (*Cephalanthus occidentalis*), marlberry (*Ardisia escallonioides*), swamp lily (*Crinum americanum),* arrowhead (*Sagittaria* spp.), and stoppers (*Eugenia axillaris* and *Myrcianthes fragrans*). The taller trees and shrubs provide habitat for various vines and epiphytes (plants that grow on other plants) such as poison ivy (*Toxicodendron radicans*), bromeliads (air plants [Bromeliaceae]), and orchids (Orchidaceae). The swamps are flooded twice daily in response to tidal cycles and are often fed by oxbows and sloughs. They are extremely vulnerable to hydrologic modifications and have been impacted by past dredging operations.

Blackwater Stream - (synonyms: blackwater river, blackwater creek) Blackwater streams are named for their tea-colored waters darkened by tannins, particulates, dissolved organic matter and iron. Occurring as either perennial or intermittent watercourses, blackwater streams originate in extensive wetlands with organic soil where rainfall is collected and slowly discharged to the stream. They generally are acidic (pH = 4.0 - 6.0), but may become neutral or slightly alkaline during low-flow stages when influenced by alkaline groundwater. Water temperatures may fluctuate substantially and are generally correlated with seasonal fluctuations in air temperature. The dark-colored water reduces light penetration and, thus, inhibits photosynthesis and the growth of submerged aquatic plants. Emergent and floating aquatic vegetation may occur along shallower and slower moving sections, but their presence is often reduced because of typically steep banks and considerable seasonal fluctuations in water level.

There are two major tributaries within the aquatic preserves' boundaries of the IRL System which are characterized as blackwater stream. These include the St. Sebastian River and Turkey Creek, both located within IR – Malabar to Vero Beach Aquatic Preserve. Like many blackwater streams, the St. Sebastian River and Turkey Creek have been significantly altered for stormwater management. The construction of the Fellsmere Canal and the C-54 Canal eliminated the historic west prong of the St. Sebastian River and facilitated the discharge of large volumes of freshwater and nutrient-laden runoff from agricultural lands into the IRL System. The upper reaches of the north prong were canalized and most of the associated wetlands north of the preserve were developed for residential uses or converted to agricultural lands. Residential and agricultural development has occurred along most of the south prong. Turkey Creek has been impacted by the development of the Melbourne-Tillman Water Control District and associated C-1 Canal. As a result of these flood control efforts, Turkey Creek now serves as the primary conveyance of freshwater draining from the historic St. Johns River floodplain into the IRL System.

Spoil Islands

While not a natural community recognized by FNAI, spoil islands have become an important biological component of the IRL. Spoil islands were created from dredge material during the construction of the ICW. The deposited material consists of sand, shell, muck and limestone rubble. In the northern portions of the IRL System, spoil islands appear as small mounds of largely barren sand. Spoil islands become more forested in the central portion of the IRL System. The spoil islands have evolved into ecological communities which significantly contribute to the biodiversity of the IRL. Much of the vegetation on the spoil islands is exotic, consisting primarily of Brazilian pepper (*Schinus terebinthifolius)* and Australian pine (*Casuarina* spp.*)*. Numerous species of native fish, invertebrates, reptiles, birds and mammals inhabit the spoil islands. The shallow edges of the spoil islands have been colonized by mangrove forest, salt marsh and seagrass beds. Spoil islands in the IRL System support the majority of bird rookeries in the IRL System.

Native Species

The IRL contains one of the richest and most productive estuarine faunas in the continental United States (Gilmore, 1985). The IRL System straddles the boundary between two biotic provinces, the temperate Carolinian Province and the tropical/subtropical Caribbean Province. As a result, the IRL System represents a latitudinal ecotone where flora and fauna from each province overlap. Many tropical and temperate species reach their north/south distribution limit within the IRL System. Due to the geographic

Spits, shoals, and sandbars on and around spoil islands serve as resting places for many shorebirds such as these sandwich and royal terns.

location, tidal connectivity through inlets, and freshwater tributaries, the IRL System is teeming with a unique combination of temperate and tropical species that tolerate a wide salinity range (fresh to estuarine). To date, more than 1,000 native species, including fish, amphibians, reptiles, birds, mammals, invertebrates and plants, have been located and identified within the IRL System and adjacent floodplain (see Appendix B.3 for complete listing).

Estuarine communities such as the IRL System are characterized by both high productivity and high biodiversity (Provancha, Hall, & Oddy, 1992). In fact, estuaries are among the most productive ecosystems on earth (Bertness, 1999). The high primary productivity of estuaries reflects their nutrient-rich conditions and the presence of many primary producers (Walters, Roman, Stiner, & Weeks, 2001). Plants, algae, fungi and cyanobacteria generate detritus which nourishes hundreds of species in the salt marsh. Detritus is composed of non-living particulate organic material including the bodies of dead organisms and fecal material colonized by decomposer microorganisms. Only a small fraction of plant tissue is eaten by herbivores while it is living, the larger percentage ends up in the water column and settles to the bottom, becoming detritus (Whitney, Means, & Rudloe, 2004). The detrital food chain, together with plankton, is the major component of the estuarine food chain. The estuarine ecosystem is an important spawning and nursery habitat for many species of fish and invertebrates. Approximately 72 percent of commercial and 74 percent of sport species of fishes and invertebrates must spend all or part of their lives in or associated with an estuarine system (Durako, Murphy, & Haddad, 1988). The wide salinity range of tributaries in the IRL System (fresh upper reaches and saline lower reaches) and associated habitats serve as a productive nursery and spawning ground for recreationally and commercially important species of fish and wildlife. Several rare fish species that rely on a tidal system with wide salinity ranges for one or more phases of their lifecycle are limited to the tributaries of the IRL.

The IRL System supports seven significant wading bird rookeries. Five of these are located in IR-Malabar to Vero Beach Aquatic Preserve; two of which are the only known rookeries for the endangered (federal and state) wood stork (*Mycteria americana*) in the IRL System. The sixth rookery is located in IR-Vero Beach to Ft. Pierce Aquatic Preserve. The seventh rookery is located near the St. Lucie Inlet in Jensen Beach to Jupiter Inlet Aquatic Preserve. In addition to wood storks, rookeries support nesting activity for snowy egret (*Egretta thula*), tricolored heron (*E. tricolor*), little blue heron (*E. caerulea*), anhinga (*Anhinga anhinga*), brown pelican (*Pelecanus occidentalis*), yellow-crowned night-heron (*Nyctanassa violacea*), black-crowned night-heron (*Nycticorax nycticorax*), glossy ibis (Plegadis falcinellus), white ibis (Eudocimus albus), double crested cormorant (*Phalacrocorax auritus)*, great blue heron (*Ardea herodias)*, great egret (*A. alba*) and roseate spoonbill (*Platalea ajaja)*. Wading bird nesting occurs to a lesser degree on many of the spoil islands throughout the IRL System. Nesting surveys conducted by IRLAP staff from January 2006 to March 2013 documented nesting activity on twenty-two spoil islands in IR-Malabar to Vero Beach Aquatic Preserve and nine spoil islands in IR-Vero Beach to Ft. Pierce Aquatic Preserve.

The many small animals and insects of the saltmarsh support the larger migrant and resident species. Among the most important species in the food chain is the fiddler crab. The most common fiddler crab species occurring in the IRL System are the Atlantic sand fiddler crab (*Uca pugilator*) and mud fiddler crab (*Uca pugnax*). The presence of hundreds of fiddler crabs in colonies is an indication of a healthy ecosystem. Fiddler crabs are keystone species. They not only prosper in a marsh system that is healthy, they provide many services. Fiddler crabs depend on intertidal zones of salt marshes, marsh edges and tidal creeks. Their burrows aerate the soil freeing nutrients, they break up algae carpeting the surface and bury organic matter that fertilizes the soils. They are important prey items for fish, birds, raccoons (*Procyon lotor*) and other animals (Whitney et al., 2004). They can also serve as an indicator species of the detrimental effects of insecticides. Fiddler crabs are commercially and recreationally exploited as bait for recreational fishing. Many areas of the IRL have lost most of their fiddler crab populations due to a variety of causes. The fiddler crab population was negatively impacted when wetlands were impounded and drag-line ditched within the IRL System. Ongoing wetland restoration efforts involving multi-agency partners may improve shoreline and high marsh habitat for fiddler crabs. Monitoring prior to the restoration and post restoration will provide valuable insight into the values added to the entire food web through restoration efforts. The SJRWMD lists restoration updates for their region at www.sjrwmd.com/upperstjohnsriver.

Snail species are one of the predominant predator species in the mollusk reefs and emergent plant communities. Several types of snails, such as whelks (*Busycon* spp.), moon snails (*Polinices duplicates*) and oyster drills (*Eupleura* spp. and *Urosalpinx* spp.), prey on all sizes of commercially important bivalves/mollusks. Oyster drills are small carnivorous snails that inhabit the shallow waters of the IRL System. Oyster drills are very effective hunters which feed mainly on bivalves but can also penetrate the defenses of barnacles (*Balanus* spp.), periwinkles (*Littorina* spp.) and, when times get tough, even other snails.

Several large breeding colonies of wood storks, a federally endangered species, are established on spoil islands throughout the IRL System.

The broad range of salinity within the IRL System coupled with the emergent vegetation and red mangroves create productive nursery habitat for commercially important species including the blue crab, cinnamon river shrimp (*Machrobrachium acanthurus)*, penaeid shrimp (pink [*Penaeus duorarum*], brown [*F. aztecus*], and white [*Penaeus setiferus*]), and several species of fish including snapper, snook (*Centropomus* spp.), tarpon (*Megalops atlanticus*), mullet, drum (Sciaenidae), sheepshead, and pompano (Carangidae). Freshwater species in the upper reaches of tributaries include black crappie (*Pomoxis nigromaculatus*), bass (Serranidae), and sunfish (*Lepomis* spp.).

Within the IRL System, spotted seatrout (*Cynoscion nebulosus)* and common snook (*Centropomus undecimalis*) are a highly prized gamefish. Recreational anglers in Florida harvest nearly 250,000 spotted seatrout annually, not counting those fishes that are caught and released. More than half of the state-wide recreational catch of spotted seatrout is taken from the IRL (Murphy, Chagaris, & Addis, 2011). Statewide, recreational anglers harvest more spotted seatrout than do commercial interests. In the Atlantic coast region from Volusia County south, including the IRL System, recreational anglers benefited greatly from the commercial gillnet ban. Prior to 1995, recreational anglers captured approximately 55 percent of the total catch in central to southern Florida. Following the net ban, this figure rose to 84 percent, with commercial interests accounting for only 16 percent of the total (Murphy, Nelson, & Muller, 1999). IRL seatrout were reported to consume shrimp in the summer and early winter, the most abundant period for shrimp; but switched to fish in late winter through spring (McMichael & Peters, 1989; Tabb, 1961). Larvae are most common in shallow seagrass beds during the summer months. Juveniles associate with seagrasses (McMichael & Peters, 1989; Tabb, 1966). Adults occur in a wide variety of estuarine habitats including shallow seagrass beds, oyster reefs, over sand bottoms, deep holes, in mangrove creeks, and in areas having manmade structures such as docks and piers. In Florida, spotted seatrout tend to spawn and live in particular estuaries, never migrating more than short distances (Johnson & Seaman, 1986). Spawning habitat includes the non-tidal areas of estuaries and bays, deeper channels adjacent to seagrass beds, near tidal inlets and also nearshore waters outside of estuaries (Jannke, 1971).

Though commercial fishing for snook is illegal in Florida, the species is still vitally important economically due to Florida's sport fishery. Muller and Taylor (2006) assessed snook stocks in Florida and estimated that the highest overall abundance of snook occur in the southern portion of the IRL including the IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves. Angler survey information

shows that approximately 90 percent of the snook captured are released, with an average of 35,000 snook harvested annually from the five-county area that encompasses the IRL. Snook are a euryhaline species with a preference for mangrove-fringed estuarine habitats (Taylor, Whittington, & Grier, 1993). However, their wide salinity tolerance accommodates the various habitat choices made by snook as they transition from freshwater to estuarine and marine habitat areas. Numbers of snook have declined over the last 50 years due to commercial and recreational overharvesting and habitat degradation and destruction (Bruger & Haddad, 1986). A bill passed in the Florida Legislature in 1957 prohibited commercial capture and sale of snook. Passage of this bill helped ameliorate fishing pressure on snook populations; however habitat loss and water quality degradation may have had more far reaching effects on snook than did commercial fishing pressures (Stevens, Blewett, & Poulakis, 2007). The current strategy for managing snook in Florida involves maintenance of very high standing stocks through the institution of low bag limits, closed seasons, and slot limits and by encouraging catch-and-release fishing. Scientific data indicate that, prior to the freeze events during the winters of 2010 and 2011, snook abundance was increasing as a result of restrictive management and angler conservation (Taylor, n.d.). Juvenile snook utilize three distinct habitat areas in their first year: freshwater tributaries, salt marshes and seagrass beds. The smallest snook primarily inhabit fresh water. When these small fish reach 1.5 to two inches in length they migrate to salt marsh habitat areas, where they remain approximately 60 to 90 days. Juveniles will next migrate to seagrass beds once they attain approximately three inches in length, and will remain in this habitat for four to five months. Seagrass beds three to nine miles from ocean inlets are the preferred habitat areas for Florida snook over six inches in length. Maturation begins when juveniles reach approximately 12 inches. At this time many juvenile snook then disperse to various fresh water, brackish and marine habitat areas, and will remain generally non-migratory as adults except for congregating to spawn in high salinity areas.

A large number of Atlantic bottlenose dolphins (*Tursiops truncatus*) inhabit the IRL. Aerial surveys conducted from 2002 to 2004 estimated seasonal abundance of dolphins in the IRL ranged from 362 in summer to 1,316 in winter (Durden, Stolen, & Stolen, 2011). Bottlenose dolphins are recognized as marine mammal sentinels in coastal environments and are apex predators in the IRL. Research suggests that at least three different dolphin communities exist within the IRL: Mosquito Lagoon, north IRL and south IRL (Mazzoil, Reif, Youngbluth, Murdoch, Bechdel, Howells, McCulloch, Hansen, & Bossart, 2008). The north IRL includes Banana River Aquatic Preserve and the northern half of IR-Malabar to Vero

A subpopulation of about 800 bottlenose dolphins live their whole lives in the IRL System.

Diamondback terrapins utilize several critical habitats of the IRL System including mangrove forests and oyster reefs.

Beach Aquatic Preserve. The south IRL includes the southern half of IR-Malabar to Vero Beach, IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves. Dolphins residing in the IRL System are exposed to an increasing variety of persistent pollutants from anthropogenic sources that degrade their habitat, limit their food resources, and increase their susceptibility to diseases (Mazzoil et al., 2008). Stranded dolphins in the IRL System suffer from immunologic dysfunction as suggested by a high prevalence of infectious and inflammatory diseases (Bossart, Meisner, Varela, Mazzoil, McCulloch, & Kilpatrick, 2003). Following increased stranding incidents in 1996 and 2000, and a National Oceanic and Atmospheric Administration (NOAA) declared unusual mortality event in 2001 (NOAA, 2013), the Health and Environmental Risk Assessment program was initiated in 2003 to investigate anthropogenic contaminants and infectious disease agents in the IRL dolphin population (Fair et al., 2006). In 2013, NOAA again declared an unusual mortality event for bottlenose dolphins in the northern IRL including Banana River Aquatic Preserve and portions of IR-Malabar to Vero Beach Aquatic Preserve (NOAA, 2013).

Named for the diamond-shaped growth rings on its carapace, the ornate diamondback terrapin (*Malaclemys terrapin)* is a small turtle that is restricted to the mangrove and salt marsh habitats of the United States from Cape Cod south to the Keys, and along the Gulf Coast to Texas. The diamondback terrapin is believed to be the only turtle in the world that lives exclusively in brackish water habitats. Although there is only one species of diamondback terrapin in the world, there are seven described sub-species in the United States. The Florida East Coast Terrapin (*M. t. tequesta*) occurs from St. Augustine to Miami, including the IRL System (Lamb & Avise, 1992).

Although diamondback terrapins live in tidal marshes, estuaries and lagoons, their preferred nesting sites are sandy beaches. Terrapins are carnivorous and are well adapted for eating hard-shelled prey including aquatic snails, crabs, and small bivalves. They also eat carrion, fish, marine worms and insects. Exhibiting extreme sexual dimorphism, adult males are significantly smaller than females in weight and carapace length. Males can reach a maximum shell length of 5.5 inches, and females can grow up to 11 inches (Moler, 1992).

The two most significant limiting factors for terrapin populations in the nation today are by-catch in the blue crab fishery and predation of adults and nests by raccoons. Other factors causing declines in terrapin populations include the loss of salt marsh habitat and destruction of nesting beaches due to

waterfront development, road mortalities of nesting females, and boat strikes. Survival rates of nests and hatchlings are very low due to high predation and flooding (Boykin, 2004).

The subspecies is currently considered a non-listed imperiled species by FWC. Diamondback terrapins have been identified as associated species of greatest conservation for critical components of the lagoon ecosystem such as saltmarsh, mangrove, oyster reef, and seagrass habitats (FWC, 2005).

Listed Species

The IRL System provides valuable habitat and protection for a variety of rare and protected species including fish, reptiles, mammals, and birds. Listed species are those which are listed by the FNAI, U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), FWC and FDACS, as endangered, threatened or of special concern. Listed species includes any species that are determined to be in danger of extinction or likely to become extinct within the foreseeable future throughout all or a significant portion of its range based upon the best scientific and commercial data available. States and/or federal agencies provide special protection and conservation measures to promote recovery of a listed species. A major distinction between the federal and Florida Endangered Species Acts is that federal authorizations and intent (Endangered Species Act, Section 2(a)), include provisions providing a means to conserve the ecosystems upon which listed species depend (conserve is defined under the Endangered Species Act, as all measures and procedures needed to delist a species).

Twenty plant and 39 vertebrate species listed as endangered, threatened, or species of special concern (SSC) potentially inhabit or utilize resources in the IRL System (see Appendix B.3). These species may spend some portion of their time in the uplands, beaches, islands, waters or associated wetlands of the IRL System. Specific management strategies for listed species preservation are addressed in Chapter 4 of this plan. All IRL System management actions are in compliance with the federal recovery plans for these species and, when necessary, in accordance with all permitting and agency consultation requirements.

Florida has more threatened and endangered native species than any state except California and Hawaii. Rapid population growth in Florida increasingly stresses species that are dependent on coastal habitats. Species can become threatened due to habitat destruction, over-utilization, disease or natural

Crab traps pose a large threat to terrapins. Lured by bait, terrapins often enter crab traps, where they become trapped and drown.

or manmade factors. Several species within the aquatic preserves have been designated by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) as rare due to limited availability of subtropical aquatic habitat and degradation of habitat quality in Florida. Four tropical peripheral fishes are known to occur within tributaries of the IRL System and are considered indicator species due to their specific habitat requirements (Beal, Hitt, Herren, Kaufmann, & Hauck, 2006; USACE & SFWMD, 2004). These four fishes, the bigmouth sleeper (*Gobiomorus dormitor)*, river goby (*Awaous banana)*, slashcheek goby (*Gobionellus psuedofasciatus)*, and opossum pipefish (*Microphis brachyurus lineatus)* are listed as Threatened by FCREPA (Ashton, 1992). Two additional rare fish species, the neotropical killifish (*Kryptolebias marmoratus*), also known as the rivulus (*Rivulus marmoratus)* and the spottail goby (*Gobionellus stigmaturus)* are listed by FCREPA as Species of Special Concern (SSC) (Ashton, 1992). Three rare snook species, the fat snook (*Centropomus parallelus)*, the swordspine snook (*C. ensiferus)* and the tarpon snook (*C. pectinatus)* also occur in the IRL System (Beal et al., 2006).

The neotropical killifish is widely distributed from Florida to Brazil, but locally rare as it reaches the northern extent of its range on both coasts in central Florida (Taylor, Davis, & Turner, 1995; Taylor, 1993). This species is listed by NMFS as a Species of Special Concern (SSC) which means that the NMFS has some concerns regarding status and threats, but insufficient information is available to indicate a need to list the species under the Endangered Species Act. The neotropical killifish reaches a length of approximately two inches. In eastern Florida, this species prefers unimpounded, high marsh habitats inside the burrows of the great land crab (*Cardisoma guanhumi)*. Within the IRL System, the neotropic killifish prefers the high marsh above the intertidal zone, which floods seasonally, after very high tides or by heavy rainfall. Habitat alteration has affected the species throughout the state, especially on the east coast where the destruction of mangroves and impounding of high marsh for mosquito control has altered and fragmented suitable habitat. Information regarding the relationship between great land crabs and neotropical killifish has been identified as a need through NMFS (http://myfwc.com/fishing/Fishes/non-native.html). The great land crab has limited protection, through its designation as a Species of Greatest Conservation Need in Florida, against take, possession, and transport. Great land crabs are also considered a SSC by FCREPA. Attention should be paid to the species' declining status.

The opossum pipefish is a circumtropical species that was designated as an SSC through NMFS in 1991 and threatened by FCREPA due to habitat destruction (associated with seawall, dock, and riprap construction), isolation from habitat due to water control structures and degraded water quality.

The IRL System contains freshwater tributaries and supports many freshwater species like this American alligator and Florida cooter.

Predictable breeding adult populations in Florida are found in panic grass (*Panicum* spp.) and smart weed (*Polygonum* spp.) limited to tributaries of Jensen Beach to Jupiter Inlet Aquatic Preserve (Gilmore, 1992, 1999). Habitat destruction is the primary limiting factor for the opossum pipefish. In addition, canal maintenance, such as use of herbicides to improve flow, poor water quality, unnatural flow rates, and significant atypical releases from water control structures negatively impacts the species (Gilmore, 1999).

The American alligator (*Alligator mississipiensis)* is another listed reptile that inhabits the IRL System. Although considered fully recovered, alligators are a federally-listed threatened species and a state-listed SSC because of their similarity in appearance to the endangered American crocodile (*Crocodylus acutus).* Alligators are most common in the major river drainage basins, such as the tributaries to the IRL and large lakes in central and south Florida. They are also commonly seen in local drainage canals, retention ponds and ditches. Alligators are tolerant of poor water quality.

Loss of breeding and feeding habitat to urban development of saltmarsh and freshwater wetlands has stressed recovering colonial waterbird species. Many of these waterbirds are listed as SSC and include little blue heron, tricolored heron, reddish egret (*Egretta rufescens)*, snowy egret and white ibis. The wood stork, both federally and state listed as endangered, primarily uses the IRL System as a breeding ground from February through July each year. The brown pelican (SSC) uses the mangroves in the IRL System as a roosting and nesting ground. Current recreation on and around islands and shoals in the IRL System and surrounding areas continue to negatively impact waterbird colonies.

The American oystercatcher is a large, conspicuous shorebird with a bright red beak found in coastal salt marshes, sand beaches and oyster bars. One of the few birds to specialize on bivalve mollusks living in saltwater, this species is completely restricted to marine/estuarine habitats. The species feeds mostly by sight, preying upon oysters, clams and mussels, but it also probes for marine worms and other food items in the intertidal zone. Although the oystercatcher inhabits coastal areas where human encroachment, habitat loss and destruction are threats, this species adapts well to spoil islands. American oystercatchers nest on sandy dunes, salt marsh islands and spoil islands, building nests well above the high tide mark. IRLAP staff has documented nesting oystercatchers in the IRL System. Specifically, nesting activity has been observed on spoil island IR-19 in IR-Malabar to Vero Beach Aquatic Preserve and spoil island IR-37 in IR-Vero Beach to Ft. Pierce Aquatic Preserve. Future population success will depend on its coexistence with humans in salt marsh and dune areas and possibly on

American oystercatchers, a state listed species of special concern, is frequently seen through the IRL System foraging and nesting on spoil islands.

the mitigation of factors affecting potential increases in sea level (Nol & Humphrey, 1994). The U.S. Shorebird Conservation Plan designates the American oystercatcher as a "Species of High Concern," due to low relative abundance, threats on breeding grounds, threats on non-breeding grounds and rather restricted non-breeding distribution. The American oystercatcher is listed as a Species of Special Concern in Florida (Butcher, Niven, Panjabi, Pashley, & Rosenberg, 2007).

The West Indian manatee is the only listed mammal (Endangered at both the federal and state level) found within the aquatic preserves. The West Indian manatee experiences low natural adult mortality. The manatee, however, is listed as endangered because its population is impacted by man-made alterations to estuarine and freshwater systems and by fast moving boat traffic in the waters where the species breeds, sleeps and feeds. The IRL System serves as a travel corridor and supports a resident population during all seasons. Although survival and reproduction rates are adequate in a small portion of its range, survivability studies indicate a cause for concern for the species population in the Atlantic region of Florida. Approximately 50 percent of Florida's total manatee population remains static or is experiencing decline (USFWS, 2014). Declining water clarity and seagrass beds, and increased boat traffic in the IRL System are of concern when considering support of the manatee population.

Within the IRL, manatee mortality rates are highest in Brevard County, typically exceeding the combined total of all other counties in the IRL System. This is due, in part, to the fact that Brevard County contains much more of the IRL than the other counties. Boat collisions account for the largest known cause of manatee deaths. Between 1976 and 2000, watercraft-related deaths accounted for 24 percent of the total mortality and increased at an average of 7.2 percent per year (USFWS, 2001). Maps of manatee protection zones in the IRL System can be accessed at http://myfwc.com/wildlifehabitats/managed/manatee/protection-zones. A summary of manatee mortality for each of the five counties in the IRL System from 2008 to 2012 is presented in Table 6.

County Name	2008	2009	2010	2011	2012	5yr Avg.
Brevard	72	107	184	99	91	111
Indian River	12	18	55	4	7	19
St. Lucie	6	9	26	15	9	13
Martin	4	15	17	11	6	11
Palm Beach	8	16	18	11	8	12

Table 6 / Manatee mortality by county, 2008 to 2012. (Source: FWC)

In winter, Florida manatees migrate to warm-water habitats such as natural springs and discharge canals of industrial power plants. The largest winter aggregations (maximum count of 100 or more animals) are at refuges in central and southern Florida. These include the Reliant Energy Plant in Titusville and the Florida Power and Light Canaveral Power Plant north of the IR-Malabar to Vero Beach Aquatic Preserve and the Florida Power and Light Riviera Beach Power Plant south of the Jensen Beach to Jupiter Inlet Aquatic Preserve. During mild winter periods, manatees at thermal refuges move to nearby sea grass beds to feed, or even return to a more distant warm season range (Deutsch, Reid, Bonde, Easton, Kochman, & O'Shea, 2000). For example, manatees using the Riviera Power Plant feed in adjacent Lake Worth and in Jupiter and Hobe sounds in Jensen Beach to Jupiter Inlet Aquatic Preserve, 12 to 15 miles to the north (Packard, 1981). Other important warm water refuges in the IRL System include the St. Sebastian River, the Vero Beach Power Plant and Treasure Coast Energy Center in Ft. Pierce. Winter aggregations at these sites typically number between 25 and 100 manatees (USFWS, 2001).

Exposure to water temperatures below 68°F for long periods can cause a complex disease process called the manatee cold-stress syndrome, which involves metabolic, nutritional, and immunologic factors. Symptoms may include weight loss, skin lesions or abscesses, internal fat loss, dehydration, constipation and other gastrointestinal disorders, internal abscesses, and other secondary infections. Unlike chronic cold stress, little is known about the effects of acute exposure to severe cold. Susceptibility to cold stress appears to be related to animal size, experience, and ability to migrate. Thus, adult manatees can handle the effects of cold better than calves. During the historic cold events in the winter of 2009-2010, cold-stress-related death of manatees increased nearly tenfold from a five-year statewide average of 27 to 244 (FWC, 2013a).

The most important spring habitat along the east coast of Florida has been the northern Banana River Lagoon and IRL and their associated waters in Brevard County; more than 300 to 500 manatees have been counted in this area shortly before dispersing in late spring (Provancha & Provancha, 1988). Shallow grass beds with ready access to deep channels are preferred feeding areas in coastal and riverine habitats. Manatees often use secluded canals, creeks, embayments, and lagoons, particularly near the mouths of coastal rivers and sloughs, for feeding, resting, cavorting, mating, and calving

The West Indian manatee, a federally endangered species, is dependent on the IRL System.

(Marine Mammal Commission, 1988; 1984). In estuarine and brackish areas, natural and artificial fresh water sources are sought by manatees. As in winter, manatees often use the same summer habitats year after year (Koelsch, 1997; Reid, Rathburn, & Wilcox, 1991). In 2013, NOAA declared an unusual mortality event for manatees in the northern IRL including Banana River Aquatic Preserve and portions of IR-Malabar to Vero Beach Aquatic Preserve (NOAA, 2013). Unusually high numbers of dead manatees may be a related to the 2011 superbloom and loss of seagrass.

Johnson's seagrass is federally listed as threatened due to its limited geographical range along the southeast Florida coastal lagoons, from Sebastian Inlet to northern Biscayne Bay (NMFS, 2002). Johnson's seagrass most frequently occurs near the outer (deep) edge of the seagrass bed, generally 1.2-1.8 meters in the IRL (Virnstein & Morris, 2007). Johnson's seagrass is typically either intermingled with sparse shoalgrass near the deep edge of the bed or located slightly deeper, beyond the deep edge of the bed. Sometimes small patches of intermingled Johnson's seagrass and paddle grass occur much deeper (greater than one meter) than the edge of the bed. Additionally, Johnson's seagrass can occur in very shallow areas—shoals, backwater bays, or at the edges of canals. Flowering beds of Johnson's seagrass have persisted at the Sebastian Inlet area for more than 15 years (NMFS, 2002). Sebastian Inlet is also the site of the northern ''critical habitat'' for this federally threatened species (U.S. Department of Commerce, 2000). One of the three recovery goals for delisting Johnson's seagrass requires that the species' present geographic range remains stable for at least 10 years or increases (NMFS, 2002) emphasizing the importance of this persistent occurrence. Surveys conducted by researchers from the SJRWMD in 2007 determined the new northern limit to be 13 miles north of the previously known limit. Johnson's seagrass was found at the extreme north end of IR-Malabar to Vero Beach Aquatic Preserve. This new northern limit is a 10 percent range extension for Johnson's grass (Virnstein & Hall, 2008). Researches argue that the northern extension of Johnson's seagrass may be ephemeral and that similar range extensions may have occurred in the past and may again occur in the future.

Invasive Non-native and/or Problem Species

Like most waterbodies in Florida, the IRL System is home to non-native species that compete with native residents for food and space. Much of the state consists of a patchwork of habitats resulting from human activities such as agriculture, water management, dredging and filling, and residential development. Due to the lack of naturally limiting predators, unoccupied niches or where an introduced species outcompetes native species, invasive species are dominating ecosystems in many areas of Florida

(Haller & Sutton, 1975). Numerous non-native species have been identified within the IRL System (see Appendix B.3 for a complete listing). The South Florida Restoration Science Forum website (www.sofia.usgs.gov/sfrsf) states that preventing invasion or establishment of noxious species is more cost-effective than post-establishment control. The most effective means of prevention would be prohibitions on import and sale of invasive species.

An invasion of a non-native species has been classified as "the second most important threat to native species, behind habitat destruction" (Ecological Society of America, 2009). Introductions of non-native marine invertebrates and seaweeds to coastal habitats in the United States have increased one hundred-fold in the last 200 years (Jacoby, Walters, Baker & Blyler, 2003). Introduction of non-native species have been both deliberate and accidental. Ships transport living organisms across oceans and between coastlines, from fouling organisms on their hulls to species living in ballast water (Jacoby et al., 2003). Saltwater species are generally spread from ballast waters and include plankton, nekton, fouling organisms and benthic organisms. Other potential activities that may cause the spread of non-native organisms are the movement of navigation buoys, marine floats, dry docks, and drilling. Disposal of dredge spoil, beach nourishment materials and equipment may also be responsible for transporting non-native species (Jacoby et al., 2003). The IRL System contains two international port facilities (Port Canaveral and Ft. Pierce), and could also be impacted by vessels or commercial traffic traveling the ICW channel, utilizing nearby marinas or vectors transported through the inlets.

A number of invertebrate species have invaded the IRL System in recent years. For example, the Australian spotted jellyfish (*Phyllorhiza punctata*) was first documented in the summer of 2001 (Smithsonian Marine Station at Fort Pierce, 2001). This species is known for its voracious ability to consume zooplankton, including fish larvae. Other IRL invaders include crabs (*Scylla serrata* and *Charybdis hellerii)*. It is not known if reproductive populations of either of these crabs are still present in the lagoon. The IRL System is vulnerable to invasion of the charru mussel (*Mytella charruana*) and Asian green mussel (*Perna viridis*). The first report of the charru mussel on the east coast of Florida occurred in 1986, in Jacksonville. Large numbers of mussels fouled intake pipes of a power plant on the St. Johns River. A nearby port with Venezuelan tanker traffic was implicated as the agent that transported the non-native species. The population subsequently died off. The species may compete with important native oyster populations already in decline (Boudreaux, Stiner, & Walters, 2006). Another non-native invasive bivalve is the Asian green mussel. This species is pervasive in parts of upper Tampa Bay and is present in high numbers in Jacksonville.

Fish species include sailfin catfish (*Pterygoplichthys* spp.), blue (*Oreochromis aureus*) and spotted tilapia (*Tilapia mariae*), walking catfish (*Clarias batrachus*), South American brown hoplo (*Hoplosternum littorale*), grass carp (*Ctenopharyngodon idella*) and Mayan cichlid (*Cichlasoma urophthalmus*). The sailfin catfish is the most successful, abundant, and widespread of the armored catfish species and is found throughout central and south Florida. Native to North Africa and the Middle East, blue tilapia were imported in 1961 and have become established throughout central and south Florida. Tilapias compete with other native species that feed primarily on plankton and small organisms living in or on bottom detritus (FWC, 2014). Native to Southeast Asia, walking catfish are an opportunistic species that consume a wide variety of food items including small fishes, aquatic insects, plant material and detritus. Due to its ability to breath air, this species thrives in water with little to no oxygen and is well-adapted to short-lived water bodies with muddy bottoms. Habitat preferences tend to segregate individuals and reduce its overall effect on native species (Smithsonian Marine Station at Fort Pierce, 2014). The South American brown hoplo was first documented in the IRL System in 1995 and is now found throughout central and south Florida. Brown hoplo can be found in a variety of freshwater habitats including muddy bottom and slow moving rivers, streams, side channels, ponds, marshes, and manmade waterways such as ditches and borrow pits. Feeding on benthic invertebrates, the species has a significant effect on the benthic community, negatively impacting native invertebrates, and competing with native fishes for food (Duxbury, Holland, & Pluchino, 2010). Brown hoplo is capable of gulping air to survive in areas with low dissolved oxygen and high hydrogen sulfide levels. To reduce maintenance costs, local municipalities stock retention and golf course ponds with triploid (sterile) grass carp. These ponds may be hydrologically connected to the IRL System during heavy rain events. The fundamental threat that grass carp present to the natural resources within the tributaries of the IRL System includes their ability to consume massive amounts of emergent (vegetation that grows in the water with the majority of the plant above the water's surface) and submerged vegetation. The Mayan cichlid is native to the Atlantic waters off Central and South America and was first recorded in Florida Bay in 1983. This species is now abundant through Lake Okeechobee and the St. Lucie Canal and tolerates a wide salinity range and habitats including canals and rivers. Mayan cichlid consume grass shrimp (*Palaeomononetes* spp.), small fish, snails and insects.

The invasive lionfish has been found around submerged structures, including these mangrove prop roots in close proximity to IRL inlets. Their range continues to expand. (Photo: Emily Dark)

Two visually identical species of the Indo-Pacific lionfish (*Pterois miles* and *P. volitans*) have become widely established along the Southeast United States and Caribbean. Lionfish have rapidly increased in abundance and are now as abundant as many native grouper species in the Atlantic Ocean (Whitfield, Hare, David, Harter, Munoz, & Addison, 2007). Lionfish were first documented in the IRL System in 2010, inside Sebastian Inlet. Since then, lionfish have been found throughout the IRL System. Lionfish are often observed around seawalls, pilings and mangroves, a key nursery for fish and other species. Hundreds have been found far inland inside Jupiter Inlet. On heavily invaded sites, lionfish have reduced their fish prey by up to 90 percent and continue to consume native fishes at unsustainable rates. Long-term effects of lionfish are unknown. Albins & Hixon (2008) suggest that direct and indirect effects of lionfish could combine with the impacts of preexisting stressors (especially overfishing) and cause substantial deleterious changes in estuarine and marine communities. Currently, FWC is encouraging harvesting of lionfish which are reported as excellent table fare. Effective August 2012, FWC announced changes to the lionfish harvest (FWC, 2013c). Harvesting invasive lionfish no longer will require a fishing license when using certain gear, and there is no recreational or commercial bag limit. Local removal efforts can significantly reduce lionfish densities (Morris, 2012).

The African cattle egret (*Bubulcus ibis*) naturally expanded its range to Florida in the early 1940s and has become ever-present. Cattle egret feed primarily in terrestrial pastures with cattle. Their unique foraging behavior, which is not tied to aquatic environments, has eliminated feeding competition with other native wading birds. The largest threat that the cattle egret presents to native species is the competition for nesting materials and rookery space. Cattle egret nest late in the year in Florida which reduces but does not eliminate the competition for space with native wood stork, egrets and herons.

Black rats (*Rattus rattus*) are established in wetlands and on islands within the IRL System and can be detrimental to native bird species and other ground or arboreal nesters and a nuisance to recreational campers. Nine-banded armadillos (*Dasypus novemcinctus*) are occasionally found on islands within the IRL System, however, they have not caused extensive damage to native habitats.

Two species of fire ants are found in Florida. Most notorious is *Solenopsis invicta*, the red imported fire ant (RIFA), followed by the much less common *S. geminata*, the tropical or native fire ant. RIFA was first introduced from Brazil into either Mobile, Alabama or Pensacola, Florida between 1933 and 1945. Since the introduction of RIFA, it has become a major agricultural and urban pest throughout

the southeastern states. In addition, fire ants cause both medical and environmental harm. The human toll from RIFA stings is an important public health concern. Stings may produce a swelling leading to anaphylactic shock (Collins & Scheffrahn, 2001). RIFA have been reported to reduce ground-nesting populations of rodents and birds. In certain instances, RIFA may completely eliminate ground-nesting species from a given area. Because there is a 10 to 20 year lag before reductions in bird populations are observed, it has been suggested that actual effects of RIFA on animal populations may be underestimated (Mount, 1981).

Brazilian pepper and Australian pine are regulated by FDACS as a Class I Prohibited Aquatic Plants, which means that these plants are under the highest amount of regulation and "under no circumstances will these species be permitted for possession, collection, transportation, cultivation, and importation except as provided in Rule 5B-64.004, F.A.C." These species have colonized the majority of spoil islands and have displaced native vegetation such as mangroves and seagrape (*Coccoloba uvifera*) along altered shorelines of the IRL System. Removal of these species is an intensive process that requires constant attention and funding.

Archaeological and Historical Resources

Prior to carbon dating, the IRL System was considered culturally non-descript (Rouse, 1951). This misconception was easily supported due to the fact that many aboriginal shell mounds along the IRL had been destroyed for roadfill for U.S. highways 1 and A1A and other highways and train beds (Brech, 2004). Since then, it has become clear that the IRL has a significant archaeological history dating back to the Paleo-Indian Period (12,000 to 8500 before present (BP)). More than a hundred archaeological sites have been identified bordering the IRL System. The majority of archaeological sites are from the Orange Period (4000 to 2500 BP), the Transitional Period (3200 – 2500 BP), and the Malabar Period (2500 BP to 1763). There is a very strong correlation between geomorphology, ecological production and archaeological site distributions within the IRL and its barrier islands. More ancient landforms have greater geomorphic stability and, therefore, have more ancient archaeological sites. Approximate

Historic Site Name	Registry Id	Location	Date	Significance	Aquatic Preserve
Banana River Seaplane Naval Air Station[1]	BR01975	Patrick Air Force Base	1939	Military	Banana River
Mathers Bridge[1]	BR01700	Indian Harbor Beach	1927	Transportation	Banana River
Old Haulover Canal[2]	78000262	Merritt Island	1850	Transportation	Banana River
Moccasin Island[2]	94000356	Rockledge	3000 BC	Prehistoric	IR-Malabar to Vero Beach
Persimmon Mound[2]	94000357	Rockledge	4000 BC	Prehistoric	IR-Malabar to Vero Beach
Jungle Trail[2]	3000700	Orchid	1900	Transportation	IR-Malabar to Vero Beach
Pelican Island NWR[2]	66000265	Sebastian	1900	Conservation	IR-Malabar to Vero Beach
Sebastian River Bridge[1]	BR01871	Sebastian	1924	Transportation	IR-Malabar to Vero Beach
Smith, Archie, Wholesale Fish Company[2]	94001275	Sebastian	1925	Commerce	IR-Malabar to Vero Beach
Spanish Fleet Survivors and Salvors Camp Site[1]	70000186	Sebastian	1700	Non-aboriginal Historic	IR-Malabar to Vero Beach
St. Lucie Village Historic District[2]	89002062	St. Lucie Village	1850	Settlement	IR-Vero Beach to Ft. Pierce
Showboat Wreck[1]	SL00034	Ft. Pierce	1899	Shipwreck	IR-Vero Beach to Ft. Pierce
Burn Brae Plantation[2]	2000002	Stuart	1875	Architecture	Jensen Beach to Jupiter Inlet
Cresthaven[2]	85000770	Ft. Pierce	1909	Architecture	Jensen Beach to Jupiter Inlet
Fort Pierce Site[2]	74002181	Ft. Pierce	1825	Military Fortification	Jensen Beach to Jupiter Inlet
House of Refuge at Gilbert's Bar[2]	74000651	Stuart	1875	Social History	Jensen Beach to Jupiter Inlet
Mount Elizabeth Archaeological Site[2]	2001011	Jensen Beach	2500 BC	Prehistoric	Jensen Beach to Jupiter Inlet
Tuckahoe[2]	5001339	Jensen Beach	1925	Architecture	Jensen Beach to Jupiter Inlet

[1]Florida Master Site File [2]National Register of Historical Places

Table 7 | Summary of sites listed in the National Register of Historic Places adjacent to the Indian River Lagoon System.

locations and rates of barrier island migration and location of historic inlets can be obtained from the presence or absence of archaeological sites from various culture periods (Brech, 2004).

Authorized by the National Historic Preservation Act of 1966, the National Register of Historic Places is the official list of historic places worthy of preservation. Managed by the National Park Service, the National Register of Historic Places is part of a national program to coordinate and support public and private efforts to identify, evaluate, and protect America's historic and archeological resources. As described in the beginning of this chapter, the IRL System has a rich history. Table 7 summarizes nationally registered historic and archaeological resources immediately adjacent to the IRL System.

Other Associated Resources

Managed by the IRL National Scenic Byway Coalition, the IRL National Scenic Byway promotes an environment where travelers are surrounded by natural areas and scenic vistas of the IRL. The IRL National Scenic Byway meanders through three national wildlife refuges, a national seashore and numerous state and local parks, and sanctuaries. Information regarding the byway can be accessed at www.indianriverlagoonbyway.com.

The Great Florida Birding and Wildlife Trail is managed by FWC. The 2,000-mile highway trail connects 514 birding and wildlife viewing sites throughout Florida. The IRL System is flanked on its borders by 17 Florida Great Birding Trail sites: four sites along Banana River Aquatic Preserve, eight sites along IR-Malabar to Vero Beach Aquatic Preserve, two sites along IR-Vero Beach to Ft. Pierce Aquatic Preserve, and three sites along Jensen Beach to Jupiter Inlet Aquatic Preserve. Maps and individual site information can be obtained at www.floridabirdingtrail.com.

The Florida Circumnavigational Saltwater Paddling Trail is a 1,515-mile sea kayaking trail which begins at Big Lagoon State Park near Pensacola, extending around the Florida peninsula and Keys, and ending at Fort Clinch State Park near the Georgia border. The trail is divided into 26 segments. Segments 19 through 22 include all four aquatic preserves discussed in this plan. Segment guides, photos and maps can be downloaded from www.dep.state.fl.us/gwt/paddling/saltwater.htm

*3.1.4 / **Values***

Florida's economic well-being is firmly linked to its marine resources. Coastal communities in the IRL System increasingly must learn how to sustain economic viability while maintaining and restoring the environmental integrity of coastal resources. Rapid coastal population growth, a concurrent increase in recreational boating and other water-related activities and declining quality of natural environments all contribute to this challenge. The IRL is one of the primary tourist and recreational attractions of the region. As a result, the local economies are directly linked to the health of the lagoon.

In 1995, the IRLNEP, in cooperation with SJRWMD and SFWMD, contracted Hazen and Sawyer Environmental Engineers and Scientists to conduct an economic assessment and analysis of the IRL. Hazen and Sawyer were contracted again in 2008 to update the 1995 analysis. Overall, residents and visitors of the IRL counties received about $3.7 billion in benefits in 2007 from the existence of the IRL (Hazen & Sawyer Environmental Engineers and Scientists, 2008). Economic benefits include recreational expenditures, recreational use, real estate, income earned, restoration, research, education and commercial fishing. Of special note is the value of seagrass. In 2007, the economic value of the lagoon's 72,400 acres of seagrass was $329 million or $4,600 per acre. Consequently, loss of seagrass has a significant negative impact on the value of the IRL. It is important to note that Hazen and Sawyer Environmental Engineers and Scientists did not include the value of seagrass as it relates to water quality. As a result, the value of seagrass may be significantly undervalued.

With more than one million registered recreational boats in Florida as well as 300,000 visiting vessels annually, 2,200 marinas, 8,400 miles of shoreline, 7,000 lakes and 51,000 miles of rivers and streams, the state ranks first in the nation in boating activity. Registered recreational boats in a four-county (Brevard, Indian River, St. Lucie and Martin) area within the IRL System totaled 38,000 in 1985 (Adams, 1985). The number of registered boats for the same four-county area has grown to over 58,000 in 2012 with an annual economic significance of $356 million (Recreational Marine Research Center, 2013).

For decades during the 20th century, coastal development in Florida routinely resulted in damage or destruction to vast regions of natural wildlife habitat, compromising the viability of key populations of marine species found throughout Florida's natural food chains. Further degradation of the IRL System can pose substantial economic impacts to the state and region. The IRL System has demonstrated to be valuable nursery habitat for countless marine species of significant ecological and economic importance to Florida's commercial and recreational fisheries. Florida's fishermen harvested nearly 90

million pounds of seafood in 2012, with a dockside value of $202 million (FWC, 2013b). In 2012, seafood landings for counties within the IRL System totaled slightly more than 12 million pounds or 14 percent of statewide landings. Hard clam aquaculture in IR-Malabar to Vero Beach Aquatic Preserve has become an important commercial fishery with far reaching economic value. Hard clam aquaculture is a primary source of revenue for commercial fishermen who have been displaced by the net ban, declines in fish stocks, and stricter harvest regulations. Further degradation of water quality could potentially close harvest of aquaculture areas due to strict federal water quality standards. Annual landing summaries can be found at www.myfwc.com/research/saltwater/fishstats.

The existence of the aquatic preserves in the IRL System helps buffer against negative environmental impacts that might result from coastal development. The IRL System can help provide a much-needed "buffer zone" within which potential environmental impacts are analyzed more closely than in unprotected marine environments. The aquatic preserves are critical to avian and aquatic biology and ecology, geology, hydrology, and restoration science. Because of the highly altered state of the IRL System, it serves as a prime study site to analyze the effect of sedimentation, algal blooms, nitrification, hypoxia, wide and rapid salinity fluctuations, heavy metals, pesticides, and non-native species on native SAV and fauna. The IRL System and its watershed will continue to provide critical information for the advancement of restoration science on a global level. Knowledge gained from pilot restoration projects within the IRL System and its watershed will lay the foundation for future similar projects. Protection of irreplaceable coastal environments, such as the IRL System, is necessary too for both commercial and recreational fishing industries through protection of fishery nursery areas important to shrimp, crabs and a variety of economically important fish. Recent increases in numbers of previously declining species, such as the goliath grouper (*Epinephelus itajara*), clearly demonstrate that protected areas, such as aquatic preserves, successfully serve important biological and economic purposes.

3.1.5 / Working Groups, Nongovernmental Organizations and Citizen Support Organizations

Intergovernmental working groups and volunteer citizen groups play an important role in the restoration and enhancement of the IRL System. Numerous opportunities for restoration and protection of the IRL System are provided through partnerships created between government, nongovernmental organizations, and private citizens.

Brevard and Indian River Counties Stormwater Working Group - The Brevard and Indian River Counties Stormwater Working Group is organized and managed by SJRWMD and consists of local government and water control district stormwater managers and staff. The working group allows for the exchange of technical information regarding stormwater management issues and techniques and coordination of funding proposals for stormwater projects.

Brevard Nature Alliance, Inc. (www.brevardnaturealliance.org) - The Brevard Nature Alliance, Inc. sponsors and promotes the development of nature-based education and activities throughout Brevard County. The Alliance is a non-profit organization that acts as a central agency for analyzing area natural resources and physical needs to help develop long-range plans for the county. It provides expertise and guidance for local governments and nongovernmental organizations regarding community environmental development.

Brevard Zoo (www.brevardzoo.org) - The Brevard Zoo has partnered with IRLAP to increase awareness of the IRL Shoreline Restoration Project by hosting Adopt-A-Mangrove workshops. At Adopt-A-Mangrove workshops, participants learn about the history of the IRL Shoreline Restoration Project, about the IRL and the importance of mangroves and shoreline restoration. At the end of each Adopt-A-Mangrove workshop, participants take home a mangrove to "foster." Once established in their container, mangroves are returned to the zoo to be used by IRLAP in restoration efforts along the IRL. The Brevard Zoo has also partnered with the University of Central Florida and The Nature Conservancy to continue the community based Oyster Reef Restoration Project. Oyster mats are constructed from mesh and oyster shells and are placed in the IRL to provide a natural substrate for oyster larvae to settle. Since the project started in 2005, approximately 25,000 volunteers and project partners have constructed and placed more than 28,000 oyster restoration mats to restore oyster reefs (Brevard Zoo, 2013).

Environmental Learning Center (www.discoverelc.org) - The Environmental Learning Center is a private non-profit organization located on Wabasso Island in IR-Malabar to Vero Beach Aquatic Preserve. The Environmental Learning Center's mission is to provide stimulating environmental education programs that instill an understanding of the natural world, enrich people's lives, and inspire participants to be active stewards of the surrounding natural resources. The Environmental Learning Center initiated shoreline restoration projects which are now managed by IRLAP.

Florida Oceanographic Society (www.floridaocean.org) - The Florida Oceanographic Society is a non-profit organization founded in 1964. The Society's mission is to inspire environmental stewardship of Florida's coastal ecosystems through education and research. The Society operates the Florida Oceanographic Coastal Center, a 57-acre marine life nature center located in Stuart, situated between the Indian River and the Atlantic Ocean. As a leading state and nationally recognized environmental organization, the Florida Oceanographic Society offers educational programs to people of all ages and conducts research and restoration programs that lead to healthy coastal ecosystems.

Friends of the St. Sebastian River (home.comcast.net/~fssr/) - The Friends of the St. Sebastian River, a citizen support organization is governed by an independent elected board. The goals of the Friends of the St. Sebastian River are to promote and protect environmental and recreational opportunities, improve water quality, promote safe boating practices, protect wildlife by supporting manatee protection, promote public education and awareness, and encourage conservation of the St. Sebastian River. The Friends strive to meet their goals through cooperation and participation with governmental agencies and other organizations that protect the St. Sebastian River.

Harbor Branch Oceanographic Institute at Florida Atlantic University (www.fau.edu/hboi) - Harbor Branch Oceanographic Institute (HBOI), located in Ft. Pierce, is a leader in ocean-related innovation, exploration, research, education and conservation. Scientists at HBOI have been studying the IRL for more than three decades, including monitoring its sea grasses and water quality to predict the impact of freshwater runoff and nutrient loading on ecosystem health. Important contributions with respect to the IRL include documenting the harmful effects of algal blooms on coastal habitats, conducting a long-term health and environmental risk assessment of IRL dolphins, and rescuing sick and injured marine mammals. HBOI provides specialized graduate and undergraduate courses for students at Florida Atlantic University as well as hosting the Marine and Oceanographic Academy with the St. Lucie County School District.

Indian Riverkeeper (www.indianriverkeeper.org) - The Indian Riverkeeper is a non-profit organization whose mission is to protect and restore the IRL, its tributaries, fisheries and habitats through advocacy, enforcement and citizen action. Funded by members, citizens, businesses, foundations and grants, the Indian Riverkeeper is currently working to help pass fertilizer use ordinances, remove derelict vessels, develop stormwater treatment and control projects, and control or eliminate Okeechobee discharges.

Indian River Land Trust (www.indianriverlandtrust.org) - The Indian River Land Trust (IRLT), a member of the National Land Trust Alliance representing land trusts since 1982, is one of the hundreds of land trusts that work to protect special places in the local community. Land trusts work solely through private transactions, whether outright purchases or conservation easements, often fulfilling the landowner's wish to keep the land intact and undeveloped for their children and future generations. Since 2009, the IRLT has acquired more than 625 acres and over 6 miles of frontage on the Indian River Lagoon. IRLT has also played an active role in the improvement and expansion of the Pelican Island National Wildlife Refuge and establishment of the St. Sebastian River Greenway.

Marine Resources Council (www.mrcirl.org) - Founded as a volunteer organization more than 20 years ago, the Marine Resources Council focuses on problems that impact the IRL. Loss of seagrass, impacts of stormwater runoff and coordination of local, state and federal programs are the primary focus of the Council. The Council is directed by a Board of Directors and is currently involved with the IRL Greenway Committee, Indian River Lagoonwatch volunteer water quality monitoring program, and "State of the IRL" public education workshops.

Ocean Research and Conservation Association (www.teamorca.org) - Located in Ft. Pierce, the Ocean Research and Conservation Association's (ORCA) primary focus is the protection and restoration of aquatic ecosystems and the species they sustain. They accomplish this through the development of innovative technologies and science-based conservation. Programs at ORCA include Kilroy, Fast Assessment of Sediment Toxicity and Sentinel. Kilroy is a continuous water-quality monitor capable of measuring water speed, direction, temperature, salinity, and prevalence of key microorganisms. Fast Assessment of Sediment Toxicity is a relatively quick method to assess relative toxicity of sediment samples using broad-spectrum toxicity tests. The Sentinel Program involves biological monitoring of contaminants through the use of bivalves. These programs provide information on water characteristics and toxicity and, when used in concert, can determine sources of non-point source pollution in coastal and estuary waters. ORCA has contracted with several municipalities throughout the IRL to help document the magnitude and source of pollution entering the lagoon.

Smithsonian Marine Station at Ft. Pierce (www.sms.si.edu) - The Smithsonian Marine Station is a research center with specialization in marine biodiversity and ecosystems of Florida. The Marine Station is

located in Ft. Pierce and is part of the Museum of Natural History, which in turn, is part of the Smithsonian Institution in Washington, D.C. Scientific investigations at the Marine Station focus on the IRL System and offshore marine waters of Florida's central east coast. The Marine Station is the depository of the IRL Species Inventory Project which catalogs and describes the organisms that inhabit the IRL. The Marine Station also provides public education and outreach programs to local schools through the Smithsonian Marine Ecosystems Exhibit. The Smithsonian collaborates with the Indian River State College to allow for dual enrollment courses in marine biology for high school students. Additionally, the Marine Station sponsors visiting scientist lectures and provides speakers for community groups.

*3.1.6 / **Adjacent Public Lands and Designated Resources***

Significant wetland losses and alterations occur along the shorelines of all counties in the IRL System. Protection and enhancement of the remaining functional upland-wetland-lagoon linkages is critical to the long-term protection of the quality and biological resources of the IRL. Management of these critical habitats can prove difficult since many of these are privately owned. The simplest way to ensure proper management of these areas is through property acquisition or easements. Passage of the Preservation 2000 Act in 1990, along with acquisition initiatives funded by local interests, Water Management Districts and the Conservation and Recreation Lands program greatly strengthened the state's ability to acquire endangered lands. Local governments within the IRL System responded to this funding availability by passing local land acquisition referendums. Land acquisition and associated land management programs exist in Brevard, Indian River, St. Lucie, Martin and Palm Beach counties. Many of the parcels adjacent to the IRL System were purchased at the county level and consist primarily of mosquito impoundments. Purchases of these types of property were crucial in order to expand the active rotational impoundment management programs of mosquito control districts. For example, the St. Lucie Mosquito Control District has successfully implemented a land acquisition preservation program with over 55 percent of the coastal barrier island in St. Lucie County now under public ownership.

The Coastal and Estuarine Land Conservation Program (CELCP) was established in 2002 by NOAA. The primary purpose of the program is to acquire property in coastal and estuarine areas that have significant conservation, recreation, ecological, historical, or aesthetic values, or that are threatened by conversion from a natural or recreational state to other uses. NOAA's Office of Ocean and Coastal Resource Management (OCRM) administers the program, which provides up to three million dollars for each eligible project. CELCP funds must be matched equally by non-federal funds. In November 2008, Florida became the fifth state to have its CELCP plan formally approved by OCRM. Critical wetland areas in the IRL System have been identified in the plan.

The IRL Blueway Project, a cooperative acquisition plan, was developed through the collaborative efforts of a variety of agencies and identified key properties throughout the IRL System for acquisition. The greater IRL Blueway project area, which includes the IRL System, includes Merritt Island National Wildlife Refuge, Canaveral National Seashore and lands protected by the State of Florida, and Brevard, Indian River, St. Lucie and Martin counties (see maps 19 through 22b). In addition to filling in the conservation landscape, protection of shoreline properties is critical to addressing threats resulting from global climate change and sea level rise. Conserving these properties will conserve the habitat's ecological services such as feeding, roosting, nesting, and nursery areas, preventing shoreline erosion, and buffering effects from storms and high waters. The most recent (2008) IRL Conservation and Management Plan Update authored by the IRL NEP continues to recommend a high priority ranking for land acquisition through the Blueway Project.

Conservation Lands Near Banana River Aquatic Preserve

Federal Public Lands

Merritt Island National Wildlife Refuge (Merritt Island NWR) (www.fws.gov/merritisland) - Located immediately north of Banana River Aquatic Preserve, Merritt Island NWR was established in 1963 as an overlay of NASA's John F. Kennedy Space Center. The refuge, consisting of 140,000 acres, provides a wide variety of habitats (coastal dunes, saltwater estuaries and marshes, freshwater impoundments, scrub, pine flatwoods, and hardwood hammocks) provide habitat for more than 1,500 species of plants and animals. The protected scrub lands and tidal wetlands of Merritt Island NWR provide important key habitat for several endangered species. Many recreational opportunities are offered at Merritt Island NWR. Bird and wildlife observation, a wildlife drive, manatee observation deck, fishing and hunting opportunities, and boating and paddling are examples of available activities.

Patrick Air Force Base - Located between Satellite Beach and Cocoa Beach, Patrick Air Force Base borders the eastern boundary of Banana River Aquatic Preserve. More than 2,000 acres of the base

are managed as conservation areas through the 45th Space Wing Conservation Program. Scientists at the Air Force Base work closely with USFWS and FWC in respect to critical wildlife habitat restoration, protecting resources, and improving biodiversity.

Cape Canaveral Air Force Station (www.nps.gov/nr/travel/aviation/cap.htm) - Located immediately northeast of Banana River Aquatic Preserve, this 15,800-acre installation includes one of the few long sections of Atlantic Ocean coastline (13 miles) that remains relatively undeveloped. Similar to Patrick Air Force Base, much of the Air Force Station is managed as a conservation area through the 45th Space Wing Conservation Program. FNAI documented eleven native plant communities at the Air Force Station. Some of these communities occur only as thin ribbons adjacent to the coastline, such as beach dune, coastal grassland and coastal strand; however, the vast majority of undeveloped land is scrub. The scrub habitat present at Cape Canaveral Air Force Station has been identified by USFWS as an integral component of the effort to recover the threatened Florida scrub-jay (*Aphelocoma coerulescens*). Natural resource managers work closely with USFWS to manage scrub habitat.

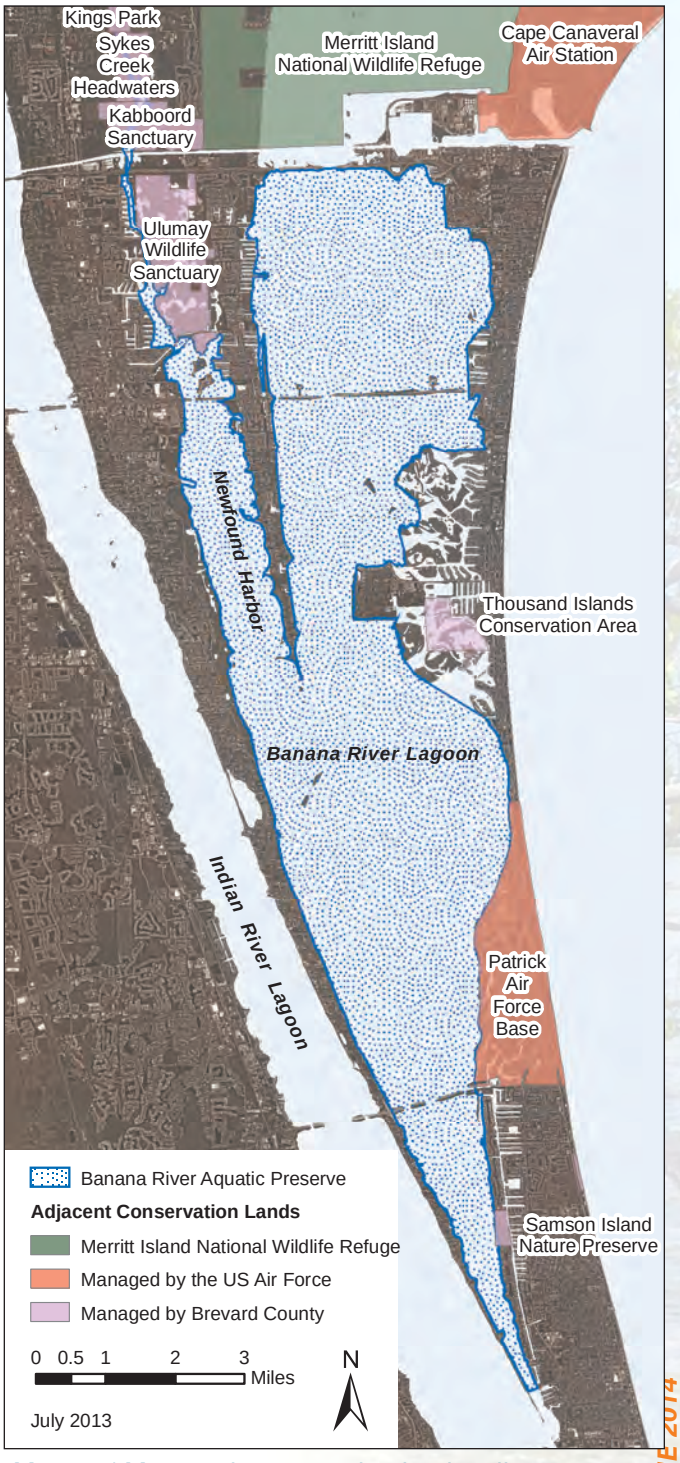
Brevard County Public Lands (www.brevardcounty.us/EELProgram) - The Brevard County Environmentally Endangered Lands (EEL) Program was established in 1990 to protect the natural habitats of Brevard County by acquiring environmentally sensitive lands for conservation, passive recreation, and environmental education. EEL sanctuaries are managed to preserve native habitats and associated plants and animal species. The EEL is managed by Brevard County's Parks and Recreation Department.

Brevard County conservation lands adjacent to Banana River Aquatic Preserve include:

Ulumay Wildlife Sanctuary - This 600-acre conservation area encompassing the Sykes Creek floodplain includes an elevated observation deck and hiking trails.

Thousand Islands Conservation Area (www.brevardcounty.us/EELProgram/Areas/ThousandIslands/Home) - This 338-acre site consists of a series of islands on the south side of Minuteman Causeway. With the exception of a short nature trail along Fourth Street South, all access to the islands is by boat. A short nature trail exists on the northernmost island (North Crawford Island), and a marked paddling trail is in development.

Kabboord Sanctuary - This 502-acre preserve comprises significant tidal marsh, wading bird habitat, and xeric oak scrub. Recreational amenities are minimal and include hiking and biking trails.



Map 19 | Managed conservation lands adjacent to Banana River Aquatic Preserve.

Sykes Creek Headwaters - This 303-acre preserve encompasses part of Sykes Creek headwaters. Natural communities on site include cabbage palm hammock, mesic hammock, salt marsh, and mangrove swamp. Most of the site is closed to the public.

Kings Park - This 240-acre community river park is primarily a wetland preserve and haven for freshwater fishing. The small developed area at the northeast corner of the park features a multiuse field

and paved parking that accommodates practice games and neighborhood play. A deep freshwater lake adjacent to the parking area offers a natural ramp for non-motorized boats. Another small lake, a canoe trail and rustic nature trails are also present.

City of Satellite Beach Public Lands (www.satellitebeachrecreation.org) - The City of Satellite Beach manages Sampsons Island Nature Preserve, accessible only by boat. In the early 1990s, city volunteers began work to eradicate exotic plants, introduce native vegetation, and provide park amenities such as picnic areas and grills. The island park offers visitors outdoor activities such as bird watching, walking the park's nature trails, and picnicking.

Conservation Lands Near Indian River-Malabar to Vero Beach Aquatic Preserve

Federal Public Lands

Archie Carr National Wildlife Refuge (www.fws.gov/archiecarr) - The 248-acre Archie Carr NWR spans 21 miles between Melbourne Beach and Wabasso Beach along Florida's east coast. The refuge consists of numerous separate parcels, many of which connect the IRL to the ocean. The refuge was designated to protect habitat for what is the most significant area for loggerhead sea turtle nesting in the Western Hemisphere, and the most significant area for green turtle nesting in North America. The refuge is also unique for its placement within a patchwork of protected lands and among properties that have already been developed. To help preserve this globally important nesting ground, USFWS has established a partnership with state and county governments and private conservation groups to acquire and manage this dune habitat. The primary management thrust is to provide long term protection of this habitat for sea turtles and other listed species as well as providing compatible public use.

Pelican Island National Wildlife Refuge (www.fws.gov/pelicanisland) - Pelican Island, a five-acre mangrove island, was established as the first federal bird reservation by President Roosevelt in 1903 because of its significance as a bird rookery. Since its inception in 1903, Pelican Island NWR has expanded to include more than 5,400 acres of mangrove and spoil islands, barrier island uplands, and submerged lands in the IRL. Public facilities were opened in 2003 as a part of the Centennial Celebration of Pelican Island and the National Wildlife Refuge System. These facilities provide the public with an opportunity to view the Pelican Island rookery from land. Recreational opportunities at the refuge facilities include hiking, bird watching, wildlife observation and photography.

State Public Lands (www.floridastateparks.org)

Indian River Lagoon Preserve State Park - Located in south Brevard County approximately 12 miles south-southeast of the city of Melbourne on the barrier island, this preserve was purchased primarily to protect the watershed of the IRL. The state park includes two parcels - Mullet Creek Islands and Inlet Grove. The state park is 402 acres, with approximately 301 upland and 101 wetland acres. Hydric hammock and tidal swamp are the dominant natural communities remaining on the properties. Disturbed ruderal areas cover approximately 80 percent of the park. This site is currently undergoing an aggressive restoration program to remove exotic invasive plants and reintroduce native species. Public access is limited while the restoration is in progress.

Sebastian Inlet State Park - The 971-acre state park is located in Brevard and Indian River counties on the barrier island between the Atlantic Ocean and the IRL and straddles the Sebastian Inlet. The State of Florida acquired Sebastian Inlet State Park to protect, develop, operate and maintain the property for public outdoor recreation, conservation, historic and related purposes. The park has fully developed facilities.

St. Sebastian River Preserve State Park - Located in Brevard and Indian River counties, the park contains 21,748 acres. The St. Sebastian River Preserve State Park overlaps IR-Malabar to Vero Beach Aquatic Preserve along the St. Sebastian River. Ongoing coordination programs include active management of the park's listed animal species, particularly the red-cockaded woodpecker (*Picoides borealis*) and the Florida scrub jay, with FWC and the USFWS. Park staff work with SJRWMD on an ambitious hydrological restoration program and with both the Water Management District and ACOE on the management of the C-54 and Fellsmere canals and associated control and maintenance facilities. IRLAP and state park staff collaborate regarding water quality protection and enhancement, in addition to other issues within the state park.

Brevard County Public Lands (www.brevardcounty.us/EELProgram)

Barrier Island Sanctuary - This 34-acre sanctuary houses the EEL Program Management and Education Center. The center provides a focal point for the Archie Carr NWR and the associated barrier island. A one mile hiking trail winds from the ocean to the IRL.

Coconut Point Sanctuary (www.brevardcounty.us/EELProgram/Areas/CoconutPoint) - This 62-acre habitat of coastal strand, oak scrub, coastal oak forest and mangrove forest at the Coconut Point Sanctuary connect the Atlantic Ocean to the IRL. Along the hiking trail is an observation platform over the IRL.

Hardwood Hammock Sanctuary - This sanctuary is comprised of several non-contiguous properties that encompass approximately 31 acres south of the City of Melbourne Beach. All of the 31 acres are located west of U.S. Highway A1A and consists of tropical hardwood hammock, maritime hammock and mangrove swamp natural communities.

Hog Point Cove Sanctuary - This sanctuary is comprised of several properties that encompass approximately 18 acres and consists of disturbed and undisturbed maritime hammock. These sites are too small for public access but aid in connecting other local and federal conservation habitat in the area.

Hog Point Sanctuary - This sanctuary encompasses approximately 20 acres. Approximately one acre of the site is coastal dune habitat located east of U.S. Highway A1A. The remainder of the property is located west of U.S. Highway A1A and consists of coastal strand, scrub and impounded tidal swamp.

Malabar Scrub Sanctuary - The variety of habitats found on the 395-acre Malabar Scrub Sanctuary make it an ideal place for visitors to learn how wetland and upland communities interact. The protected habitats include xeric (dry) hammock, scrub, scrubby flatwoods, pine flatwoods, sand pine scrub, ponds, sloughs, and depression marshes. Trails weave through many of these natural communities, including several areas recently treated with prescribed fire. The sanctuary is a refuge for the Florida scrub-jay, gopher tortoise, and Eastern indigo snake. Restrooms are available at the adjacent Malabar Community Park.

Maritime Hammock Sanctuary - This 150-acre sanctuary features a hiking trail with two bridges, boardwalk over wetland areas, and an observation deck over a marsh pond. The sanctuary includes coastal strand, maritime hammock and mangrove forests.

Turkey Creek Sanctuary - Acquired and managed by the City of Palm Bay, the Audubon Society, and the EEL Program, a boardwalk nature trail and jogging trails wind through the 130-acre sanctuary. The boardwalk trail passes through hydric (wet) hammock, mesic (moist) hammock and sand pine scrub communities, and much of it overlooks Turkey Creek. The sanctuary can also be accessed by canoe or kayak. The Margaret Hames Nature Center provides interpretive exhibits, a gift shop and restrooms.

Twin Shores Park - This 29-acre parcel is managed by Brevard County Parks and Recreation Department under the Save Our Coast Program. The property consists of somewhat disturbed maritime hammock/coastal strand. Nearly half the property is dominated by Brazilian pepper.

Washburn Cove - Washburn Cove encompasses 39 acres and is managed by the EEL Program. The property has no public amenities. It is primarily maritime hammock with an area of hydric hammock (~6 acres) along the east shore of the IRL.

Ponce Landing - This 26-acre regional beach park features two beach crossovers, a small pavilion, restrooms, and parking. Coastal strand and mangrove forest connect the Atlantic Ocean to the IRL. The park commemorates the epic 1513 voyage of Juan Ponce de León and his possible landing near Melbourne Beach, Florida on April 2.

Snag Harbor - This 15-acre site is immediately adjacent to the much larger Maritime Hammock Sanctuary. The undeveloped site is comprised of coastal strand, maritime hammock, and mangrove forest.

Cameron Preserve - This 100-acre preserve consists of undeveloped scrubby flatwoods that support a population of scrub jays.

Coconut Point Park - This 37-acre community beach park is an important sea turtle nesting site and is part of the Great Florida Birding Trail. East of A1A, the site is comprised of coastal dunes. West of U.S. Highway A1A, the site contains scrubby flatwoods and estuarine wetlands. Popular for surfing, beachcombing and fishing, the park amenities include a picnic shelter, restrooms and outside showers.

Barrier Island Ecosystem Center - This 34-acre sanctuary offers visitors an invitation to explore the barrier island's diverse habitats through interactive exhibits at the Center, and along a one-mile hiking trail that winds from the Atlantic Ocean to the IRL. The Center provides a focal point for Archie Carr NWR and the associated barrier island by providing exhibit space, a presentation hall, and ongoing educational programs that promote stewardship of the area's fragile natural resources.

Apollo Eleven Park - Located on both sides of U.S. Highway A1A, this undeveloped 21-acre site is part of the Archie Carr NWR project area. The site contains sea turtle nesting beaches as well as coastal strand, maritime hammock and mangrove forest.

Indian River County Public Lands - (www.ircgov.com/departments/General_Services/Parks/Conservation)

Captain Forster Hammock Preserve - The 110-acre Captain Forster Hammock Preserve was purchased to conserve natural and cultural resources on the site. The Preserve contains maritime hammock, coastal strand and wetland plant communities and contains trails and restrooms.

Kroegel Homestead - The Kroegel Homestead project protects and preserves an important part of our nation's heritage. The subject property is the homestead of Paul Kroegel, the first federal wildlife warden of the nation's first wildlife refuge, Pelican Island. The project is adjacent to the IRL and is an integral part of Pelican Island NWR, which is located directly east of the Kroegel Homestead. The property includes remnant coastal hammock and a pre-historic shell midden. The site is not currently open to the public.

Lost Tree Islands Conservation Area - This conservation area is comprised of approximately 508 upland, wetland and submerged acres located in the IRL, immediately north of the Barber Bridge in Vero Beach. It is situated between the mainland and the barrier island, and lies within the jurisdictions of the City of Vero Beach, the Town of Indian River Shores and Indian River County. The property extends from the southern portion of a mosquito impoundment known as McCuller's Point, formerly an estuarine tidal marsh, southward to include all of two and a portion of a third "inner islands," and three "outer islands," as well as six low spoil islands located in Gifford Cut, a navigational channel between the inner and outer islands. The marsh and the six larger islands were natural landforms and supported native vegetative communities prior to human alteration during the 20th century. They now exhibit considerable ecological degradation as a result of the marsh impoundment (aimed at control of mosquito populations), and the deposit of dredge spoil from the ICW and Gifford Cut on the islands. The six small islands in Gifford Cut are manmade spoil deposits.

Indian River Land Trust (www.indianriverlandtrust.org/cfiles/projects.cfm)

Bee Gum Point - The 111-acre property is one of the last undeveloped wetlands on the barrier island, containing a mile of lagoon shoreline. The primary purpose for purchasing Bee Gum Point is to protect important habitat along the IRL. The property will remain as a natural area for conservation and will be available for periodic IRLT-guided walking and bird watching tours.

Quay Dock Road - The four-acre conservation property is located at the end of Quay Dock Road, an historic wagon road built in the 1890s used by early settlers on John's Island and the peninsula to transport their produce from the Quay Dock to Quay Station, now Winter Beach. The parcel contains mostly mangrove swamp.

Winter Beach Salt Marsh - The 47-acre property contains one-quarter mile of lagoon frontage and is one of two intact high salt marshes remaining in Indian River County. The property is made up of approximately one-third uplands, one-third oak hammock and one-third wetlands. It is adjacent to Spoonbill Marsh, a 45-acre man-made marsh owned by the Indian River County Utilities Department.

Pine Island - The 190-acre property contains one of the largest remaining examples of salt marsh in Indian River County. The property is closed to the public and is being managed as a wading bird sanctuary.

Toni Robinson Trail (www.irlt.org/cfiles/projects_lagoonwaterfront.cfm) - Purchased in 2009, the Toni Robinson Waterfront Trail totals eight acres on the west side of the lagoon. The property contains oak trees, scrub forest and mangrove swamp. Amenities include parking, trails and a dock.

Private Conservation Lands (www.mitigationmarketing.com/cgw_mb.html)

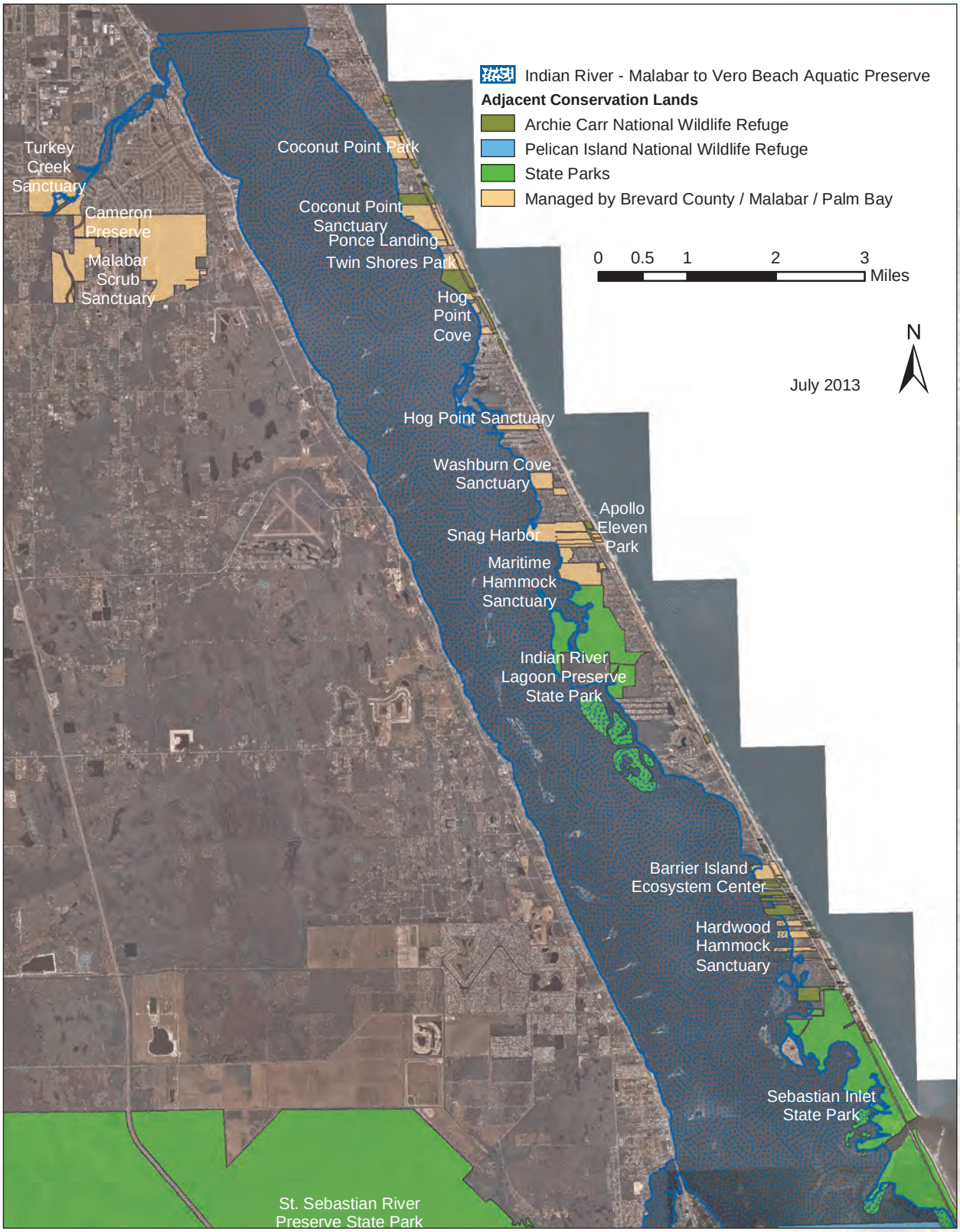
CGW Mitigation Bank is located along the western shore of the IRL, north of Vero Beach in Indian River County. The bank site is 150 acres and the implementation of the bank will involve hydrologic enhancement, salt marsh restoration, and exotic vegetation eradication. Habitats present on the site include impounded salt marshes, mangroves, and coastal (hydric) oak hammocks. The service area includes drainage basins for the IR-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce aquatic preserves.

Conservation Lands Near Indian River-Vero Beach to Ft. Pierce Aquatic Preserve

State Public Lands (www.floridastateparks.org)

Avalon State Park (www.floridastateparks.org/avalon) - The park is located in St. Lucie County about nine miles south of Vero Beach on the barrier island. Presently the park comprises approximately 656 acres. The park connects the Atlantic Ocean to the IRL. The eastern portion has been developed for public beach access and includes restrooms and pavilions. The western portion of the park includes coastal hammock and mangrove forest and is closed to the general public. An aggressive program to remove invasive Brazilian pepper is underway.

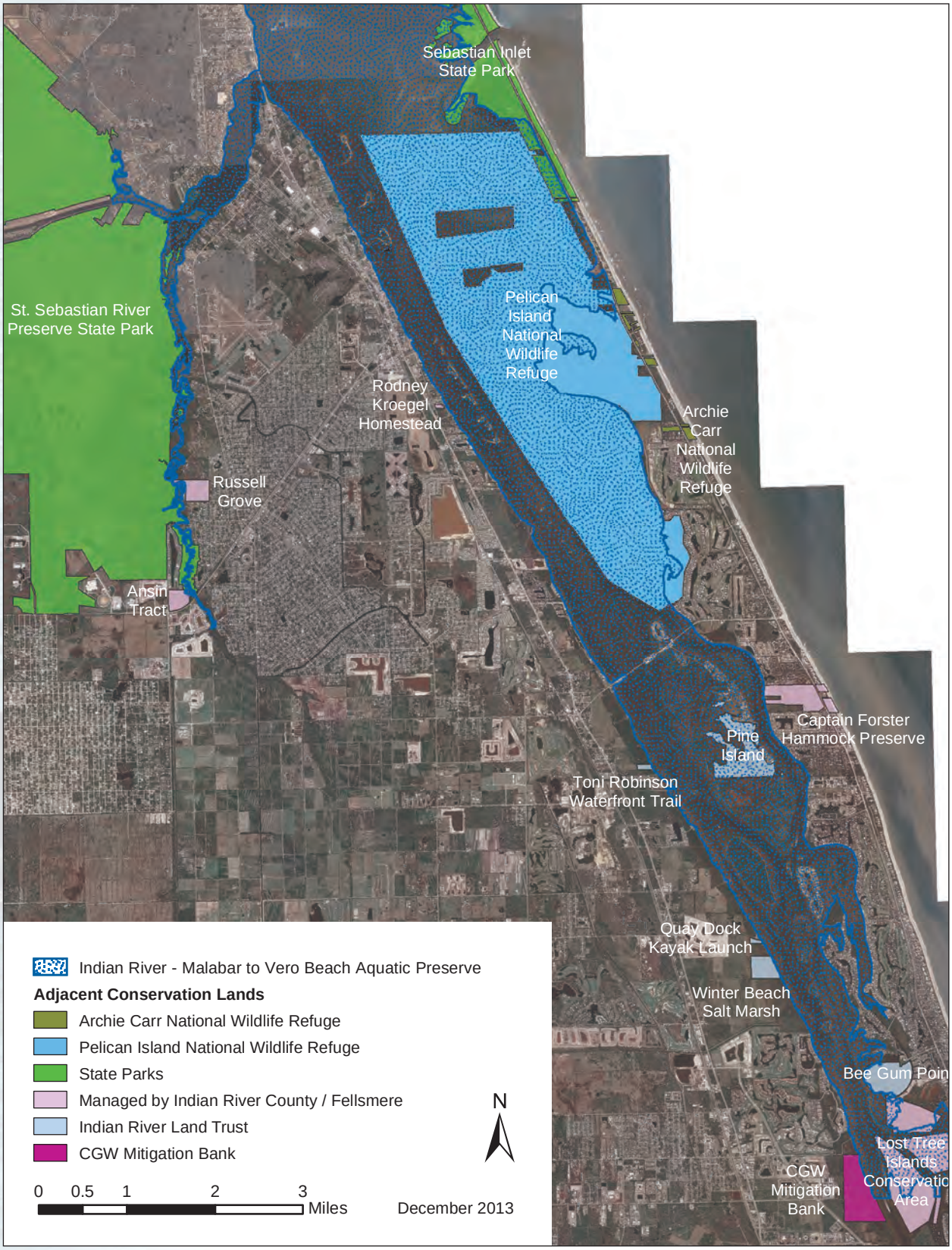
Ft. Pierce Inlet State Park (www.floridastateparks.org/fortpierceinlet) - Located on the north side of Ft. Pierce Inlet in St. Lucie County, the park is divided into two distinct parcels, Jack Island and Ft. Pierce Inlet. Large portions of the 1,141-acre park have been altered for the purposes of mosquito control and construction and maintenance of the inlet. Significant natural features remain and include seagrass beds and maritime hammock. The park is fully developed and includes restroom facilities, pavilions and park office buildings.



Map 20a / Managed conservation lands adjacent to Indian River-Malabar to Vero Beach Aquatic Preserve (north section).

Indian River County Public Lands (www.ircgov.com/departments/General_Services/Parks/Conservation)

Flinn Tract - This tract is a part of the Oslo Riverfront Corridor and contains 37 acres of coastal hammock and wetlands bordering the IRL. The property provides green-space in a rapidly developing area, and conserves key habitat for wading birds and lagoon fisheries. Plans for improvements include a small parking area, trailhead, educational signs and trails.



Map 20b / Managed conservation lands adjacent to Indian River-Malabar to Vero Beach Aquatic Preserve (south section).

Harmony Oaks Conservation Area - This 90-acre conservation area consists of coastal hammock and wetlands. Upcoming improvements include a mitigation project that will restore the ruderal area in the south-west portion of the property. Parking, trailhead, interpretive signs, trails and boardwalks are planned for public use improvements in the near future.

Oslo Riverfront Conservation Area - The 441-acre conservation area consists of undeveloped mature coastal hammock, scrubby flatwoods and estuarine wetlands. Facilities include boardwalks, observation tower, canoe launch, educational information and trailhead, approximately one mile of trails and parking.

Oyster Bar Salt Marsh - This 155-acre conservation area is comprised of maritime hammock and impounded wetland. The primary purpose of this parcel was to bring the impounded wetland into the active RIM program of the Indian River Mosquito Control District and prevent development of the maritime hammock. Future access improvements will include walking trails, boardwalks, trailhead with kiosk and interpretive signs.

Prange Islands Conservation Area - This conservation area includes several islands totaling 27 acres and is located just south of the 17th Street Bridge in Vero Beach. The Islands contain native maritime hammock and are fringed by mangrove forest. Prange Island was the historic homestead of the Prange Family from the early 1900s. Primitive camping is allowed. A small boat dock is located on the east side of Prange Island.

Round Island South Conservation Area - The 59-acre conservation area is located south of Round Island Riverside Park and contains mature maritime hammock and coastal wetlands.

Green Salt Marsh - This site is comprised entirely of a 16-acre mosquito impoundment dominated by mangrove forest. There is no public access at this site.

St. Lucie County Public Lands (www.stlucieco.gov/erd/preserve_opportunities.htm)

D.J. Wilcox Preserve - This 105-acre preserve primarily consists of pine flatwood, mangrove swamp, oak hammock and bay-gall swamp. Several large specimens of slash pine (*Pinus elliottii*) are found on the site. A one-mile self-guided interpretive trail winds through the site along the west side of the IRL.

Harbor Branch Preserve - The 268-acre Harbor Branch Preserve Project is a collaborative effort between three governmental agencies; Florida Communities Trust, Division of State Lands and St. Lucie County. The preserve is on the mainland and is adjacent to the western shore of the IRL. The preserve contains ten parcels that encompass 268 acres. The project consists of a variety of improved and unimproved areas that include upland and wetland habitats. The Harbor Branch Preserve is being managed to restore and maintain the natural condition of the native plant communities, retain high-quality wildlife habitat, and maintain water quality.

Kings Island Preserve - Once the site of a Native American fishing camp, this upland and wetland preserve encompasses 174 acres and features nearly three miles of trails, two 30-foot boardwalks, covered picnic tables and two observation platforms.

Pepper Park Riverside - This 27-acre park provides a kayak/canoe launch. Facilities include fishing piers, covered pavilions and restrooms.

Queens Island Preserve - Once the site of a Native American fishing camp, this 232-acre upland and wetland preserve features a 292-foot boardwalk/ fishing pier and kayak/canoe access from a short trail located at the parking area. The preserve connects the ocean and the IRL and is primarily mangrove forest.

St. Lucie Village Heritage Park - This 70-acre site, located along the IRL, contains some very old live oak (*Quercus virginiana)* and cabbage palm. Local historians claim this 70-acre site was the location of the 1849 Russell/Barker skirmish, which led to the Third Seminole War (1855-1858). Two short interpretive trails wind through the site.

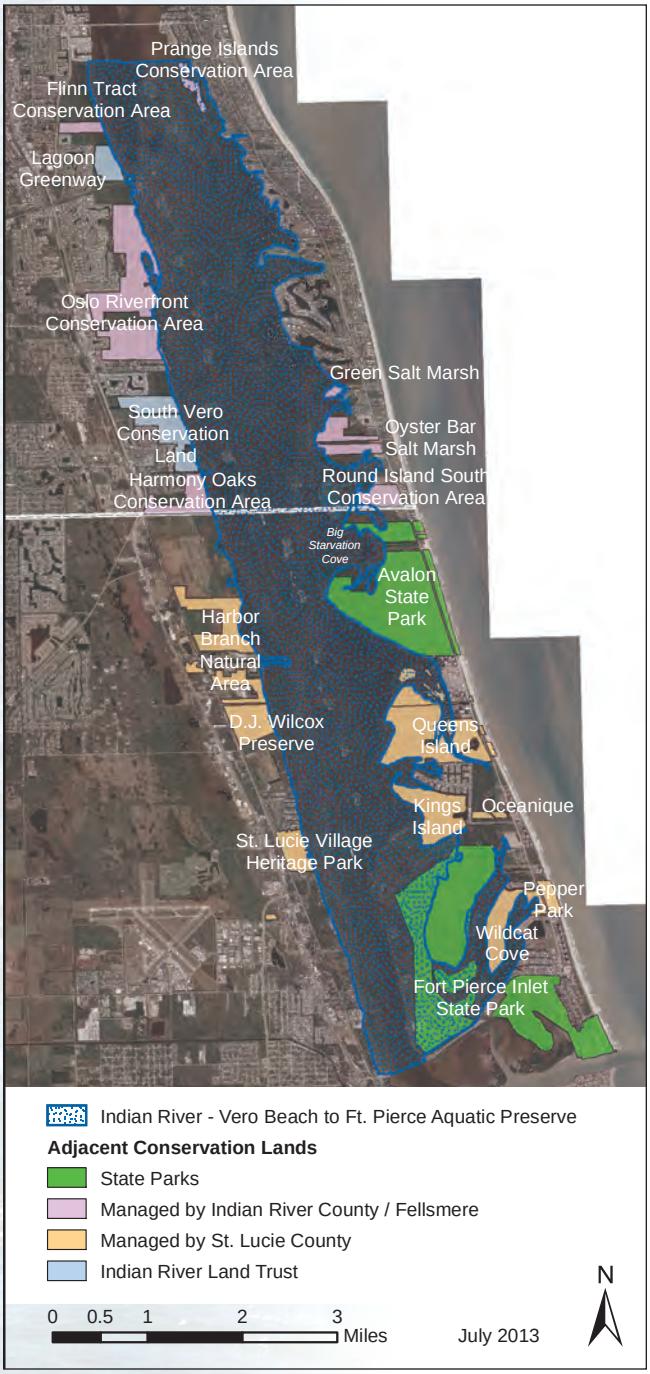
Wildcat Cove Preserve - This preserve consists of a 111-acre mosquito impoundment. The perimeter dyke of the impoundment has been developed into a two mile loop trail. An observation platform and a 52-foot boardwalk/fishing pier are located along the trail.

Oceanique - This 17-acre site consists of two parcels divided by a tidal creek of the IRL. The eastern parcel consists primarily of uplands dominated by exotic plant species. The western parcel is dominated by a mixed mangrove community, mostly black and red mangroves, with occasional salt marsh halophytes.

Indian River Land Trust (www.indianriverlandtrust.org/cfiles/projects.cfm)

Lagoon Greenway - This 187-acre property consists of oak hammock and mangrove forest impounded for mosquito control. Development is limited to parking and trails.

South Vero Conservation Land - The 185-acre South Vero Conservation Land contains oak hammocks, wetlands, and ponds. The property establishes a five-mile conservation corridor on the west side of the lagoon.



Map 21 / Managed conservation lands adjacent to Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.

Conservation Lands Near Jensen Beach to Jupiter Inlet Aquatic Preserve

Federal Public Lands

Hobe Sound National Wildlife Refuge (www.fws.gov/hobesound) - This coastal refuge is bisected by the IRL into two separate tracts of land totaling greater than 1,000 acres. The 735-acre Jupiter Island tract provides some of the most productive sea turtle nesting habitat in the United States. The mainland tract contains 300 acres of sand pine scrub. Headquarters include an exhibit room, gift shop, environmental education classroom, and short nature trail. The nonprofit Hobe Sound Nature Center, the refuge's cooperating association, operates the exhibit room, gift shop, and classroom.

Jupiter Inlet Lighthouse Outstanding Natural Area (www.pbcgov.com/erm/natural/natural-areas/jupiter-inlet) - This 120-acre site contains lands owned by the U.S. Department of the Interior, Bureau of Land Management; the U.S. Coast Guard; and the Town of Jupiter. Palm Beach County manages 78 acres of the natural area under a cooperative agreement with the Bureau of Land Management, with the assistance of the Village of Tequesta. The managed area contains Florida scrub, maritime hammock and mangrove swamp natural communities. Volunteers planted more than 6,000 mangrove seedlings as part of a two-acre tidal wetland restoration project on the north side of Beach Road. The entire 120-acre site has received federal designation as an outstanding natural area through the Bureau of Land Management's National Landscape Conservation Area Program. The part of the site on the south side of Beach Road lies within the Town of Jupiter and contains the historic 1860 Jupiter Inlet Lighthouse and Museum, the George Washington Tindall Pioneer House and the Town of Jupiter Lighthouse Park.

State Public Lands (www.floridastateparks.org)

Jonathan Dickinson State Park - This park is located in Martin and Palm Beach counties and contains approximately 11,459 acres. The park protects one of southeast Florida's largest contiguous areas of natural habitat; representing a diverse mosaic of 16 natural communities, including rare coastal sandhill upland lakes and scrub. The park protects most of the Loxahatchee National Wild and Scenic River corridor, Florida's first federally-designated Wild and Scenic River. The park also protects significant historical features including the Trapper Nelson Zoo Historic District, a National Register Site; the World War II remnants of Camp Murphy, a radar operations training base used by the U.S. Army during the formative years of the technology; and numerous prehistoric and historic archeological sites.

Savannas Preserve State Park - This 6,695-acre park is located in St. Lucie and Martin counties. The main use area of the park, with its developed Environmental Education Center, is located approximately two miles east of U.S. Highway 1 on Walton Road. Stretching more than 10 miles from Ft. Pierce to Jensen Beach, this preserve is the largest and most intact remnant of Florida's east coast savannas, or freshwater marshes.

Seabranch Preserve State Park - This 922-acre park is located in eastern Martin County. The IRL forms the eastern boundary of the park. U.S. Highway A1A on the west boundary provides access to the park. The park's rare and diverse habitats occur within a relatively small area and include one of the largest protected tracts of scrub and contiguous baygall communities in southeast Florida. The park's communities provide ecosystem connectivity and native wildlife genetic diversity along the Florida Atlantic Coastal Ridge. The park's recreational facilities are limited to a small shelter, an interpretive kiosk and 10 miles of unimproved hiking trails.

St. Lucie Inlet Preserve State Park - This park is located in Martin County about four miles southeast of Stuart. Access to the park is by private boat or walking three miles north from Hobe Sound NWR. The park is approximately 4,786 acres. A boardwalk takes visitors across mangrove forests and oak hammocks to the beach on the Atlantic Ocean. The island is an important nesting area for loggerhead, leatherback and green turtles.

St. Lucie County Public Lands (www.stlucieco.gov/erd/preserve_opportunities.htm)

Bear Point Sanctuary - The location of the last recorded Native American black bear (*Ursus americanus)* hunt on Hutchinson Island, this wetland preserve encompasses more than 352 acres and features a one-mile trail, an elevated observation platform, two covered picnic tables and one 450-foot fishing pier.

Blind Creek Natural Area - Comprised of a 365-acre wetland preserve along the IRL, Blind Creek Natural Area features one-and-a-half miles of trails, an observation platform and a 242-foot fishing pier.

John Brooks Park Riverside - Encompassing 427 acres, this wetland preserve features nearly a mile of trail and shoreline fishing.

Ocean Bay Riverside - This 53-acre upland and wetland preserve features a mile-long trail and a 200-foot fishing pier. Parking is available at Ocean Bay Beachside. A trail across U.S. Highway A1A leads you to the IRL.

Savannas Outdoor Recreation Area - Covering 582 acres and five distinct biological communities, the Savannas provide access to pine flatwoods, wet prairie, marsh, lake and scrub. With the goal to educate as well as recreate, the area provides interpretive trails on both land and water. The Savannas provides camping, boating, fishing and picnic facilities.

Walton Scrub Preserve - Overlooking the IRL, this 31-acre site contains many threatened and endangered species of plants that are found only in this scrub. A half- mile self-guided interpretive trail leads visitors through the site.

Martin County Public Lands (geoweb.martin.fl.us/parkfinder/)

Jensen Beach Impoundment - This 92-acre site consists primarily of mangrove swamp. There is approximately four acres of maritime hammock.

Dutcher Cove - This 62-acre site contains pristine mangrove swamp.

Jensen Beach West - This 33-acre site is almost completely mangrove swamp. Ten acres are heavily disturbed with Brazilian pepper and Australian pine.

Muscara - This 21-acre site is bisected by East Ocean Boulevard. The site includes beach dune, coastal strand and mangrove swamp.

Indian RiverSide Conservation Area - This 46-acre site includes 18 acres of mangrove swamp. The site includes a boardwalk and an educational pavilion.

Joe's River Park - This 15-acre parcel includes parking facilities, a pavilion, a boardwalk and a canoe/kayak launching site.

River Cove - This property is a popular launching point for non-motorized vessels. The site is a mix of remnant salt marsh, mangrove swamp, beach and upland communities.

Santa Lucea - This nine-acre site is bisected by MacArthur Boulevard and contains regionally significant archaeological features. The property includes beach dune, coastal strand, maritime hammock and mangrove swamp. Site development includes parking, showers and a dune crossover.

Clifton S. Perry Beach - This 19-acre property is bisected by MacArthur Boulevard and includes beach dune, coastal strand and maritime hammock.

Bathtub Beach - This seven-acre property is bisected by MacArthur Boulevard. The IRL side has a dock through the mangroves for observation and fishing.

Gomez - This 57-acre site includes a wide variety of habitats. The only public access is a trail system that connects this parcel with other conservation areas to the north and south.

Peck Lake Park - This 74-acre site includes a wide variety of habitats. Public access includes restrooms, parking, picnic pavilions, a trail system/ boardwalk and a fishing platform.

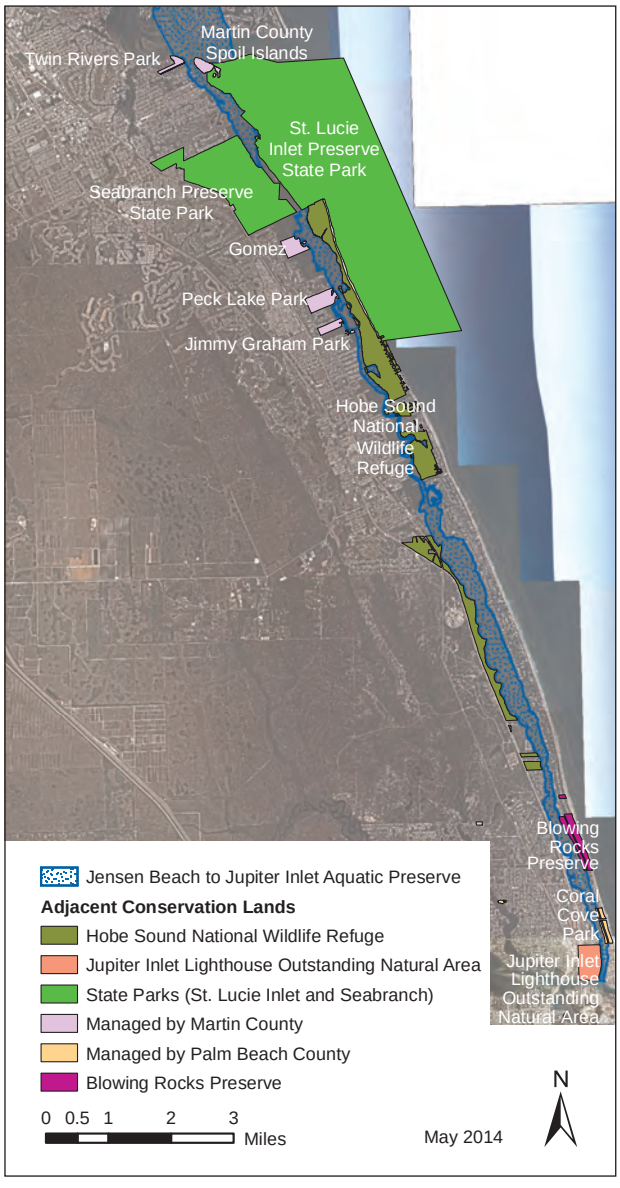
Jimmy Graham Park - This 34-acre site contains mangrove and freshwater swamp habitats. Public access includes parking, restrooms and a boat ramp.

Bob Graham Beach - This 20-acre property includes dune, coastal strand, maritime hammock and mangrove tidal swamp. Public access features include parking, showers, dune crossovers and a hiking trail.

Beachwalk Pasley - This 13-acre property includes mangrove tidal swamp, maritime hammock, coastal strand, and dune. Facilities include showers, dune crossovers and a hiking trail.

Curtis Beach - This six-acre parcel includes dune, coastal strand, maritime hammock and mangrove tidal swamp. Public access features are limited to a hiking trail.

Florida Oceanographic Site - This 41-acre property includes hammock and mangrove tidal swamp. Facilities include an oyster cultch production facility, a marine ecology education facility and hiking trails/ boardwalks.



Map 22a / Managed conservation lands adjacent to Jensen Beach to Jupiter Inlet Aquatic Preserve (north section).

Map 22b / Managed conservation lands adjacent to Jensen Beach to Jupiter Inlet Aquatic Preserve (south section).

Private Conservation Lands

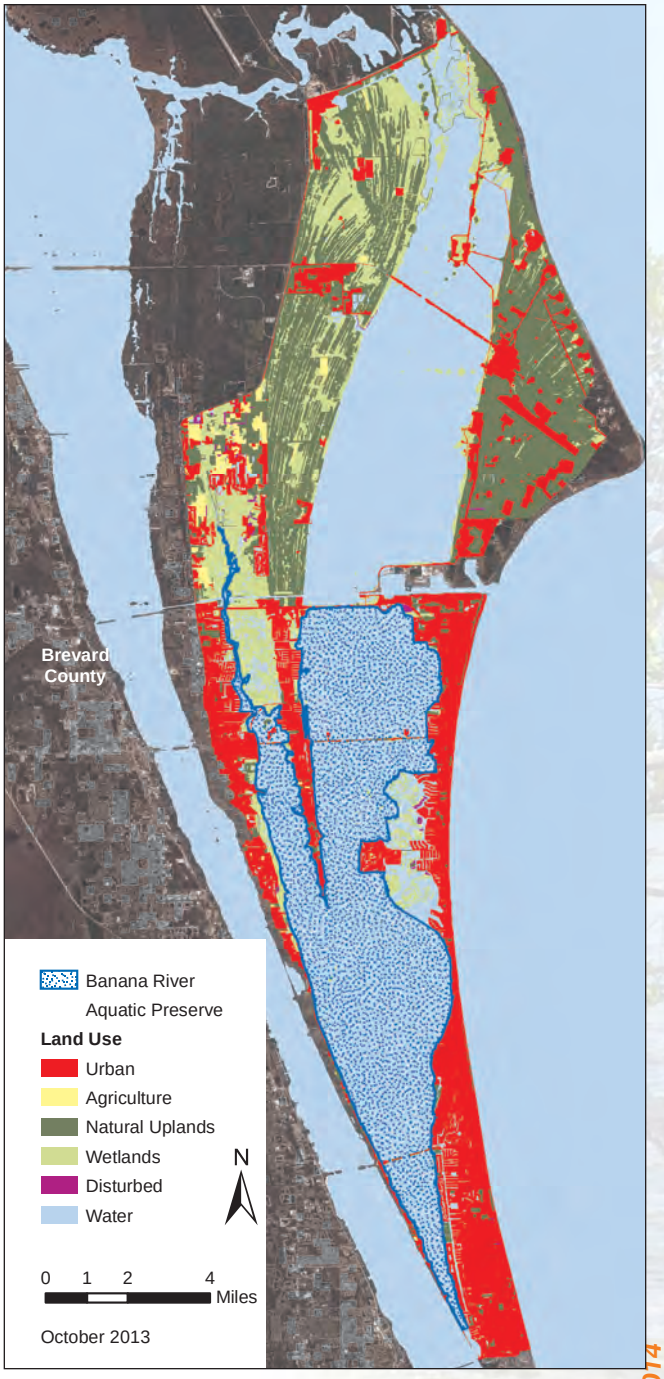
Blowing Rocks Preserve (www.nature.org/ourinitiatives/regions/northamerica/unitedstates/florida/placesweprotect/blowing-rocks-preserve.xml) - Blowing Rocks Preserve began in 1969, when residents of Jupiter Island donated 73 acres of their island to The Nature Conservancy. The preserve was named for its rocky Anastasia limestone shoreline – the largest on the U.S. Atlantic coast. During extreme high tides and after winter storms, seas break against the rocks and force plumes of saltwater up to 50 feet skyward. The preserve runs for one mile from north to south and connects the Atlantic Ocean to the IRL on the west. Today, the restored preserve reflects what South Florida barrier islands looked like a century ago. Native habitats include beach dune, coastal strand, mangrove swamp and tropical hardwood hammock. Facilities include an education center, native plant demonstration garden, hiking trails, boardwalks, and restrooms.

*3.1.7 / **Surrounding Land Use***

Land use within the IRL System watershed was classified according to the following categories: urban, infrastructure, agriculture, natural upland, wetland, disturbed and water. Urban land use classes include industrial, municipal, business, utility, single and multi-family homes, mobile homes, rural homes, utilities, airports and transportation. Agricultural land use classes include citrus, row crops, nurseries, ranching, dairy and silviculture (tree farming). Natural upland land use classes include undeveloped land, conservation land, and forest regeneration. Wetland land use classes include freshwater and estuarine herbaceous and forested wetlands. Disturbed land use classes include borrow areas, spoil areas and rural land in transition. Land uses in each of the four aquatic preserves' watersheds are presented in Maps 23 through 26.

Land use within the Banana River Lagoon watershed is primarily natural uplands and wetlands (60 percent). While urban land use comprises only 25 percent of the watershed, nearly all of it is concentrated around the perimeter of Banana River Aquatic Preserve (see Map 23). The northern half of the Banana River Lagoon watershed is protected from future development due to the presence of Merritt Island NWR and Cape Canaveral Air Station (see Map 19).

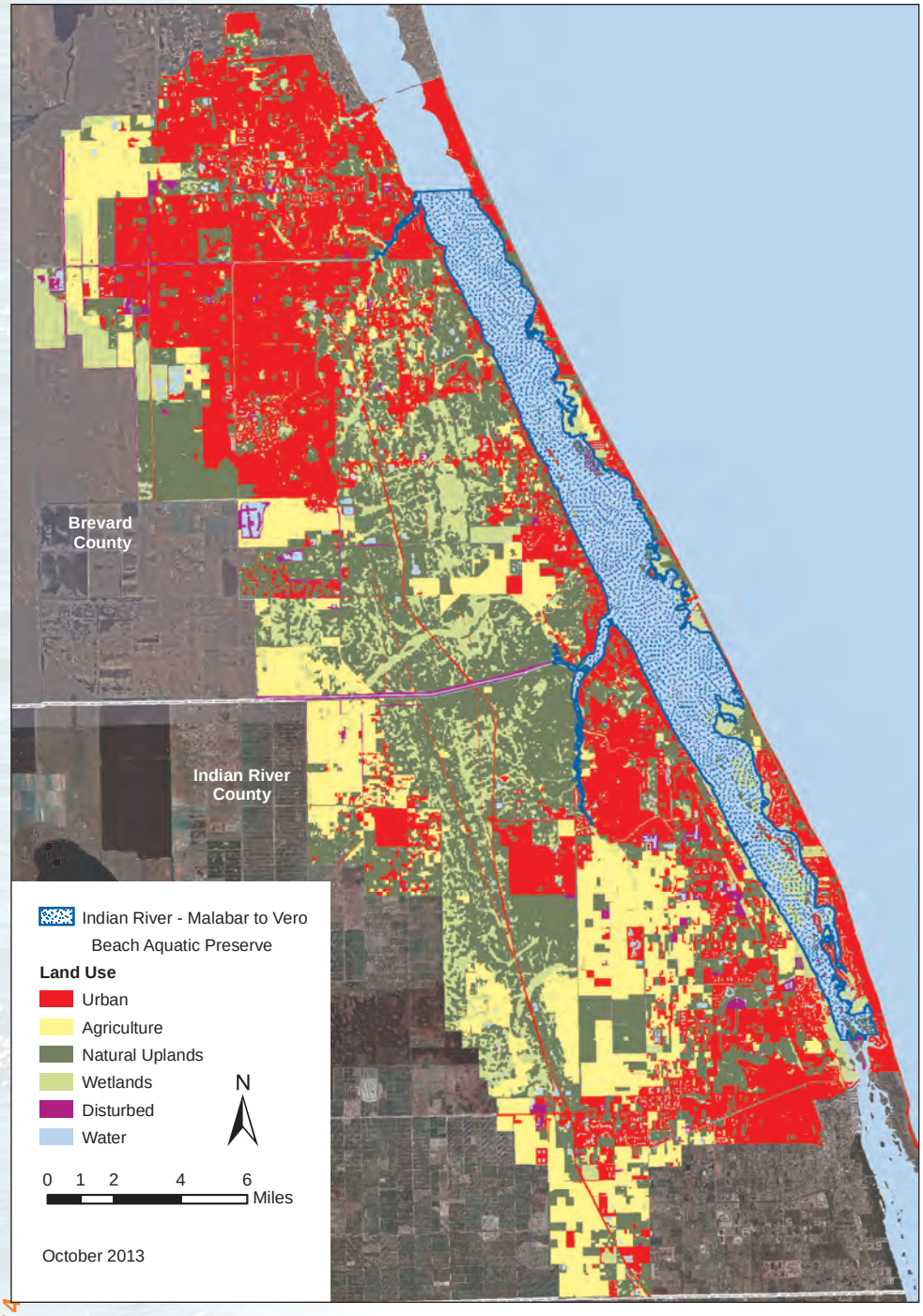
Land use within the IR-Malabar to Vero Beach Aquatic Preserve watershed is 33 percent urban, 17 percent agriculture, and 46 percent natural upland and wetland (see Map 24). The urban areas include nearly the entire barrier island, Palm Bay to the north, Sebastian to the south, and Fellsmere to the west. Agricultural lands surrounding these areas are quickly being lost to development. The 22,000 acre St. Sebastian River Preserve State Park, located in the center of the watershed, provides an important buffer along the western shore of the St. Sebastian River.



Map 23 / Land use in the Banana River Aquatic Preserve watershed.

Urban land use in the IR-Vero Beach to Ft. Pierce Aquatic Preserve watershed is only 13 percent. Similar to the Banana River Aquatic Preserve, however, urban land use is concentrated along the IRL, including the barrier island and the City of Vero Beach (see Map 25). The remaining portion of the watershed is primarily comprised of agriculture (58 percent).

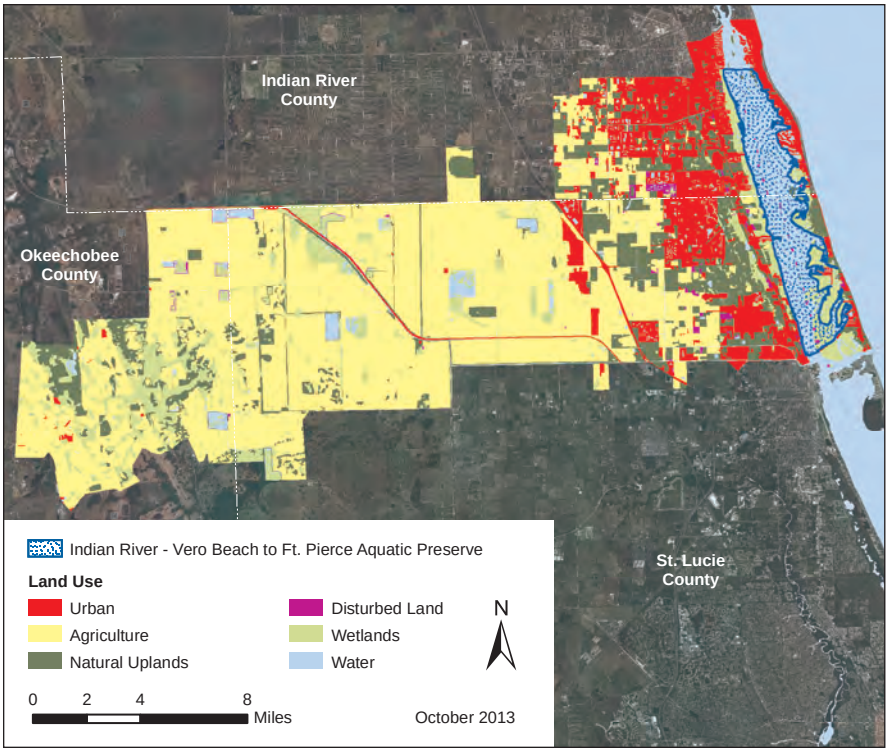
Land use in the Jensen Beach to Jupiter Inlet Aquatic Preserve watershed is 19 percent urban, 37 percent agriculture, and 37 percent natural upland and wetlands (see Map 26). Again, urban areas are concentrated along the coast including Ft. Pierce, Port St. Lucie, St. Lucie West, Jensen Beach, Stuart, Jupiter and Palm Beach Gardens. As discussed previously, much of the western watershed historically flowed into the Okeechobee basin. As a result of major water control projects, the Jensen Beach to Jupiter Inlet Aquatic Preserve watershed now extends up to 30 miles west. Approximately 60 percent of the watershed has been artificially expanded. Land use in the expanded watershed is predominately agriculture.



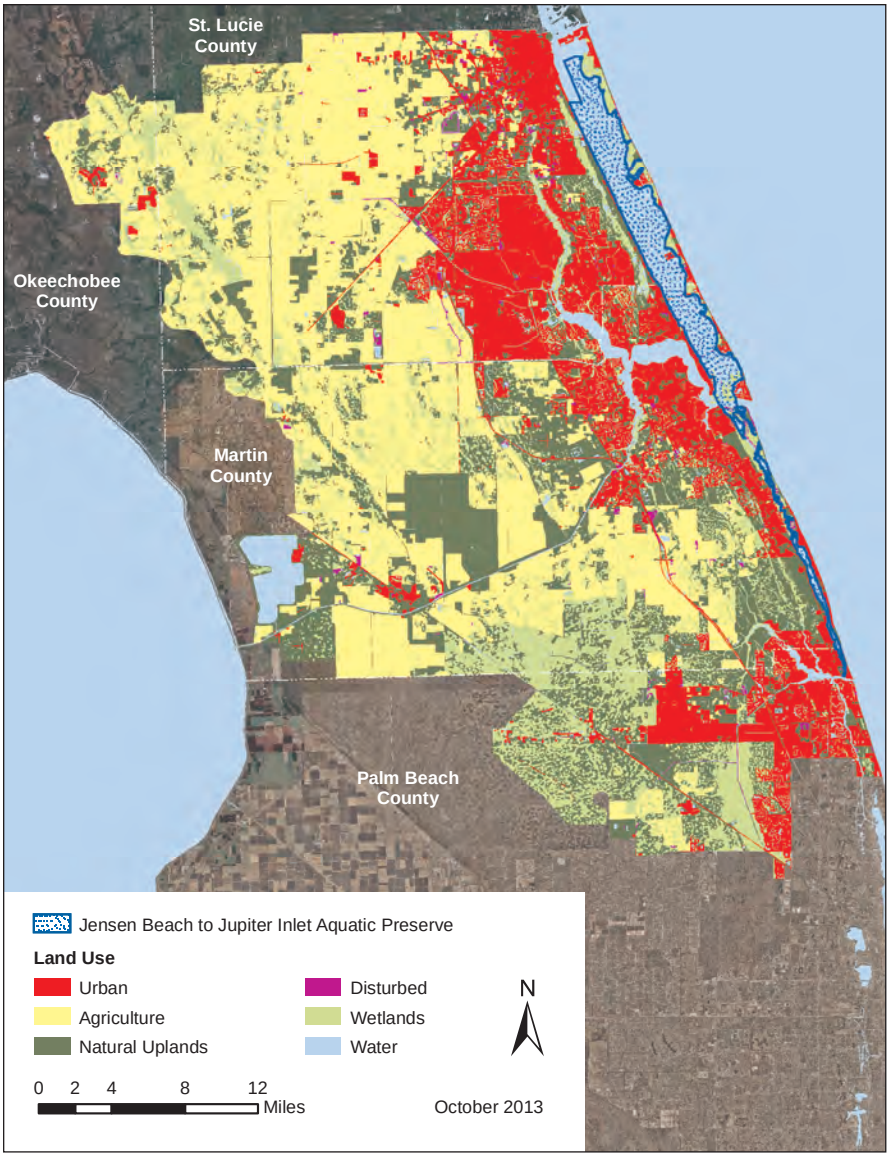
Map 24 / Land use in the Indian River-Malabar to Vero Beach Aquatic Preserve watershed.

Both agriculture and urban land use within the IRL System watershed can affect water quality. Runoff associated with these land uses is characterized by high turbidity, high nutrients and low dissolved oxygen. Agriculture stormwater runoff is diverted to the IRL System via large conveyance canals. Urban stormwater runoff is diverted to the IRL System via local drainage canals and stormwater collection systems. In both cases, untreated stormwater runoff has heavily impacted the IRL System.

With the exception of adjacent conservation lands, the IRL System is almost entirely surrounded by urban areas. In many places, there is no buffer between the IRL and urban land. In these cases, the natural shoreline has been removed and properties extend to a seawall, retaining wall, riprap or directly to the mean high water line. According to the University of Florida (2013), urbanization is expected to steadily increase within the IRL System watershed.



Map 25 / Land use in the Indian River-Vero Beach to Ft. Pierce Inlet Aquatic Preserve watershed.



Map 26 / Land use in the Jensen Beach to Jupiter Inlet Aquatic Preserve watershed.

IRLAP staff work with FWC biologists to protect nesting coastal birds. This least tern colony on a spoil island was roped off to prevent disturbance.

Part Two

Management Programs and Issues

Chapter Four

The Florida Coastal Office's Management Programs and Issues

The work performed by the Florida Coastal Office (FCO) is divided into components called management programs. In this management plan all site operational activities are explained within the following four management programs: Ecosystem Science, Resource Management, Education and Outreach, and Public Use.

The hallmark of Florida's Aquatic Preserve Program is that each site's natural resource management efforts are in direct response to, and designed for unique local and regional issues. When issues are addressed by an aquatic preserve it allows for an integrated approach by the staff using principles of the Ecosystem Science, Resource Management, Education and Outreach, and Public Use Programs. This complete treatment of issues provides a mechanism through which the goals, objectives and strategies associated with an issue have a greater chance of being met. For instance, an aquatic preserve may address declines in water clarity by monitoring levels of turbidity and chlorophyll (Ecosystem Science - research), planting eroded shorelines with marsh vegetation (Resource Management - habitat restoration), creating a display or program on preventing water quality degradation (Education and Outreach), and offering training to municipal officials on retrofitting stormwater facilities to increase levels of treatment (Education and Outreach).

Issue-based management is a means through which any number of partners may become involved with an aquatic preserve in addressing an issue. Because most aquatic preserves are endowed with very few staff, partnering is a necessity, and by bringing issues into a broad public consciousness partners who

wish to be involved are able to do so. Involving partners in issue-based management ensures that a particular issue receives attention from angles that the aquatic preserve may not normally address.

This section will explore issues that impact the management of the Indian River Lagoon (IRL) System directly, or are of significant local or regional importance that the aquatic preserves' participation in them may prove beneficial. While an issue may be the same from aquatic preserve to aquatic preserve, the goals, objectives and strategies employed to address the issue will likely vary depending on the ecological and socioeconomic conditions present within and around a particular aquatic preserve's boundary. This management plan will characterize each of the issues of the IRL System and delineate the unique goals, objectives and strategies that will set the framework for meeting the challenges presented by the issues. The three primary issues identified in this plan include: I) water quality; II) loss of natural community function and species diversity; and III) sustainable public use.

Each issue will have goals, objectives and strategies associated with it. Goals are broad statements of what the organization plans to do and/or enable in the future. They should address identified needs and advance the mission of the organization. Objectives are a specific statement of expected results that contribute to the associated goal, and strategies are the general means by which the associated objectives will be met. Appendix D contains a summary table of all the goals, objectives and strategies associated with each issue.

4.1 / ***The Ecosystem Science Management Program***

The Ecosystem Science Management Program supports science-based management by providing resource mapping, modeling, monitoring, research and scientific oversight. The primary focus of this program is to support an integrated approach (research, education and stewardship) for adaptive management of each site's unique natural and cultural resources. FCO ensures that, when applicable, consistent techniques are used across sites to strengthen the State of Florida's ability to assess the relative condition of coastal resources. This enables decision-makers to more effectively prioritize restoration and resource protection goals. In addition, by using the scientific method to create baseline conditions of aquatic habitats, the Ecosystem Science Management Program allows for objective analyses of the changes occurring in the state's natural and cultural resources.

4.2 / ***Status of Ecosystem Science in the IRL System***

There is a very large and committed group of partners and agencies that conduct extensive monitoring, modeling and research in the IRL System. The group includes the St. Johns River Water Management District (SJRWMD), South Florida Water Management District (SFWMD), the IRL National Estuary Program (NEP), Florida Fish and Wildlife Conservation Commission (FWC), Harbor Branch Oceanographic Institute (HBOI) at Florida Atlantic University in Fort Pierce, Ocean Research Conservation Association (ORCA), Florida Department of Environmental Protection (DEP) Division of Environmental Assessment and Restoration Bureau of Watershed Restoration, Smithsonian Marine Station, county agencies, Florida Department of Agriculture and Consumer Services (FDACS), Florida Department of Health, and numerous other groups. The Ecosystem Science Management Program within the IRL System is geared to assist various partner agencies and/or university researchers with ongoing research and monitoring efforts. The IRL Aquatic Preserves (IRLAP) office manages seven aquatic preserves from Volusia County, south to Palm Beach County. It is challenging to maintain a regular research or monitoring presence within these seven aquatic preserves because of their sizes, distances and the logistics between them. Therefore, FCO fosters strong working partnerships with multiple agencies and researchers, and assists with equipment and staff as needed to complete research projects and monitoring efforts.

2011 Superbloom

Currently, much of the research being conducted in the IRL is focused on the eutrophication of the IRL and associated algal blooms and loss of biodiversity. From early spring through late fall of 2011, a massive bloom of phytoplankton *(Pedinophyceae* spp.) and loss of seagrass occurred throughout most of the IRL, extending from southern Mosquito Lagoon to just north of Ft. Pierce Inlet, including the Banana River, Indian River (IR)-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce aquatic preserves. This bloom (referred to as the 2011 Superbloom) and seagrass decline far exceeded any past events remembered or documented in terms of geographic scale, bloom intensity and duration, and rate and magnitude of seagrass loss. The 2011 Superbloom clearly illustrated the need to identify and prioritize critical gaps in scientists' understanding of the lagoon and for partners to continue to collaborate to fill

those gaps and sustain and improve long-term research and management of the lagoon system. Current ecosystem science in the IRL is primarily focused on understanding the cause/effect relationship that led to the 2011 Superbloom (SJRWMD, 2012b).

In response to the 2011 Superbloom, SJRWMD convened a consortium of academic organizations and government agencies to investigate cause-effect relationships and, if possible, recommend management actions to limit future blooms. The IRL 2011 Consortium includes 25 members comprising current and former SJRWMD scientists, scientists from FWC, Smithsonian Marine Station at Fort Pierce, and faculty and students from universities involved in lagoon research. By 2012, the Consortium developed the IRL 2011 Superbloom Plan of Investigation (SJRWMD, 2012b). The purpose of the plan was to describe a deliberate, scientific approach for investigating the cause(s) and impacts of the phytoplankton bloom in 2011 that expanded throughout the northern IRL, including the Banana River and Mosquito lagoons. Seagrass is the main subject of the bloom impacts. The main objective of the Consortium is to prepare a report that includes a consensus-driven thesis on the 2011 Superbloom, its impacts on submerged aquatic vegetation (SAV), any observations regarding post-2011 recovery of SAV and water quality, and management recommendations. Secondary objectives include identifying, prioritizing, and filling critical gaps in our understanding of the lagoon, and continuing inter-institutional collaboration among the Consortium institutions to sustain and improve long-term research and management of the IRL System (SJRWMD, 2012b).

In addition to the IRL 2011 Consortium, SJRWMD established the IRL Protection Initiative to better understand the lagoon's complex ecosystem, the possible causes for unexpected change and how to protect the IRL. The Initiative is a four-year program in which scientists are conducting projects aimed at increasing the scientific understanding of the lagoon system through monitoring, data collection, field and lab work and model development. Currently in its first phase, the Initiative is focusing on water quality monitoring, seagrass transplant experiments, and studies of drift algae. In addition, SJRWMD is cost-sharing other plankton and fish sampling undertaken by the University of Florida and FWC (IRL NEP, 2013).

Final products of the Initiative will include:

- strategies for controlling algal bloom formation;
- strategies for enhancing a healthy, biologically diverse estuary;
- strategies for facilitating seagrass growth;
- feasibility of seagrass transplanting;
- feasibility of targeted removal of drift algae;
- descriptions of imbalances or weaknesses that induce bloom formation, and;
- recommendations for addressing human-caused imbalances related to nutrients and pollution sources.

Unusual Mortality Events

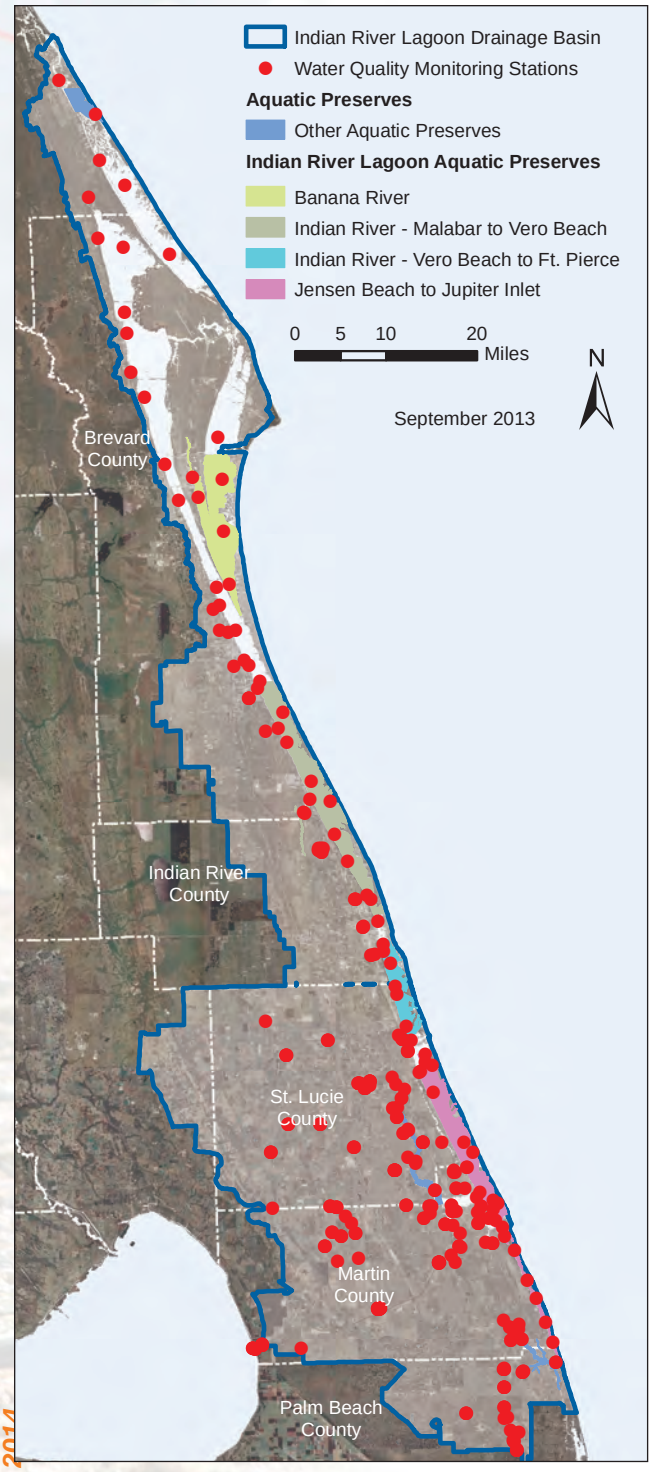
Beginning in July 2012, mortality of bottlenose dolphins, manatees and brown pelicans increased dramatically in the IRL in Brevard County (the same area that suffered from the 2011 Superbloom). Under the Marine Mammal Protection Act of 1972, an Unusual Mortality Event was declared for bottlenose dolphins in the IRL System along the east coast of Florida from January 2013 through the time this was written (March 2014) (NOAA, 2014). Current bottlenose dolphin strandings are almost three times the historical average for the IRL. All age classes of bottlenose dolphins are involved. The most significant and unifying gross necropsy finding is emaciation. As part of the Unusual Mortality Event investigation process, the Marine Mammal Section of FWC's Fish and Wildlife Research Institute (FWRI), Hubbs–SeaWorld Research Institute and the National Oceanic and Atmospheric Administration (NOAA) Southeast Fisheries Science Center are researching and responding to dolphin deaths in the lagoon.

A separate Unusual Mortality Event was declared by NOAA Southeast Fisheries Science Center in April 2013 for elevated manatee mortalities in Brevard County. From July 25, 2012 to June 14, 2013, FWC documented 250 manatee deaths in Brevard County (FWC, 2013a). A cause for these mortalities has not been determined. Unlike the dolphins, dead manatees do not appear emaciated. The Marine Mammal Section of FWRI is researching and responding to manatee deaths in the lagoon.

During the first half of 2013, FWC received reports of more than 300 dead brown pelicans in the northern IRL. Scientists with FWC believe the pelican and manatee deaths are related. Once afflicted, pelicans slowly die during a span of several weeks and are left emaciated and plagued with parasites (FWC, 2013d). FWC researchers continue to assess specimens and the environment for information that can help identify a potential cause.

Water Quality Monitoring Network

The IRL Water Quality Monitoring Network (WQMN) was established in 1988 as a coordinated multi-agency project spanning the entire length of the IRL. Participants of the IRL WQMN include SJRWMD, SFWMD, Volusia County, Brevard County, Indian River County and the National Aeronautics and Space Administration (NASA). These agencies collectively manage a total of 150 stations (Map 27). The mission of the IRL WQMN is to (1) characterize the IRL over the long term, (2) identify problem areas, (3) measure effectiveness of management actions, (4) provide current information to re-direct management plans, and (5) provide accountability to the public by relating restoration progress and protection of the IRL. In 1996, the IRL WQMN was redesigned to eliminate statistically redundant sampling and meet modeling requirements. Laboratory analysis was centralized to eliminate inter-laboratory variability. Major changes incorporated in the redesigned monitoring program included increased sampling frequency and measurement of organic and inorganic fractions of total suspended solids (Sigua & Tweedale, 2004). Additional water quality monitoring programs are summarized in Chapter Three.



Map 27 / Water Quality Monitoring Network sample locations in the Indian River Lagoon.

Water quality data-sets are available online that include both historical and current data for the IRL System. All IRL WQMN data is accessible on the Florida STORage and RETrieval (STORET) database at www.epa.gov/storet/. Additional hydrologic, meteorologic, hydrogeologic and water quality data for the IRL System is available through the water management districts' web pages. The SJRWMD and SFWMD environmental databases can be accessed through the Environmental Data Retrieval Tool (http://webapub.sjrwmd.com/agws10/edqt/) and DBHYDRO (http://www.sfwmd.gov/dbhydroplsql/show_dbkey_info.main_menu), respectively. Both browsers allow you to search using one or more criteria, and to generate a summary of the data from the available period of record. Data sets of interest can be selected and dynamically displayed in tables or graphs. Data can also be downloaded to a computer for later use.

Harmful Algal Blooms

Cultural eutrophication has resulted in increased frequency and intensity of harmful algal blooms (HAB) in the IRL (Phlips, 2002). Indeed, in the summer of 2013, a massive bloom of *Microcystis* sp., a toxic blue/green algae, occurred in the St. Lucie Estuary and adjoining portion of Jensen Beach to Jupiter Inlet Aquatic Preserve. Lake Okeechobee discharge is associated with the bloom. Levels of the toxic algae were sufficient enough to prompt the Martin County Health Department to issue health advisories from Lake Okeechobee down current to the St. Lucie Inlet. In an effort to better understand HABs in the IRL, IRL NEP funded a multiagency study to examine the temporal and spatial variability in the distribution of harmful algae species in the IRL (Phlips et al., 2011). From 2006 to 2009, researchers documented 24 phytoplankton taxa of HAB species. Of the 24 HAB species, 16 are considered potential toxin producers. *Pyrodinium bahamense* was the most commonly observed species at bloom levels. Study results indicate that the frequency of HABs, including blooms of *P. bahamense*, in the IRL related in part to nutrient inputs from

rainfall and to water residence time. The northern IRL is characterized by lengthy water residence times and is, therefore, particularly prone to intense blooms.

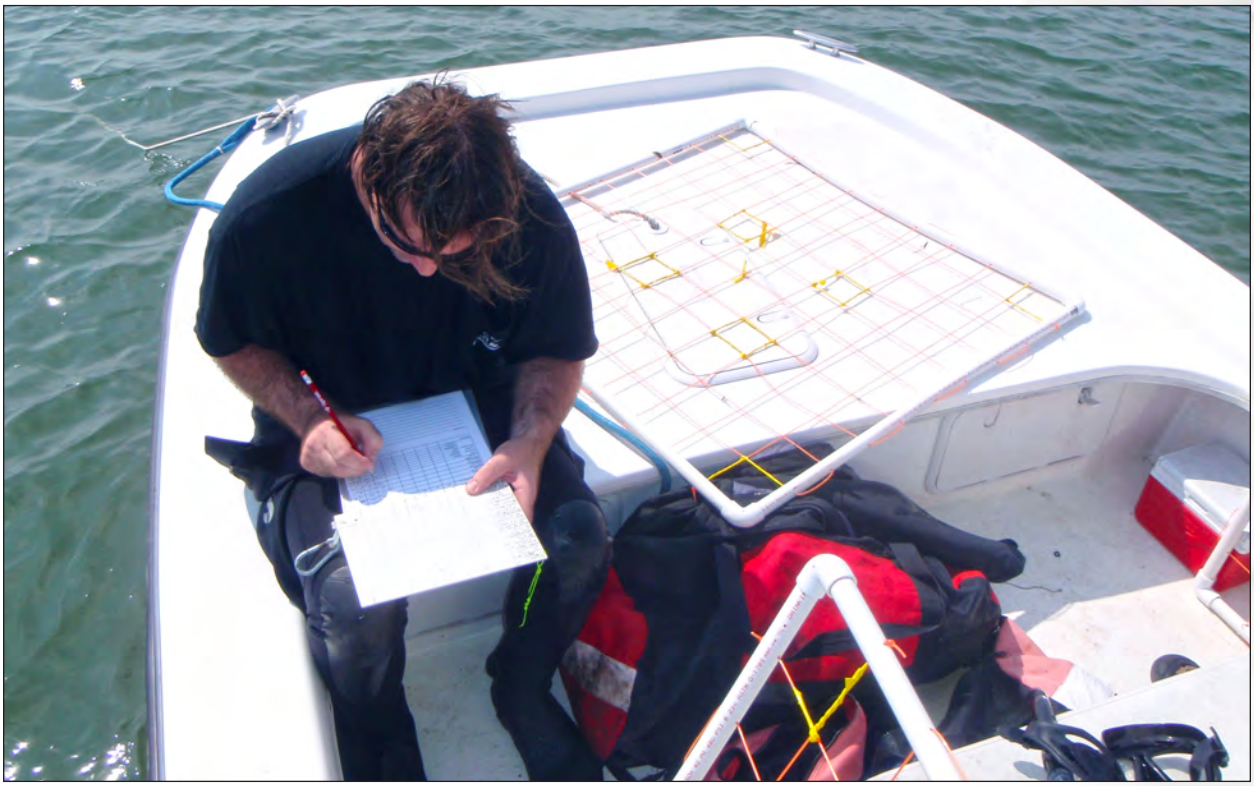
P. bahamense has been associated with the production of saxitoxin within the IRL (Landsberg, Hall, Johannessen, White, Conrad, & Abbott, 2006). Paralytic Shellfish Poisoning is caused by saxitoxins, and affects humans through consumption of shellfish that have filtered significant quantities of *P. bahamense*. Toxins produced by the dinoflagellate will concentrate within shellfish tissues, particularly during HAB events. Meanwhile *Karenia brevis* is associated with the production of brevetoxins and Neurotoxic Shellfish Poisoning. Brevetoxins can also affect humans as the toxins become airborne in sea spray and cause eye irritation and respiratory problems (Fleming et al., 2011).

In 2002, FWC began assessing the risk of saxitoxin puffer fish poisoning from saxitoxins in the IRL. Analysis of puffer fish filets revealed high toxicity. As a result, FWC imposed a permanent ban beginning in 2004 on the harvest of puffer fish from the IRL. Also in 2002, saxitoxins were confirmed in shellfish from the IRL. As a result, the Florida Department of Agriculture and Consumer Services (FDACS), in collaboration with FWC, established the Biotoxin Contingency Program to monitor shellfish for saxitoxin. FDACS Division of Aquaculture conducts routine monitoring for harmful algae in Class II shellfish harvesting waters within the IRL System. FWRI analyzes the water and clam meat for *P. bahamense* cell counts and saxitoxin, respectively. If saxitoxin levels in shellfish increase (usually during the warmer months), sample collection is increased and the geographic collection sites are expanded to the north and south (FDACS, 2011).

HAB events periodically lead to the closure of shellfish harvesting areas due to the large concentration of phytoplankton cells and/or toxins in the water. Since 2003, FDACS has ordered 30 shellfish harvesting area closures when saxitoxin levels equaled or exceeded the international standard tolerance limit, 80 micrograms per 100 grams. As of mid-2013, there had been no reports of saxitoxin related illnesses in Florida (FWC, 2013e).

Seagrass Monitoring

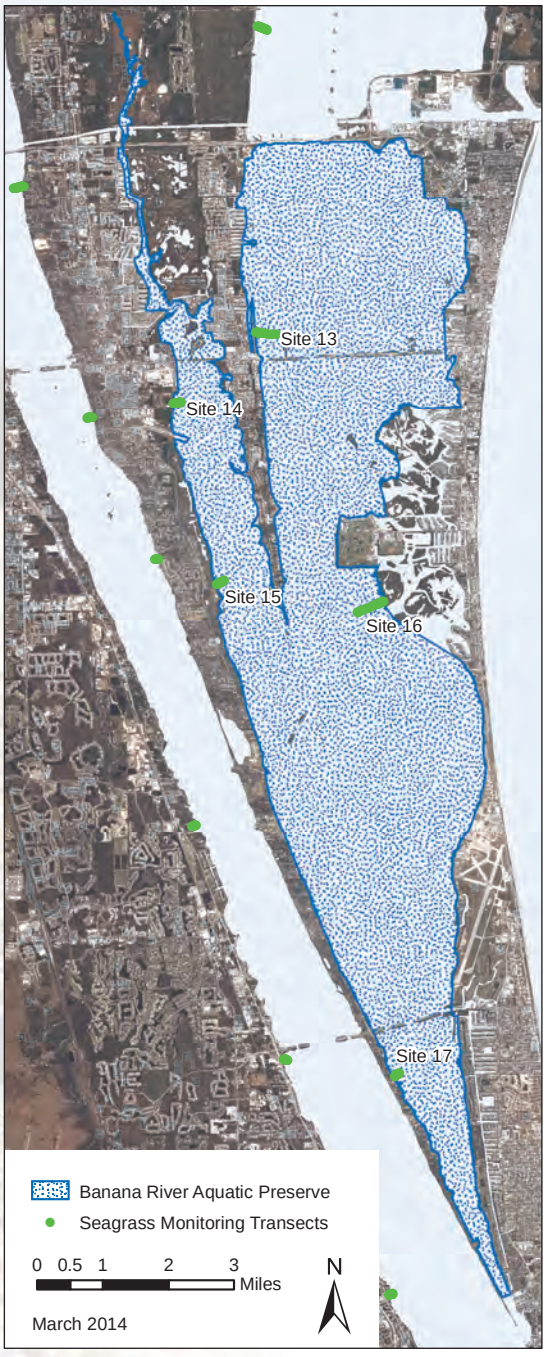
Seagrass monitoring within the IRL System is coordinated by SJRWMD and SFWMD through monthly and bi-annual seagrass surveys using permanent underwater transects and by examination of aerial photography. Seagrass beds (acreage, depth of the edge of seagrass bed, and sunlight penetration) are the primary indicators used to measure estuary health throughout the entire IRL basin (Steward et al., 2003). The water management districts have defined specific seagrass coverage targets as indicators of



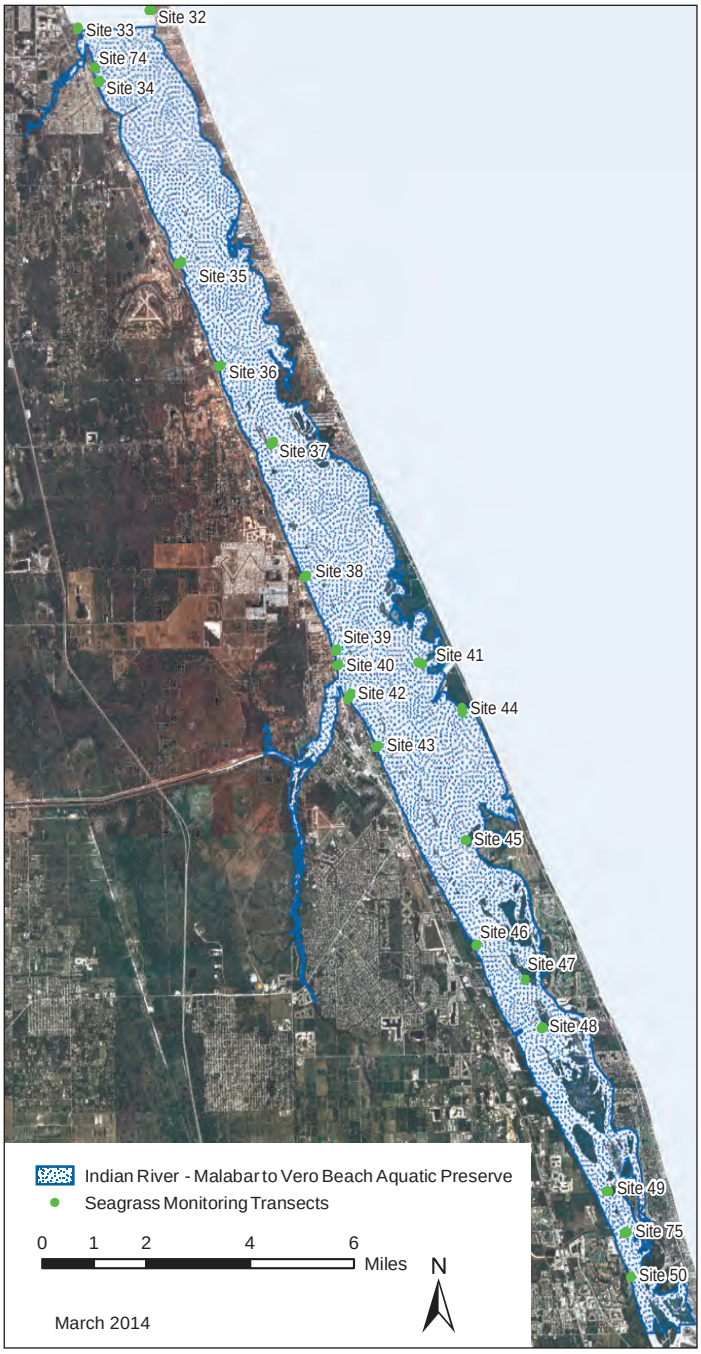
IRLAP staff, in conjunction with SJRWMD, monitors the health of seagrass beds at several sites throughout the IRL System.

the health of the waters (Virnstein, Carter, Morris, & Steward, 2000). The primary goal for the seagrass monitoring program is to return the number of acres of seagrass to historic (1943) levels based on aerial photographs from that period.

The water management districts have divided Banana River Aquatic Preserve into three segments with five permanent monitoring transects, IR-Malabar to Vero Beach Aquatic Preserve into six segments with 19 permanent monitoring transects, IR-Vero Beach to Ft. Pierce Aquatic Preserve into three segments with eight permanent monitoring transects, and finally Jensen Beach to Jupiter Inlet Aquatic Preserve into four segments with 21 permanent monitoring transects (see Maps 28 – 31b). SJRWMD coordinates seagrass mapping and monitoring efforts north of the St. Lucie River while the SFWMD coordinates efforts south of the St. Lucie River. IRLAP staff assist in the seagrass monitoring effort by conducting biannual surveys at ten of the permanent transects in the Jensen Beach to Jupiter Inlet Aquatic Preserve from Ft. Pierce to the St. Lucie Inlet. These include sites 59 through 67 and site 83 (see Map 31a and 31b). In 2011, FWRI began compiling and summarizing statewide seagrass trends in a monitoring report entitled Seagrass Integrated Mapping and Monitoring for the State of Florida (Yarbro & Carlson, 2011).



Map 28 / Seagrass monitoring segments and transect locations in Banana River Aquatic Preserve.



Map 29 / Seagrass monitoring segments and transect locations in Indian River-Malabar to Vero Beach Aquatic Preserve.

Site Number*	Project Zone	2009 acreage	2011 acreage	Percent Change
Outside of IRL System	BR1-2 (North Banana River)	12,291	2,123	83% loss
13-7	BR3-7 (South Banana River)	11,516	1,030	91% loss
23-37, 74	IR12-13B (Southern Brevard County)	2,250	229	90% loss
38-47	IR14-15 (Sebastian Area)	3,643	1,250	66% loss
48-50, 52, 53, 75	IR16-20 (Vero Beach Area)	3,462	1,357	61% loss
54-73, 77, 79, 82-86	IR21-26 (Southern IRL)	2,882	2,515	13% loss

**The monitoring sections included in each Project Zone are presented in Maps 28 – 31b. Source: DEP, Division of Water Resource Management, 2006.*

Table 8 / Seagrass loss in the Indian River Lagoon from 2009 to 2011 (DEP Water Quality Restoration Program, 2013).

The historical trends of seagrass in the IRL System are detailed in Chapter Three. Beginning in 2001, seagrass coverage began increasing steadily in areas throughout the IRL System which had been previously experiencing losses. By 2007, seagrass coverage in Banana River Aquatic Preserve had exceeded 1943 acreages. Within IR-Malabar to Vero Beach Aquatic Preserve, 2007 seagrass coverage in the vicinity of Sebastian had almost tripled compared to 1943 acreage and coverage in the vicinity of Vero Beach exceeded 1943 acreage and was double that recorded in 1996 (Morris, 2011). By 2007, seagrass coverage in the IR-Vero Beach to Ft. Pierce Inlet and Jensen Beach to Jupiter Inlet aquatic preserves had reached maximum coverage since the first mapping effort in the early 1940s (Robbins et al., 2011).

All this changed drastically, however, following the 2011 Superbloom. Seagrass decline has far exceeded any past documented events in regards to geographic scale, bloom intensity and duration, and rate and magnitude. The 2011 Superbloom covered approximately 130,960 acres of open water including the Mosquito Lagoon, IRL north of IR-Malabar to Vero Beach Aquatic Preserve, and the Banana River Lagoon including all of Banana River Aquatic Preserve. This bloom surpassed all previous documented blooms in intensity (often exceeding 100 micrograms per liter Chlorophyll a). As a result of the persistent superbloom, there was a marked decline in water transparency. By the end of June 2011, the loss of seagrass was substantial. Relative to 2009, seagrass coverage was reduced by 90 percent in the Banana River Aquatic Preserve and northern portions of IR–Malabar to Vero Beach Aquatic Preserve, and 60 percent in the southern portion of IR-Malabar to Vero Beach Aquatic Preserve and throughout IR–Vero Beach to Ft. Pierce Aquatic Preserve. Seagrass loss in Jensen Beach to Jupiter Inlet Aquatic Preserve has been much less at 13 percent reduction from 2009 to 2011 (Table 8). Members of the IRL 2011 Consortium are working together to investigate the cause of the 2011 Superbloom and the associated seagrass die-off (SJRWMD, 2012b).

Map 30 / Seagrass monitoring segments and transect locations in Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.

Diamondback Terrapin Turtle Monitoring

The diamondback terrapin turtle monitoring program was previously established by the East Central Florida Aquatic Preserves Office which was absorbed into the IRLAP in 2008. In 2012, IRLAP staff restarted monitoring in partnership with local conservation groups.

Terrapin population status is unknown in the IRL System, but it is believed to be in decline due to habitat loss, historic overharvesting, crab trap mortality, and predation by unchecked native (e.g., raccoons) and exotic species. Terrapin sensitivity to habitat loss and utilization of many critical components of the lagoon ecosystem (saltmarsh, mangrove, oyster reef, and seagrass habitats) make them a useful indicator species. Terrapins have also been recorded nesting on spoil islands in multiple aquatic preserves throughout the IRL System. Recent studies have shown that through seagrass grazing, terrapins disperse seagrass seeds to new areas up to one mile away (Sumoski & Orth, 2010). This is particularly important to the IRL region which has encountered significant seagrass losses due to the 2011 Superbloom.

IRLAP staff are working with local environmental groups to assess remaining populations, threats, and appropriate conservation efforts. Through previous studies and citizen sightings, Banana River Aquatic Preserve is known to support nesting populations of terrapins, although recent data is lacking. The Banana River has been the target of the initial study, beginning in 2013, with other areas to follow as methods are developed and staff/ funding availability allows. Efforts are spread across local environmental groups which make up the East Coast Florida Diamondback Terrapin Group (name pending), and encompass

Map 31a / Seagrass monitoring segments and transect locations in Jensen Beach to Jupiter Inlet Aquatic Preserve (north section).

Map 31b / Seagrass monitoring segments and transect locations in Jensen Beach to Jupiter Inlet Aquatic Preserve (south section).

trappings via modified crab pots, citizen sighting reporting, and educational programs to encourage stewardship and raise awareness. The objective of IRLAP's monitoring efforts are to determine distribution and nesting site information in order to effectively manage submerged and spoil island resources within its management boundaries.

Spoil Island Coastal Bird Monitoring

Spoil islands in the IRL System serve as critical nesting habitat for a wide array of coastal bird species. As development increases both on the mainland and barrier islands, spoil islands are becoming increasingly important roosting and nesting habitat. The Spoil Island Management Plan (Florida Department of Natural Resources, 1990) has designated islands that support nesting bird populations for conservation to preserve this function. IRLAP staff monitors spoil islands by boat during nesting season (February-August) to document species and number of birds utilizing the islands. Assistance from volunteers and local environmental groups is solicited to help with boat surveys. Aerial surveys are performed as funding and availability allows. Aerial surveys better identify the number of nests or individuals using colonies on the interior of an island, whereas boat surveys only allow for a limited view of each island's periphery. Data from bird monitoring surveys is reported to the Florida Shorebird Database and analyzed by IRLAP staff to assess changes in nesting populations and identify management needs.

Local and state wildlife law enforcement officers are notified of important nesting islands to reduce disturbance by humans. In 2013, a colony of least terns, a state threatened shorebird, established on a recreation spoil island in IR-Malabar to Vero Beach Aquatic Preserve. IRLAP staff partnered with FWC to flag off the area and post signage to limit disturbance. Degradation of island nesting habitat can be caused by erosion or loss of vegetation due to storms. Heavy use of an island by birds can also damage and reduce vegetation over time. By identifying important habitat types and areas, IRLAP staff can provide protection or manage public use around these sites and plan for restoration of appropriate native habitats, as needed. Staff strives to provide adequate vegetation structure for use by roosting and nesting wading birds in the IRL System.

Partnerships

Florida Atlantic University – Harbor Branch Oceanographic Institute

HBOI is monitoring nutrient dynamics in the IRL and its tributaries, fingerprinting nutrient sources from the surrounding watershed, and identifying algal toxins responsible for fish and wildlife mortalities in the northern IRL and St. Lucie Estuary. Three current projects include an IRL-wide nutrient study along the main-stem of the system, a stormwater

Common Name	Status
American oystercatcher	SSC
Brown pelican	SSC
Least tern	ST
Little blue heron	SSC
Reddish egret	SSC
Snowy egret	SSC
Tricolored heron	SSC
White ibis	SSC
Wood stork	FE

Table Key: *FE- federally-designated endangered; ST- state-designated threatened; SSC- state species of special concern.*

Table 9 | Commonly seen nesting bird species on spoil islands in the Indian River Lagoon System.

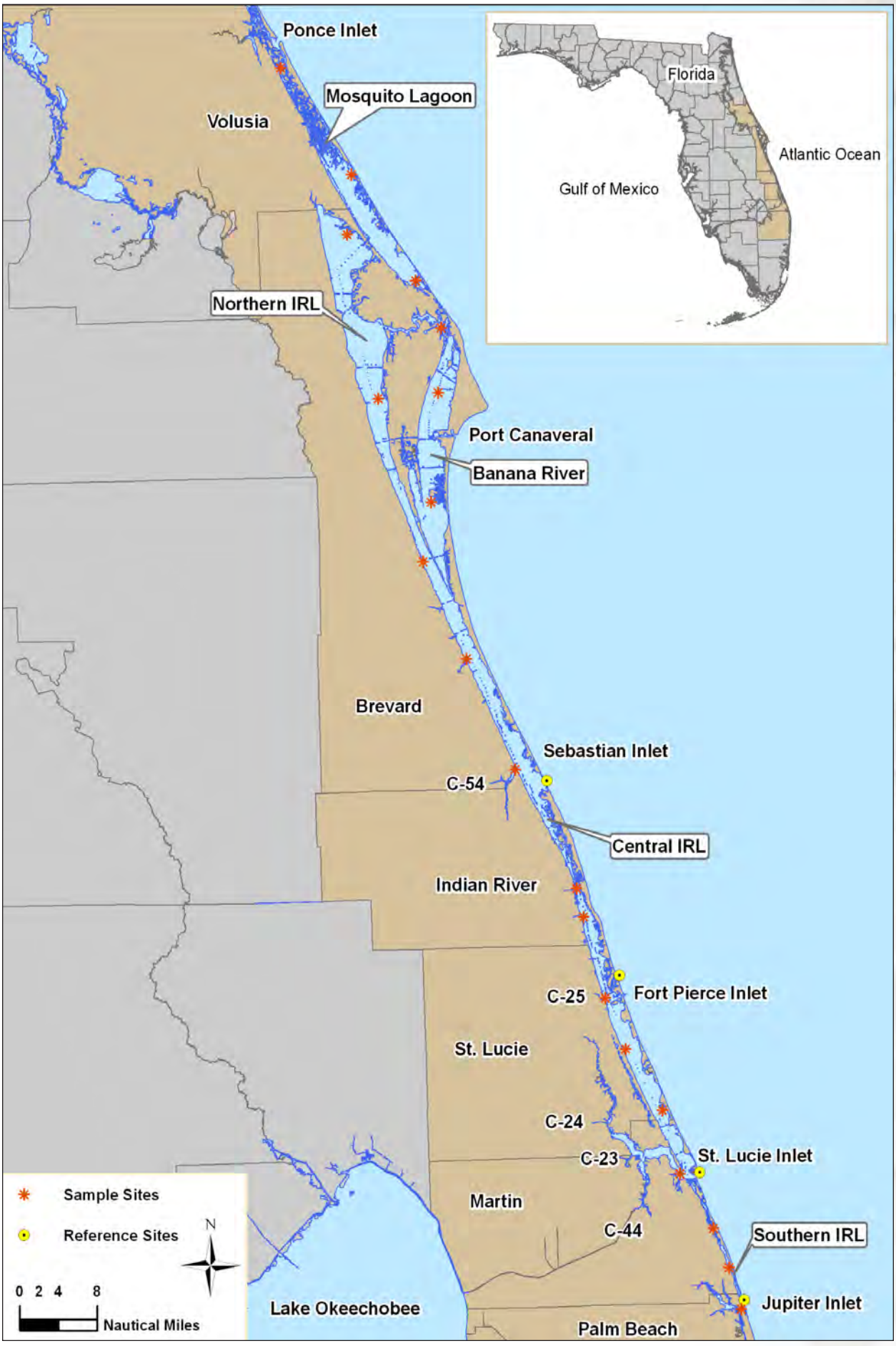
Diamondback terrapins nest on spoil islands and sandy shorelines throughout the IRL System.

Least terns are ground nesters and raise their chicks in shallow depressions in sandy areas, often on spoil islands.

Residential fertilizers, which run into the IRL System, are a major contributor to algal blooms.

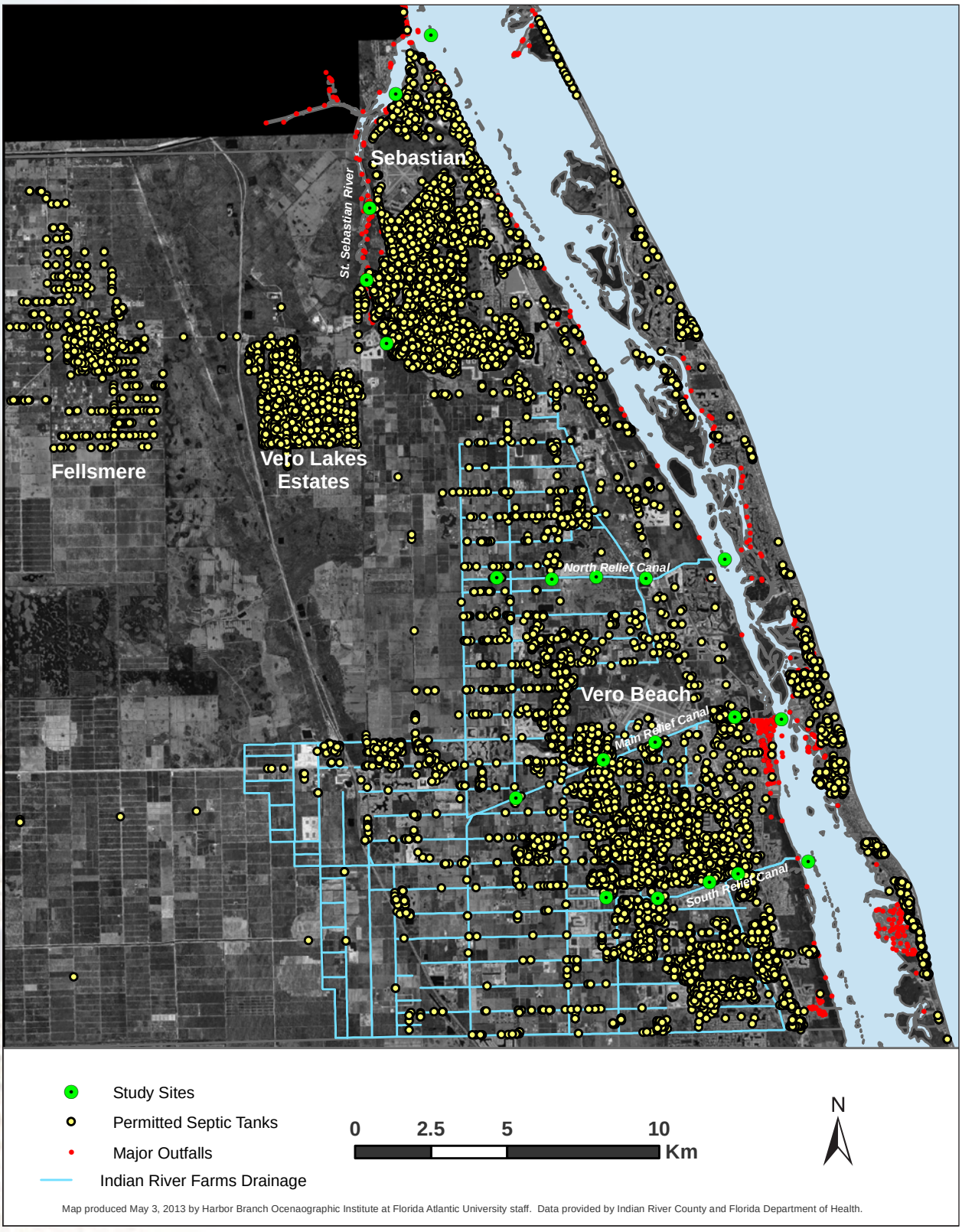
study in seven tributaries along the IRL, and a local study to look at the influences of septic tanks on the IRL water quality in Indian River County. The IRL-wide nutrient study documents dissolved nutrient concentrations in seawater, the nutrition of macroalgae and seagrasses (carbon:nitrogen:phosphorus ratios), and the source of nitrogen and carbon in macroalgae and seagrass tissue (via stable isotope analysis of Delta-N-15 and Delta-C-13) during both the wet (January – May) and dry (June – October) seasons. The sample sites for the IRL-wide nutrient samples are presented in Map 32. The study, which consists of 20 sites along the IRL and four nearshore reference sites, began in the 2011 dry season and remains funded to date through the Save Our Seas specialty license plate fund. The IRL stormwater study entails the documentation of dissolved nutrients and aqueous isotope analysis of several inorganic forms of nitrogen to fingerprint the nutrient sources at 20 urban, agricultural, and natural forested sites along seven IRL tributaries (Eau Gallie, Crane Creek, Turkey Creek, St. Sebastian River, Taylor Creek, St. Lucie River and the Loxahatchee River). Samples are collected at the beginning (first flush), the middle, and the end of the storm event. The Indian River County study is a partnership with Indian River County and the Florida Department of Health and focuses on water quality at 15 sites in the three primary relief canals (North, Main and South) in Indian River County and the St. Sebastian River on the Indian River/Brevard County line. The study is looking at the relationship between water quality and septic tank and major stormwater outfall locations (Map 33). Similar to the other HBOI studies, this project documents dissolved nutrient concentrations in surface and groundwater, the nutrition (carbon:nitrogen: phosphorous) of macrophytes (water lettuce, duckweed, and macroalgae), and stable isotope values in the surface water, groundwater, and tissue to fingerprint nutrient sources (i.e. fertilizer runoff, wastewater runoff, atmospheric deposition). The study also incorporates analysis of the sterol coprostanol in sediments as a tracer for human waste. HBOI researchers have also collaborated with NOAA scientists to isolate and identify harmful algal and cyanobacterial toxins responsible for fish and wildlife (especially manatee and dolphin) mortalities in the Banana River Lagoon, northern IRL and the St. Lucie Estuary (personal communication, Laura Herren, August 2013).

To increase the amount and frequency of nutrient and water quality data available to the public, HBOI researchers deployed the first Land/Ocean Biogeochemical Observatory (LOBO) in the IRL in 2013 as part of HBOI's Indian River Lagoon Observatory. The near real-time LOBO data are recorded every hour and posted to a website (http://fau.loboviz.com/) that can be accessed by the public. The first LOBO was placed along the HBOI channel in the IRL and records water temperature, salinity, dissolved oxygen, turbidity, colored dissolved organic matter, Chlorophyll *a*, nutrients (nitrate and phosphate), water



Map 32 | Harbor Branch Oceanographic Institute nutrient sample locations.

depth, and current speed and direction. A Campbell Scientific meteorological station, installed directly above, was coupled with the LOBO to also provide hourly weather data. The HBOI meteorological station was modeled after the National Estuarine Research Reserve System-Wide Monitoring Program stations (for comparison purposes) and records air temperature, barometric pressure, humidity, rain, photosynthetically active radiation (PAR), wind direction, wind gust and wind speed. HBOI's long-term goal is to deploy a network of LOBOs along the IRL for more efficient long-term monitoring of this system (personal communication, Laura Herren, August 2013).



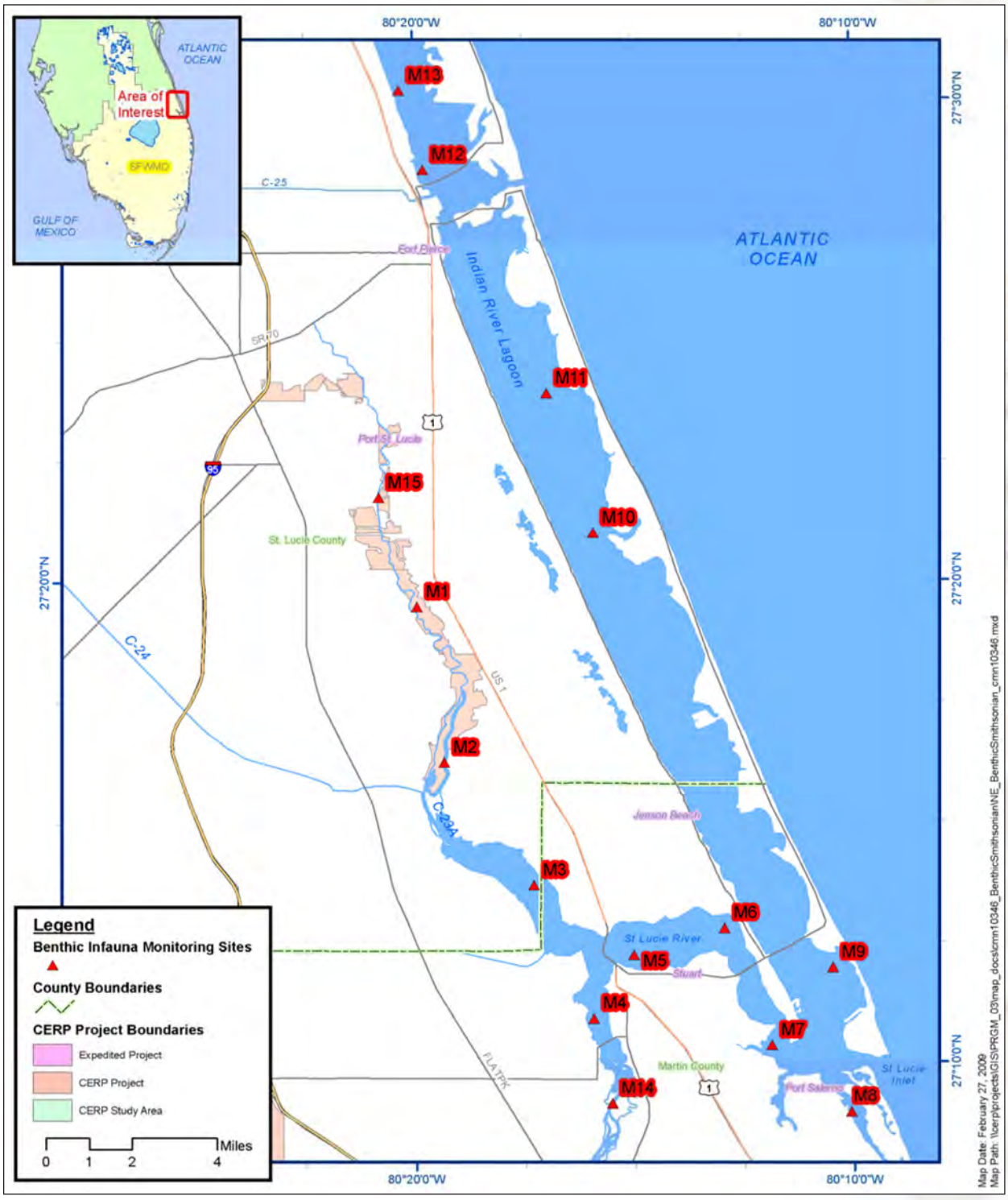
Map 33 / Indian River County septic tank study.

Ocean Resource and Conservation Association

Scientists at ORCA have been working with Indian River County utilizing the Kilroy Network to monitor nutrient levels in IR-Vero Beach to Ft. Pierce Aquatic Preserve. Kilroy units are located at the mouth of the Vero North, Vero Main and Vero South canals which drain Indian River Farms Water Control District in Indian River County. ORCA has also teamed up with the Florida Oceanographic Society (FOS) and is establishing a Kilroy Network in the St. Lucie Estuary. Real-time data can be accessed at (www.teamorca.org).

Smithsonian Marine Station at Ft. Pierce

Scientists at the Smithsonian Marine Station at Ft. Pierce have been actively conducting marine research in the IRL since the early 1970s. Research at the Station focuses on biodiversity, life histories and ecology of marine organisms. Current resident science programs involve benthic ecology, chemical



Map 34 | Benthic macroinvertebrate sampling sites. Source: ACOE & SFWMD, 2004.

ecology and life histories of marine invertebrates. In addition, postdoctoral and graduate student projects are continuously underway. A complete list of previous and current research projects, as well as a list of publications, is available on the Marine Station's web page (http://www.sms.si.edu/).

Benthic Macroinvertebrate Monitoring

In support of the Comprehensive Everglades Restoration Plan (CERP) monitoring program, the Smithsonian Marine Station has been sampling benthic macroinvertebrates in the St. Lucie Estuary and the adjacent southern IRL since 2005. Two sample sites are located in IR-Vero Beach to Ft. Pierce Aquatic Preserve and four sample sites are located in Jensen Beach to Jupiter Inlet Aquatic Preserve (Map 34). Each site is visited four times per year, twice (January and April) during months that typically fall into Florida's dry season (November - April) and twice (July and October) during months that typically fall into Florida's wet season (May - October). Species composition and abundance information is summarized in an index whose value measures environmental condition. Sediment quality and water quality are also sampled. The level of diversity and abundance of invertebrate taxa are used to place sample sites on a status gradient: high, good, moderate, poor and bad. All of the sites in the southern IRL exhibit good ecological status and have either shown a small but steady improvement, or remained consistent over the past six years (ACOE & SFWMD, 2004).

IRL Species Inventory Database

Another important contribution by the Smithsonian Marine Station to ecosystem science in the IRL is its lead role in developing and maintaining an online IRL Species Inventory database. The Smithsonian Marine Station became the depository for the IRL Species Inventory in 1997. The searchable database includes species reports, habitat descriptions, a photo gallery, special status species and non-native species. Initial funding for the IRL Species Inventory database was provided by grants to the Smithsonian Marine Station from SJRWMD, through the IRL NEP, NASA and the U.S. Environmental Protection Agency (EPA). Renewed funding is being provided by the IRL NEP and the Board of County Commissioners, St. Lucie County, Florida. The IRL Species Inventory Database can be accessed online at (www.sms.si.edu/irlspec/index.htm).

Fish and Wildlife Research Institute Fisheries Independent Monitoring

The FWRI Fisheries-Independent Monitoring (FIM) program is a long-term program which monitors the relative abundance of fishery resources in Florida's major estuarine, coastal and reef systems. The program was developed to provide timely information for use in management plans and identify trends in relative fishery abundance throughout Florida. Fisheries-Independent Monitoring program sampling began in the northern IRL (north of State Road 60 in Vero Beach) during 1990 and in the southern IRL (south of State Road 60 in Vero Beach) during 1997. The FIM program uses a monthly stratified-random sampling design which utilizes a multi-gear approach to collect data on various life history stages of fishes and selected invertebrates from a wide variety of habitats.

In 2011, a total of 338,539 animals, including 133 taxa of fishes and ten taxa of invertebrates, were collected from 839 samples in the northern IRL. During the same year, a total of 32,810 animals, including 96 taxa of fishes and five taxa of invertebrates, were collected from 144 southern IRL samples (FWC, 2012). Trends in annual indices of abundance (IOA) for recreationally important species are detailed in the *Fisheries Independent Monitoring Program 2011 Annual Data Summary Report* (FWC, 2012). Abundances of mature spotted seatrout in the northern IRL increased steadily from 2001 through 2005, and have since fluctuated without trend with a peak in abundance in 2010 and 2011. In the southern IRL, relative abundance of mature spotted seatrout has remained relatively stable since 1997 with a few minor peaks and valleys. Abundance of the common snook in the northern IRL has declined from 2009 to 2011. Annual IOAs of adult common snook in the southern IRL were high from 1997 to 1999, declined in 2000, and remained fairly stable through 2009. As a result of record cold events, snook abundance decreased substantially in 2010 and has remained low through 2011. Throughout the IRL, redfish (*Sciaenops ocellatus*) recruitment has remained relatively low, but stable. Abundance of sheepshead in northern IRL remained relatively stable from 1998 - 2002 and was variable thereafter with peaks in abundance occurring in 2004, 2007 and 2011. Sheepshead IOAs for the northern and southern IRL exhibit cyclical patterns; increases in sheepshead abundance in the northern IRL are generally accompanied by lows in the southern IRL. Sheepshead occur in the northern IRL at lower abundances than in the southern IRL. Annual IOAs of adult pinfish (*Lagodon rhomboids)* in the northern IRL varied without trend with the exception of extremely high abundances in 2004 and 2010 - 2011. Annual IOAs of adult pinfish in the southern IRL showed small peaks in 1997, 2009 and 2011, but otherwise remained stable and at lower levels than the northern IRL (FWC, 2012). The effects of the 2011 Superbloom on fisheries are still unknown as the results from 2012 have yet to be published by FWC.

Total Maximum Daily Loads and Basin Management Action Plans

Florida regulatory agencies adopted a watershed management approach in order to provide a framework for implementing the requirements of the Federal Clean Water Act and the 1999 Florida Watershed Restoration Act. A waterbody that does not meet its designated use (i.e., aquatic life use support-based, primary contact and recreation, fish and shellfish consumption, or protection of human health) is defined as impaired. The Clean Water Act requires states to submit lists of impaired surface waters that do not meet applicable water quality standards and to establish Total Maximum Daily Loads (TMDLs) for these waters on a prioritized schedule. The TMDL represents the maximum amount of a given pollutant that a waterbody can assimilate and still meet all of its designated uses. As such, development of TMDLs is an important step toward restoring IRL System waters to their designated uses. The Watershed Management Program is based on a five-phase cycle that rotates through Florida's basins every five years. Objectives and specific tasks in each phase of the cycle are as follows:

- Phase One - Initial Basin Assessment (Basin Status Report)
- Phase Two - Coordinated Monitoring (Basin Assessment Report)
- Phase Three - Data Analysis and TMDL Development
- Phase Four - Basin Management Plan Development (Basin Management Action Plan)
- Phase Five - Implementation of Basin Management Plan

Phase One - Initial Basin Assessment

In Phase One of the Watershed Management Program, a Basin Status Report was developed for the IRL Basin (DEP, 2006) and the St. Lucie/Loxahatchee Basin (DEP, 2004). The IRL Basin Status Report Included the Banana River and IR-Malabar to Vero Beach aquatic preserves and the northern half of IR-Vero Beach to Ft. Pierce Aquatic Preserve. The St. Lucie/Loxahatchee Basin Status Report included the southern half of IR-Vero Beach to Ft. Pierce Aquatic Preserve and Jensen Beach to Jupiter Inlet Aquatic Preserve. The status reports contain a *Planning List* of potentially impaired waters that may require the establishment of TMDLs. The reports characterize each basin's hydrologic, ecological, and socioeconomic setting as well as historical, current, and proposed watershed management issues and activities. They also contain a preliminary evaluation of major water quality parameters, water quality issues by planning unit, an evaluation of ecological resources, and basin-wide pollutant loading trends related to land uses.

Phase Two - Coordinated Monitoring

In Phase Two of the cycle, a Basin Assessment Report was developed for the IRL Basin (DEP, 2006) and the St. Lucie/Loxahatchee Basin (DEP, 2004) which contained a *Verified List* of impaired waters that required the establishment of TMDLs. With the exception of Sykes Creek in Banana River Aquatic Preserve, all surface waters in the IRL System are impaired by a pollutant or pollutants for one or more designated uses. Sykes Creek was considered to be potentially impaired but more monitoring was required at the time the Assessment Report was developed. Factors contributing to impaired water designation in the IRL System primarily include low dissolved oxygen (DO), excessive nutrients, fecal coliform, presence of heavy metals, and mercury in fish (DEP, 2006).

Phase Three - Data Analysis and Total Maximum Daily Load Development

In Phase Three of the cycle, specific TMDLs were developed for the St. Lucie Basin, (Parmer, Laskis, McTear & Peets, 2008), the Banana River Lagoon and central IRL (Gao, 2009), the Southwest Fork Loxahatchee River (White & Turner, 2012), 11 tributaries of the central IRL (Gao & Rhew, 2012), and Sykes Creek and the Barge Canal (Gao, 2012). All of the Banana River, IR-Malabar to Vero Beach, and northern half of IR-Vero Beach to Ft. Pierce aquatic preserves are directly addressed by the aforementioned TMDLs. The St. Lucie Estuary is the major tributary to Jensen Beach to Jupiter Inlet Aquatic Preserve. Development of TMDLs for the St. Lucie Estuary had a higher priority than the receiving IRL. Consequently, TMDLs have not yet been developed specifically for Jensen Beach to Jupiter Inlet Aquatic Preserve, nor for the southern half of IR-Vero Beach to Ft. Pierce Aquatic Preserve.

DEP adopted total nitrogen (TN) and total phosphorous (TP) TMDLs for the IRL north of the Indian River/St. Lucie County line, including Banana River Aquatic Preserve, IR-Malabar to Vero Beach Aquatic Preserve and the northern half of IR-Vero Beach to Ft. Pierce Aquatic Preserve. The TMDLs focus on the water quality conditions necessary for seagrass regrowth at the depth limits where seagrass historically grew based on a multiyear composite of seagrass coverage. The median depth limits for seagrass coverage in the IRL decreased over the years due to changes in water quality conditions that prevented the seagrass from growing in deeper water. To determine the nutrient reductions needed to improve lagoon water quality in each sub-basin, the TMDL analysis regressed nutrient loading estimates for nonpoint and point sources and data for seagrass depth limits. This median depth target limit was based on historical seagrass data

Periodic discharges of freshwater from Lake Okeechobee have noticeable effects on the adjacent IRL System. The freshwater plume can be easily seen on the left side of the photo.

from 1943 to 1999 to determine at what depths the deep edge of the seagrass beds previously grew. Since changes in the IRL Basin will likely prevent 100 percent restoration of seagrass at these depths, the TMDL allowed for a 10 percent reduction in the target seagrass depth (DEP, 2009).

DEP identified nine sub-basins in the St. Lucie River and Estuary Basin as impaired by nutrients. This determination was made based on concentrations of chlorophyll-*a*, DO, and/or biochemical oxygen demand (BOD) in each of the sub-basins. In March 2009, DEP adopted the St. Lucie Basin TMDL for TP, TN, and BOD.

Water quality issues (TN, TP and DO) were also identified in tributaries that discharge into the IRL. DEP developed TMDLs for nutrients and BOD for eleven tributary segments within the IRL Basin that would restore their water quality. Of the 11 tributaries, eight directly impact the IRL System. These include five sub-basins of the St. Sebastian River and the North Canal, which flow directly to IR-Malabar to Vero Beach Aquatic Preserve, the Main Canal, which flows into the IRL within the City of Vero Beach, and the South Canal which flows into IR-Vero Beach to Ft. Pierce Aquatic Preserve (Gao & Rhew, 2012).

The Sykes Creek/Barge Canal system was verified for nutrient impairment due to elevated annual chlorophyll *a* concentrations observed in 2009 and 2010. DEP established a TMDL for allowable loadings of nutrients to the Sykes Creek/Barge Canal system such that the waterbody will meet the applicable water quality criteria for nutrients (Gao & Rhew, 2012).

Originally verified impaired in 2004, the Southwest Fork Loxahatchee River remains impaired for fecal coliform. The TMDL establishes the allowable fecal coliform loading to the Southwest Fork Loxahatchee River that would restore the waterbody so that it meets its applicable water quality criteria for fecal coliform (Gao & Rhew, 2012).

Phase Four - Basin Management Plan Development

Basin Management Action Plans (BMAPs) are a critical product of the Watershed Management Program because they provide the roadmap for implementation of the TMDLs, and serve as basin-specific, consensus driven implementation plans. To date, BMAPs have been developed for the Banana River Lagoon (DEP, 2013a), including Banana River Aquatic Preserve, the central IRL (DEP, 2013b), including IR-Malabar to Vero Beach Aquatic Preserve and the northern half of IR-Vero Beach to Ft. Pierce Aquatic Preserve, and the St. Lucie River and Estuary (DEP, 2013c). TMDLs and associated BMAPs have not been established for the IRL proper, south of the Indian River/St. Lucie County line. This area includes the southern half of the IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves.

For each BMAP, DEP works with local stakeholders to specify how established goals will be achieved by recommending management activities, establishing who is responsible for implementation, establishing a schedule for implementation, and noting how the effectiveness of the plan will be assessed. While the plans focus on implementation of TMDLs developed in the associated basin, they also address more general watershed goals. BMAPs provide for phased implementation of the strategies necessary to ultimately achieve the associated TMDLs. This approach allows stakeholders to incrementally plan, budget, and execute projects while simultaneously assessing progress towards water quality restoration. The total required reductions in TMDLs are spread over a 15-year period. Reductions will be implemented in three separate five-year BMAP iterations, which align with DEP's approach to evaluate basin health every five years. The aforementioned BMAPs represent the first five-year iteration.

Phase Five: Implementation of Basin Management Plan

Implementation of the BMAPs and associated water resource protection and restoration efforts, including development and implementation of best management practices (BMPs), habitat protection and restoration activities, environmental infrastructure improvements, and issuance of permits are underway. With the implementation of the projects outlined in the BMAPs, reductions in watershed nutrient loading are expected to improve water quality conditions and seagrass coverage. The following outcomes are expected from BMAP implementation: Improved water quality trends in the IRL, which will help improve seagrass coverage;

- Decreased loading of the target pollutants (TN, TP, and BOD);
- Decreased loading in total suspended solids from some of the projects implemented to reduce TN and TP loads;
- Modest improvement in water quality trends in the watershed tributaries and the St. Lucie River and Estuary;
- Increased coordination between state and local governments and within divisions of local governments when solving problems for surface water quality restoration;
- Additional state and local funding secured for water quality restoration;
- Improved identification of effective projects through stakeholder decision-making and priority-setting processes;
- Enhanced public awareness of pollutant sources, pollutant impacts on water quality, and corresponding corrective actions; and
- Enhanced understanding of basin hydrology, water quality, and pollutant sources.
  During the BMAP process, several research priorities were identified, but are contingent on the availability of funding. The *Indian River Lagoon 2011 Superbloom Plan of Investigation* (SJRWMD, 2012b) addresses or complements a number of the listed priorities. These research topics include the following:
- Collecting data to update the bathymetry for the IRL Basin that would be used in the seagrass depth limit evaluations;
- Continuing and increasing the frequency of the monitoring along the existing seagrass transects to track seagrass composition, density and extent;
- Implementing phytoplankton, drift algae and macroalgae monitoring in the basin;
- Implementing storm event monitoring at the major outfalls;
- Tracking watershed loads by monitoring inflow and outflow nutrient concentrations for each jurisdiction;
- Verifying the BMP effectiveness values used in the BMAP, as needed;
- Collecting data on the nutrient load reduction that results from staging/retaining stormwater runoff;
- Collecting data on ground water nutrient concentrations and volume reaching the tributaries and IRL;
- Collecting data on nutrient flux/internal recycling of legacy nutrient loads held within the IRL sediments and exchanged with the water column, and;
- Testing/verifying the TN, TP, and seagrass depth regression equations using the seagrass data collected since 1999.

*4.2.2 / **Ecosystem Science Issues***

*Issue I / **Water Quality***

The degradation of water quality within the IRL System and the effects of stormwater discharges on the estuarine system are well documented (Graves, Wan, & Fike, 2004; Graves, Thompson, & Fike, 2002; Doering, 1996; Chamberlain & Hayward, 1996; Graves & Strom, 1992, 1995a, 1995b; Rudolph, 1990; Haunert & Startzman, 1980, 1985; Murdock, 1954). Primary factors affecting water quality in the IRL are the quantity, quality, timing, and distribution of stormwater runoff from urban and agricultural sources. More specifically, the system suffers from salinity imbalances, turbid water, high nutrient and sediment

loading, hypoxia, and heavy metal and pesticide accumulation in the sediments (Rand, Carriger, Lee, & Pfeuffer, 2003; Haunert, 1988; Wang, Krivan, & Johnson, 1979). The consequences of these physical and chemical disturbances include fish kills, chronic fish abnormalities (fin rot, ulcerations, scoliosis, abnormal lateral lines, scale disorientation, discolored patches, live rot on body, eye and body deformities, growths, bleeding, and severe parasite infestation), algal blooms, a shift from nekton to plankton-dominated system, low transparency, and a lack of SAV and oyster reefs (Ewing, Browder, Kandrashoff, & Kandrashoff, 2006; Chamberlain & Hayward, 1996; Doering, 1996; Murdock, 1954).

In the past, numerous drainage systems were constructed throughout the IRL watershed. Much of this development predated present-day stormwater treatment requirements. As a consequence, stormwater, with its associated pollutants and volumes of freshwater, reach the IRL System with little or no pre-treatment. Cumulative impacts of past and present human activities present a significant challenge to conserving the viability of these coastal resources. Promoting BMPs for retrofitting older developments and planning new developments, educating homeowners and making certain accurate resource information is provided to regulatory personnel are important activities for sustaining the natural resources of the IRL System.

In addition to dramatic watershed changes, shoreline and benthic communities have also been directly impacted. In many areas of the IRL System, seawalls, docks and rip-rap have replaced natural mangroves, seagrasses and oyster habitats along the shorefront. Natural shorelines help stabilize the sediments, dissipate wave action, filter stormwater runoff and provide quality intertidal habitat for numerous birds and aquatic organisms. It is important to promote appropriate set-backs for buildings and natural “living” shoreline stabilization options to regulatory staff, local governments and riparian land owners in order to restore these lost habitat functions. In recent years, the impacts of stormwater discharges and incompatible development practices have been recognized and many local governments have taken action to address these impacts.

Goal 1 / Maintain and improve water quality within and entering the IRL System to meet the needs of the natural resources.

Objective 1.1 / Regularly assess water quality conditions within the aquatic preserves and the potential impacts on natural resources.

Integrated Strategies:

1.1.1 / **Collaborate with groups collecting water quality data within the aquatic preserves to stay informed about water quality.** Water quality data in the IRL System are collected by multiple agencies and non-profit groups. A water quality guide that identifies how to access raw data from each of the entities collecting water quality data will be drafted and maintained for use by the general public. Summaries produced by those collecting water quality data will allow staff to better understand water quality conditions and how these conditions may be impacting the natural resources within the IRL System. This strategy requires additional staffing for implementation.

Performance Measure:

1. Create a user-friendly guide that identifies the location of water quality monitoring stations within the aquatic preserves and how to access raw data from each of the entities collecting water quality data.

1.1.2 / **Assess compiled data to identify status, trends and information gaps.** The status, trends and information gaps related to the IRL System have been regularly summarized in the annual IRL NEP Comprehensive Conservation Management Plan (CCMP) updates. More recently, status, trends and information gaps have been detailed in the IRL BMAP process. Final reports produced by the 2011 Superbloom Consortium will identify important information gaps related to the understanding of nutrient cycling in the IRL System. This recurring strategy was initiated fiscal year (FY) 2008 - 2009.

Performance Measures:

1. Complete reports that assess the status and trends of water and sediment quality.
2. A prioritized list of monitoring and research needs to address water and sediment quality is developed.

1.1.3 / **Use or build on existing monitoring efforts to address information gaps.** Information gaps identified in Integrated Strategy 1.1.2 will be addressed through existing monitoring results. Additional monitoring programs will be developed where necessary. This recurring strategy will be initiated FY 2014 - 2015.

Performance Measure:

1. Data gaps in the monitoring programs are addressed.

Issue II / ***Loss of Natural Community Function and Species Diversity***

Habitats within the IRL System consist primarily of shallow water communities which comprise some of the most diverse and productive ecosystems in the United States. Major ecological communities present include tidal wetlands, mudflats, oyster reefs, seagrass beds and islands.

While many of these communities within and adjacent to the IRL System continue to be highly diverse and productive, they have suffered impacts as the result of growth and development in the region. These impacts threaten long-term sustainability of the IRL System's natural resources. As described in Chapter Three, there have been losses to wetlands and seagrass acreage, impacts to oyster reef extent and function, and an influx of non-native, invasive plants and animals. In addition, there is the potential for additional losses of these habitats in the future from incompatible land use practices and public use.

Significant habitat restoration efforts are underway and additional opportunities exist to conserve and restore species diversity within the IRL System. In the last two decades several thousand acres of impounded coastal wetlands, originally altered to control mosquitoes, have been reconnected to the IRL. Research and monitoring studies have determined that upon reconnection to the surrounding marsh, these impacted coastal wetlands are able to rapidly recruit native vegetation and exhibit significant increases in the number of fish species. For example, as tidal exchange was restored to one impounded area in the IRL, the cover of salt-tolerant plants increased by 1,056 percent in less than three years and fish population diversity increased from nine fish species to 40 fish species (Poulakis, Shenker, & Taylor, 2002; Brockmeyer et al., 1997). Ongoing research has led to the refinement of methods for reconnecting and managing impounded wetlands that allow for habitat restoration while providing effective mosquito control (Steward et al., 2003).

Seagrass habitat within the IRL System has suffered substantial loss over the last several years. The most recent data indicates seagrass coverage has declined up to 90 percent in portions of the IRL System due to the 2011 Superbloom. This negated a near decade-long net increase of seagrass throughout the IRL. Investigations are ongoing to determine the factors responsible for the recent collapse in seagrass coverage.

Oysters are an example of a keystone species in coastal ecosystems such as the IRL System. Oysters function as filter feeders, helping to improve water quality. Oyster reefs help stabilize shorelines, bottom habitats and sediments and they provide refuge and essential intertidal habitat for juvenile fishes and other wildlife (e.g., shrimp, crabs, red fish, sea trout and wading birds). Populations of oysters are significantly stressed by factors such as siltation, disease and altered water quality (Ortega, 1981). There is a need to determine the relative importance of these factors to prioritize efforts to conserve this valuable resource. The expansion of oyster habitat restoration efforts in the IRL System is currently being initiated.

Invasive plants and animals are threatening ecosystems in many areas of Florida. These species may outcompete native species because they may have been removed from naturally evolved population controls (e.g., predators, parasites and disease), or they may be more efficient at exploiting disturbed habitats. Invasive species can have a dramatic effect on species composition, habitat stability and function. These changes may be equally damaging to natural communities as well as local recreational and commercial interests (Smee, 2012).

Goal 1 / Implement management practices that maintain or improve viable habitats and populations within the IRL System.

Objective 1.1 / Collect and compile existing and ongoing research studies, reports and data on the IRL System.

Integrated Strategy:

1.1.1 / **Attend and/or participate in IRL conferences and meetings.** There are a large number of agencies and non-profit groups involved in research directly related to the IRL System. It is imperative that IRLAP staff stay informed on research, reports and available data in order to implement the most effective science-based management of the IRL System. This has been a recurring strategy since the development of the first IRLAP management plan adopted in in the 1980s.

Performance Measure:

1. Actively participate in IRL conferences and meetings and/or create meeting summaries.

Objective 1.2 / **Associate aquatic species with specific habitats located in each aquatic preserve with the IRL System.**

Integrated Strategies:

1.2.1 / **Develop a GIS database and maps that link aquatic species locations to specific aquatic habitats located within the IRL System.** The consolidated Florida Natural Areas Inventory natural lands map will serve as a base layer in ArcGIS for overlaying rare and listed aquatic species sighting data. This will ultimately facilitate understanding of species-habitat association patterns and improve protection efforts. Association maps will provide IRLAP staff with necessary documentation to better understand and comment on the cumulative impacts of permitted projects on natural resource communities and individual species with specific habitat requirements in the IRL System. This strategy requires additional staffing.

Performance Measures:

1. Create a waypoint list (including date, species, and observer) for collected/observed rare and listed aquatic species.
2. Create a map through GIS with species sighting data overlaid on the Florida Natural Areas Inventory natural lands map.

1.2.2 / **Assist research and conservation groups and agencies with maintenance of species inventories**. The existing species inventory database (including source data) will be maintained by IRLAP staff as new species are documented in the IRL System. Species may be documented through peer-reviewed literature, personal observations from IRLAP staff or other users, and photographs. To ensure accuracy, aquatic preserve staff will verify newly documented species within the preserve. The species list will be available on the IRLAP website and from the IRLAP field office. This recurring strategy was initiated FY 2007 - 2008.

Performance Measure:

1. Annually update the species list for the aquatic preserves and post on the IRLAP website.

Objective 1.3 / **Establish, implement and build upon existing routine biological monitoring programs for essential habitats, and rare and listed species.**

Integrated Strategies:

1.3.1 / **Monitor bird rookeries**. All nesting colonies and nesting activities (abundance and diversity) within the IRL System will be documented on a monthly basis during each nesting season. IRLAP will use a data collection method (datasheet) that will facilitate comparison with other nesting data collected around the state. Data collected from rookeries will be analyzed and summarized for distribution to interested parties. Data from bird monitoring surveys is reported to the Florida Shorebird Database. This recurring strategy was initiated FY 2005 – 2006

Performance Measure:

1. Summarize annual monitoring data.

1.3.2 / **Monitor shorebird nesting.** All shorebird nesting activities within the IRL System will be documented on a monthly basis during each nesting season. IRLAP staff will coordinate with FWC to protect active shorebird nesting sites from human disturbance with temporary signage. This recurring strategy was initiated FY 2005 - 2006.

Performance Measure:

1. Summarize annual monitoring data.

1.3.3 / **Monitor diamondback terrapins.** IRLAP staff is working with local environmental groups to assess remaining populations, threats, and appropriate conservation efforts for the diamondback terrapin in Banana River Aquatic Preserve. The objective of IRLAP's monitoring efforts are to determine terrapin distribution and nesting site information in order to effectively manage submerged and spoil island resources within its boundaries. This strategy was initiated FY 2012 - 2013 and will last three years.

Performance Measure:

1. Create a report and maps detailing distribution of terrapins and recommendations for their conservation.

1.3.4 / **Assist partners with natural resource monitoring efforts (i.e., seagrass).** IRLAP staff assist the SJRWMD by conducting biannual monitoring of long-term seagrass transects from Ft. Pierce to St. Lucie Inlet. Data is collected following protocols established by SJRWMD. This recurring strategy was initiated FY 1994 - 1995.

Performance Measure:

1. Complete biannual monitoring at all transect locations.

1.3.5 / Collaborate with academic institutions to meet research and monitoring needs. A list of research needs necessary to address management questions within the IRL System will be created and maintained by IRLAP staff. Meetings will be held with professors and scientists at Indian River State College, Florida Atlantic University, HBOI, Smithsonian Marine Station at Ft. Pierce, University of Florida, and other academic institutions to discuss research needs and funding opportunities. This recurring strategy was initiated FY 2013 - 2014.

Performance Measure:

1. Produce summaries from meetings with professors and scientists at academic institutions.

1.3.6 / Establish a program to collect information from researchers and commercial fisherman within the aquatic preserves. A program was implemented in Florida's state parks in which researchers collecting data on these public lands are required to complete a non-regulatory permit application which would help managers document the work and obtain a copy of the written reports to make educated management decisions about the resources within the park. A similar, but voluntary program has been established at Rookery Bay National Estuarine Research Reserve in Naples. IRLAP staff will use these existing programs as a model for the IRL System. This strategy requires additional staff.

Performance Measure:

1. Design a non-regulatory, voluntary research/collection application form to help the IRLAP manager document research monitoring, and collection/harvest being conducted within the IRL System.

4.3 / The Resource Management Program

The Resource Management Program addresses how FCO manages the IRL System and its resources. The primary concept of IRL System Resource Management projects and activities are guided by FCO's mission statement: "Conserving and restoring Florida's coastal and aquatic resources for the benefit of people and the environment." FCO's sites accomplish resource management by physically conducting management activities on the resources for which they have direct management responsibility, and by influencing the activities of others within and adjacent to their managed areas and within their watershed. Watershed and adjacent area management activities, and the resultant changes in environmental conditions, affect the condition and management of the resources within their boundaries. FCO managed areas are especially sensitive to upstream activities affecting water quality and quantity. FCO works to ensure that the most effective and efficient techniques used in management activities are used consistently within our sites, throughout our program, and when possible, throughout the state. The strongly integrated Ecosystem Science, Education and Outreach, and Public Use Programs, provide guidance and support to the Resource Management Program. These programs work together to provide direction to the various agencies that manage adjacent properties, our partners and our stakeholders. The IRLAP office also collaborates with these groups by reviewing various protected area management plans. The sound science provided by the Ecosystem Science Program is critical in the development of effective management projects and decisions. The nature and condition of natural and cultural resources within the IRL System are diverse. This section explains the history and current status of our Resource Management efforts.

4.3.1 / Status of Resource Management in the Indian River Lagoon System

As a result of various federal and state designations, restoration and management of the IRL System is addressed by several plans. In addition to the BMAPs previously addressed in Section 4.1.1, management plans include the Surface Water Improvement and Management (SWIM) Plan, the IRL NEP CCMP and CERP. The following is a summary of these plans.

Surface Water Improvement and Management Plan

Adopted in 1989, the SWIM Plan was a result of a state mandated effort directing the state's five regional water management districts to design and implement plans for many natural surface water systems that were being degraded. The SWIM Plan primarily concentrates on conducting scientific investigation and applying the findings of those investigations directly to restoration actions. Cooperatively managed by both SJRWMD and SFWMD, the IRL SWIM Plan has three goals:

1. To attain and maintain water quality in order to support a healthy, macrophyte based, estuarine lagoon system.
2. T o attain and maintain a functioning macrophyte-based ecosystem which supports endangered and threatened species, fisheries and wildlife.
3. To achieve heightened public awareness and coordinated interagency management of the IRL ecosystem that results in the accomplishment of the two aforementioned goals

The IRL SWIM Plan was updated in 1994 and again in 2002. Major accomplishments under the SWIM program were summarized in the 2002 update. Since the plan's adoption in 1989, nearly 56,000 acres of wetlands and uplands had been acquired for water quality remediation projects and habitat preservation. There was significant reduction in wastewater discharge, improvements in stormwater management and removal of harmful muck deposits. Most notable, was the hydrologic reconnection of 23,000 acres of impounded wetlands (Steward et al., 2003).

A major contribution of the 2002 IRL SWIM Plan update was the determination that future work on water quality and seagrass should be focused on non-point source controls. Indeed, proposed projects in the 2002 SWIM plan direct efforts at large-scale watershed projects designed to reduce key pollutants affecting water quality and excessive freshwater discharges detrimental to salinity regimes. Proposed projects for the IRL include acquisition and reconnection of impounded wetlands, acquisition of remaining Blueway parcels, rehabilitation of dragline-impacted wetlands, and shoreline and spoil island enhancement (Steward et. al., 2003).

Indian River Lagoon Comprehensive Conservation Management Plan

In 1987, the NEP was established as part of the federal Clean Water Act. Following proclamation that the IRL was an Estuary of National Significance, the IRL NEP was established in 1990. The IRL NEP is cooperatively managed by SJRWMD, SFWMD, and EPA. During the infancy of the IRL NEP, local, state and federal agencies developed goals and related actions for restoration and protection of the IRL. These efforts were documented in the IRL CCMP completed in 1996 (Adams et. al., 2006). The IRL CCMP was developed in concert with the SWIM Plan to the extent that the IRL CCMP adopted the same priority problems and goals as the SWIM Plan. The 1996 CCMP identified issues and developed action plans for the IRL. A set of 68 action items were recommended in four topic areas. The topic areas guide the IRL NEP and include 1) water and sediment quality improvement, 2) living resources, 3) public and governmental support and involvement, and 4) financing CCMP implementation. The water and sediment quality improvement topic area addressed action plans for point source discharges, on-site sewage disposal systems, management of freshwater and stormwater discharges, marina and boat impacts and atmospheric deposition. The living resources topic area addressed action plans for biodiversity, seagrass, wetlands, impounded marshes, land acquisition, endangered and threatened species, and fisheries. The public and governmental support and involvement topic area addressed action plans for public involvement and education, future implementation, data management and monitoring. The financing topic area addressed estimated costs to implement the plan, identification of funding opportunities by jurisdiction, and state and local options for securing new and expanded funding (Adams, Ainsley, Busby, Day, Recore, & Rice, 1996).

Comprehensive Everglades Restoration Plan

First authorized in 1948, the Central and Southern Florida Project is a multi-purpose project designed to provide flood control, water control, and water supply to an area stretching from Orlando to Florida Bay. Cooperatively managed by the U.S. Army Corps of Engineers (ACOE) and SFWMD, the project has performed its intended purposes well. The project, however, has also significantly contributed to the decline of the south Florida ecosystem. In 1992 and 1996, the Water Resources Development Acts directed the ACOE to evaluate impacts of the Central and Southern Florida Project and to recommend improvements and modifications to restore the south Florida ecosystem while still meeting water resource needs. The resulting comprehensive plan was approved in the Water Resources Development Act of 2000 and is known as CERP. The plan provides a framework and guide to restore, protect, and preserve the water resources of central and southern Florida, including portions of the IRL. The plan includes more than 60 elements and is estimated to take at least 30 years to complete (ACOE & SFWMD, 2003).

A major component of CERP addresses improved water deliveries to the IRL. Two IRL feasibility studies were conducted during the development of CERP. The IRL-North Feasibility Study (ACOE & SFWMD, 2002) included the portion of the IRL from the Ponce De Leon Inlet in Volusia County, through Brevard and Indian River counties, southward to Fort Pierce Inlet in St. Lucie County, and included the Mosquito Lagoon and Banana River Lagoon. Issues under consideration for this study included improving habitat, improving circulation, improving water quality, developing a sediment strategy, better control of runoff, exotic vegetation removal and increasing recreational opportunities.

The IRL-South Feasibility Study (ACOE & SFWMD, 2004a) included the portion of the IRL south of the Ft. Pierce Inlet and investigated options to alter detrimental effects of surface water flow through the existing canal systems to the IRL. Emphasis was placed on the C-25 (Belcher Canal), C-24 (Diversion Canal), C-23, and C-44 (St. Lucie Canal). The IRL–South Feasibility Study focused on improvements which

Spoil islands can make excellent picnic spots.

will restore the environmental health of the southern IRL watershed and the receiving water body. The feasibility study determined the appropriate placement of reservoirs to maximize water quality treatment, natural storage of captured flows, and removal of damaging muck from the estuary. The primary objective is the restoration, preservation, and protection of the IRL, the St. Lucie River and St. Lucie Estuary, and the associated watershed.

During its development, the IRL-North Feasibility Study was transitioned from CERP to a separate ACOE funding source that was subsequently de-funded. As a result, the ACOE did not have a dedicated funding source to carry the study to completion and the IRL-North Feasibility Study was abandoned. Following completion of the IRL-South Feasibility Study, the associated portion of the IRL was incorporated into the Northern Estuaries Module of CERP.

The latest CERP Status Report Update was published in December 2012 (ACOE & SFWMD, 2012). Current projects specific to the IRL System are limited to benthic invertebrate sampling. Other projects within the Northern Estuaries Module include oyster studies in the Caloosahatchee River Estuary and mapping in the Caloosahatchee River Estuary, St. Lucie Estuary, Loxahatchee River Estuary and Lake Worth Lagoon for bottom type (i.e., shell, silt, mud and muck), and location of oyster beds and SAV.

Spoil Islands

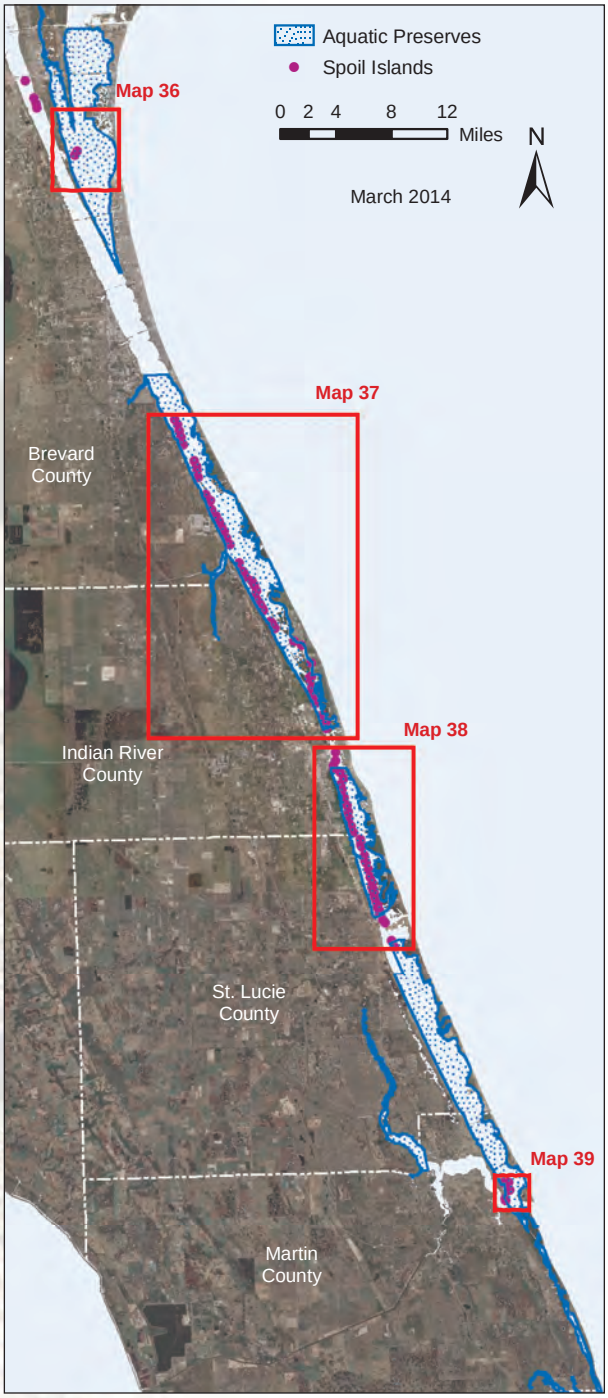
Although not technically natural, spoil islands have become integral to the IRL ecosystem since their creation in the 1940s and 1950s. Spoil islands are often surrounded by seagrass beds and mangrove fringe, which provide habitat for a variety of organisms important to the ecology and economy of the region. Spoil island uplands can support a variety of flora and fauna, both native and exotic, as well as provide an opportunity for recreation by the public.

Spoil island management is guided by the Spoil Island Management Plan (Florida Department of Natural Resources, 1990) which was drafted in 1990 by the DEP (then Florida Department of Natural Resources) with support from the Florida Inland Navigation District. Spoil islands fall under three basic designations: Recreation, Education and Conservation. Recreation islands are further broken down into “active” and “passive.” Active recreation islands are typically larger and may support overnight camping whereas

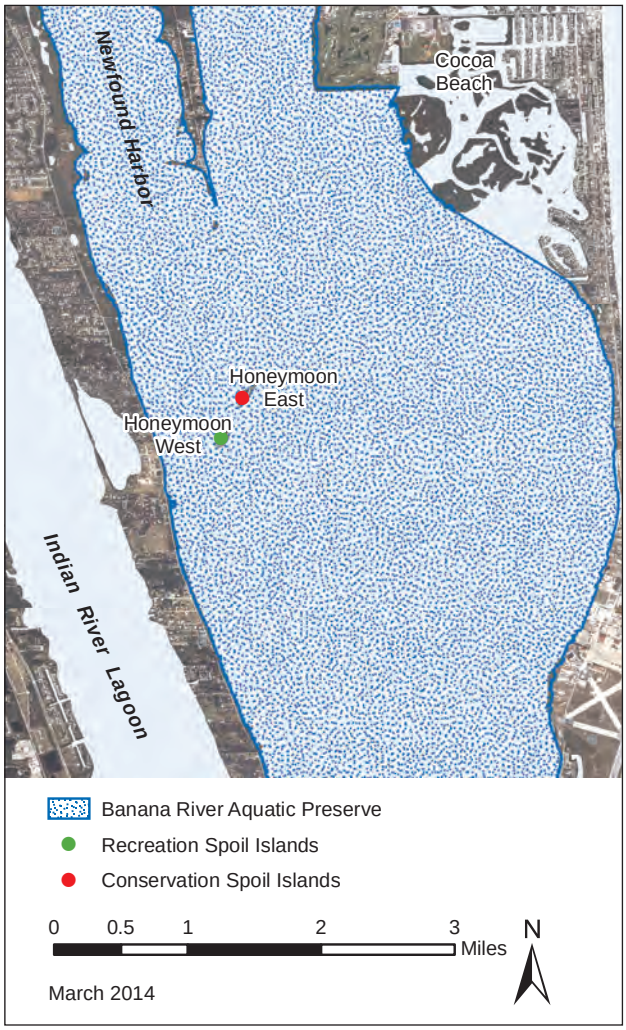
passive recreation islands are smaller and are more suitable for picnicking. Education islands typically possess diverse representative habitats and may be used for educational programs. Conservation islands possess sensitive habitat such as roosting sites for breeding bird populations or dense, shallow seagrass beds with no deepwater boat access. Short term, primitive camping is allowed on recreation and education islands. Due to their sensitive resources, visitors are asked to refrain from using conservation islands. Detailed information on island designations and locations can be found in the Spoil Island Management Plan or online at www.spoilislandproject.org.

In order to effectively manage spoil islands within the IRL System, IRLAP staff leads a partnership with state and federal agencies, local environmental groups, and public stewards. Collectively known as the Spoil Island Workgroup, the coalition sets short term management goals for island enhancement. IRLAP staff hosts Spoil Island Project (SIP) workdays from September to April each year in which volunteers and workgroup members visit select recreation islands for maintenance and enhancement of sites. Typical tasks include removal of exotic plants, addition of native plants, shoreline stabilization, recreational enhancements, trail clearing and debris removal.

Conservation islands are monitored for nesting bird populations and managed as refuges for coastal wildlife. IRLAP staff works with local law enforcement to limit human disturbance, particularly during nesting season. Monofilament is removed from vegetation when encountered to prevent fatality due to entanglement.



Map 35 / Spoil islands of the Indian River Lagoon System.

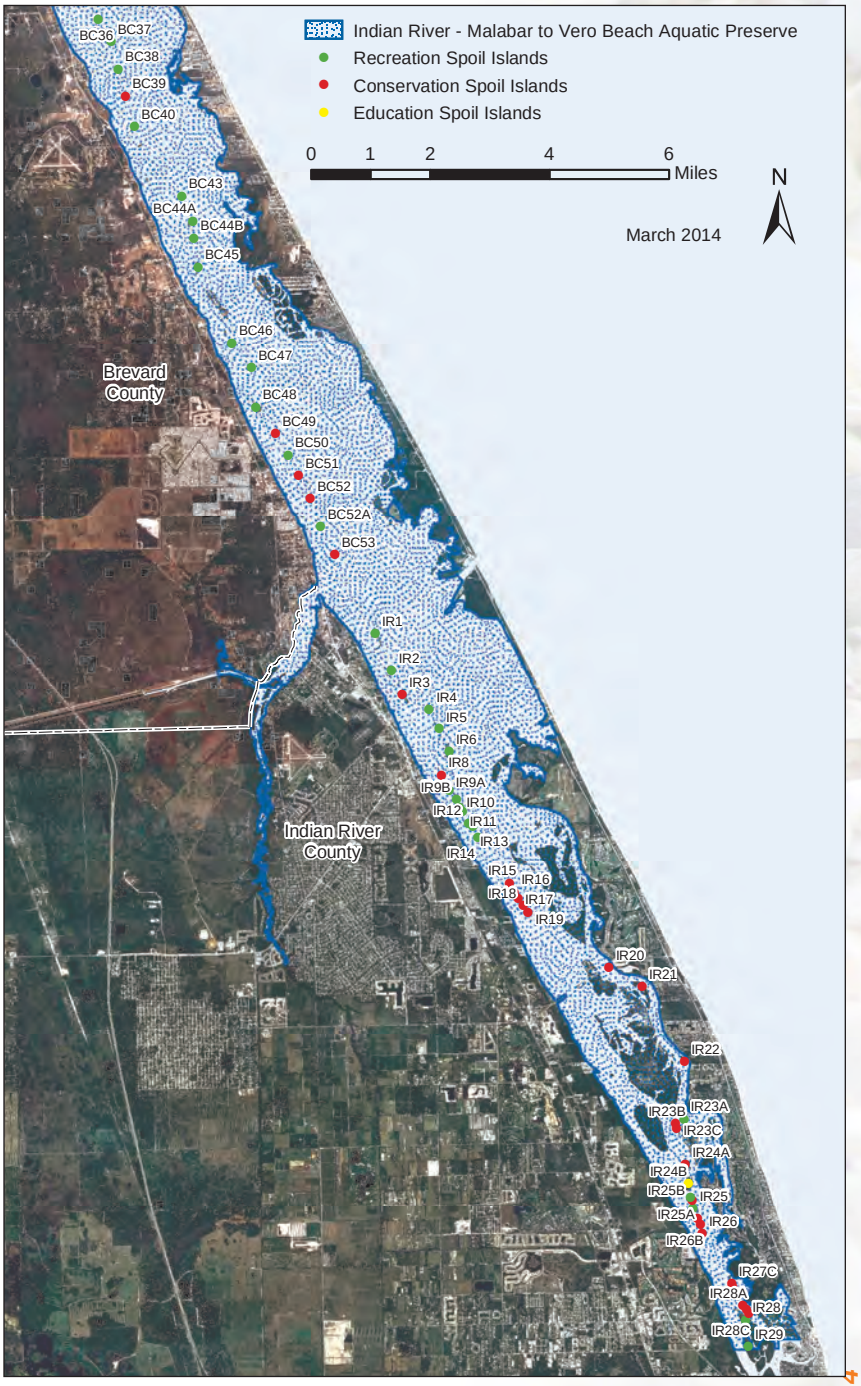


Map 36 / Spoil islands of Banana River Aquatic Preserve.

Erosion is the greatest single threat facing all spoil islands in the lagoon. Every winter, high seasonal water levels coupled with strong northerly winds serve to erode the northern side of many islands. Most islands also have a high occurrence of exotic plant species (Brazilian pepper and Australian pine) which are not salt tolerant. During times of high water, these plants can die due to saltwater inundation and remove critical shoreline protection from the island. Through the IRLAP's Shoreline Restoration Project (SRP), staff is experimenting with methods to re-establish fringing mangroves along critically eroding shorelines to prevent further loss of the islands. Native, salt tolerant plants are also added when needed to increase biodiversity and resiliency of upland areas.

Shoreline Restoration Project

Since the mid-1900s fringing mangrove habitat along the shorelines of the IRL System has been declining as a result of development and erosion. The Environmental Learning Center began the IRL SRP in 1995 with the goal of reversing this trend. IRLAP took over management of the IRL SRP in February 2008. Prior to 2008, red mangroves were planted in polyvinyl-chloride (PVC) encasements. As the new managing entity, IRLAP conducted an experiment to test two other mangrove planting methods against the PVC encasement method; planting a three-gallon, multi-stem, container-grown red mangrove, and planting a mature seven-gallon, container-grown red mangrove. There was no significant difference in survival of the three different planting methods. In 2010, the SRP shifted its focus from solely planting red mangroves to planting salt marsh vegetation. IRLAP staff hypothesized that the advantages would be two-fold; immediate shoreline stabilization and ecosystem restoration through the natural succession from salt marsh habitat to mangrove dominated shorelines. In 2010, two pilot projects were implemented in Brevard County on Archie Carr National Wildlife Refuge (NWR) properties, Archie Carr NWR North and Archie Carr NWR South. Both sites received similar treatments of *Spartina patens* and *S. alterniflora* (Vaughn & Herren, 2010). Results after one year had shown natural recruitment of red mangroves, seeding of both species of grass, rhizome spreading, and sediment trapping which resulted in erosion prevention. Since establishing the experimental sites, a total of twelve new sites have been planted between 2010 and 2012 throughout Brevard, Indian River and St. Lucie counties. Salt marsh grass planting designs differed among sites. Each site received a treatment based on surrounding vegetation and erosion factors. Monitoring of the salt marsh grass planting sites indicates early success. The goal of salt marsh grass planting sites is to facilitate recruitment of mangroves and succession into mangrove dominated communities along stabilized shorelines.



Map 37 / Spoil islands of Indian River-Malabar to Vero Beach Aquatic Preserve.

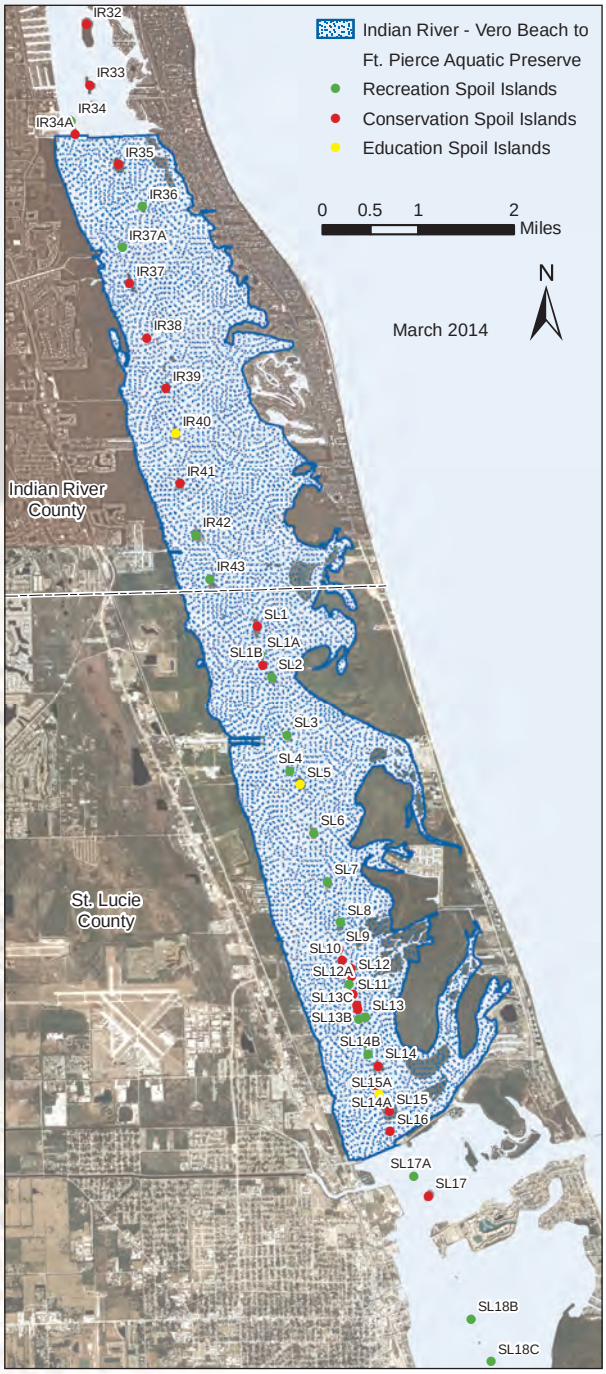
IRLAP currently manages 51 restoration sites. Data collected in 2012 indicate that 980 cubic meters of canopy volume and 917 square meters of salt marsh habitat have been added to the IRL shoreline through the SRP since 1995. For fiscal year (FY) 2013-2014, the IRL SRP is funded through IRL license plate monies generated in Indian River and Brevard counties, and distributed by IRL NEP. Consequently, new planting sites will be limited to Indian River and Brevard counties.

Coastal Wetland Plant Nursery

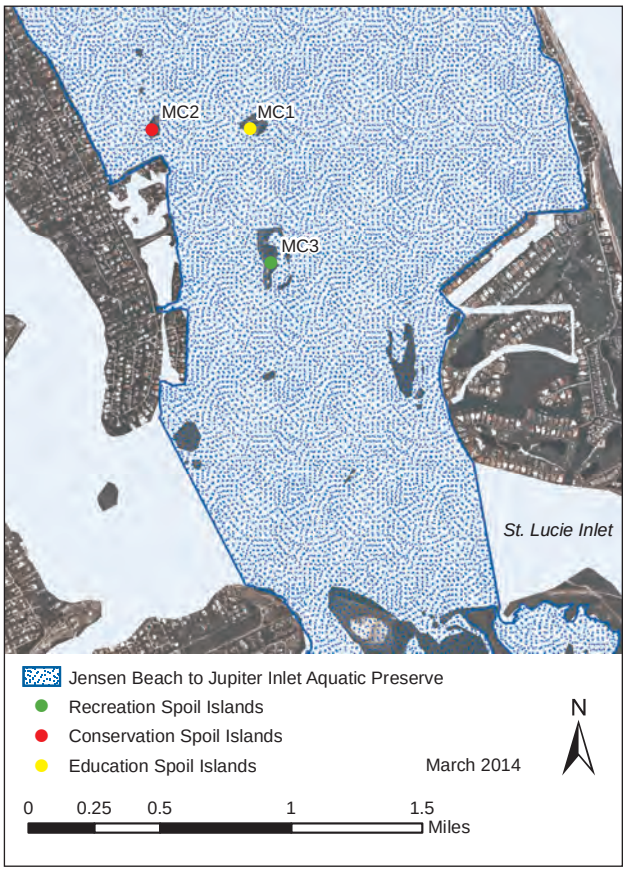
Mangroves and saltmarsh vegetation used for shoreline plantings are stored at St. Sebastian River Preserve State Park. Park staff allows the project coordinator to use two sheds and nursery space on park property for the SRP. All SRP plants stored at the nursery are maintained by the project coordinator, IRLAP staff and volunteers.

The nursery currently supports 26 holding ponds (55 inches by 41 inches) constructed of wood and lined with heavy duty vinyl shower curtains. Plants in the nursery are maintained on different conditioning schedules. Using a refractometer, the salinity level in all ponds is maintained at a minimum of five parts per thousand (ppt) using brackish lagoon water stored in a 550 gallon plastic holding tank. Individuals scheduled to be planted in the field are gradually conditioned to 20 ppt over the course of several months and kept at 20 ppt for a minimum of three months prior to the planting event. This helps to reduce osmotic stress and improves chances for success in the field. Saltmarsh grasses are trimmed during nursery maintenance days prior to planting events.

Since propagules are generally not dispersed farther than 1.24 miles (two kilometers) from their source (Sengupta, Middleton, Yan, Zuro, & Hartman, 2005), propagules collected from



Map 38 / Spoil islands of Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.



Map 39 / Spoil islands of Jensen Beach to Jupiter Inlet Aquatic Preserve.

locations south of Sebastian Inlet are used for plantings south of the inlet and those collected from locations north of the inlet are used for plantings north of the inlet. Due to the shifting focus of the SRP, saltmarsh grasses are now being used predominantly with red mangroves supplemented as needed.

Oyster Restoration

Oysters are a keystone species in the IRL System. Oyster health has been targeted as one of the main estuarine indicators of success for CERP. Oysters filter water and provide critical habitat for many commercially and recreationally important fin fish and invertebrates. Oysters in the IRL System have dramatically declined since the late 1800s due to overfishing, habitat degradation, reduced water quality, increase in disease, and disturbance from boat wakes (Wilson et. al., 2005). Oyster reef restoration in the IRL typically involves deployment of appropriate substrate (cultch) which provides structure for settlement of naturally occurring oyster (spat). While oyster larvae may settle on any hard surface, survival is much greater when they settle on other oyster shells. Oyster restoration projects in the IRL have utilized natural oyster shell, fossilized oyster shell, limerock and concrete rubble as cultch designed to provide points of attachment for oyster larva. While natural oyster shell is preferred, it is not always feasible to obtain sufficient quantities for large-scale restoration projects.

Several organizations and agencies are actively involved in oyster restoration projects in the IRL. These include IRLAP, University of Central Florida, The Nature Conservancy, Brevard Zoo, FOS, U.S. Fish and Wildlife Service (USFWS), and Martin and St. Lucie counties. Extensive oyster restoration has been conducted in the IRL; projects within the four aquatic preserves addressed in this management plan are more limited.

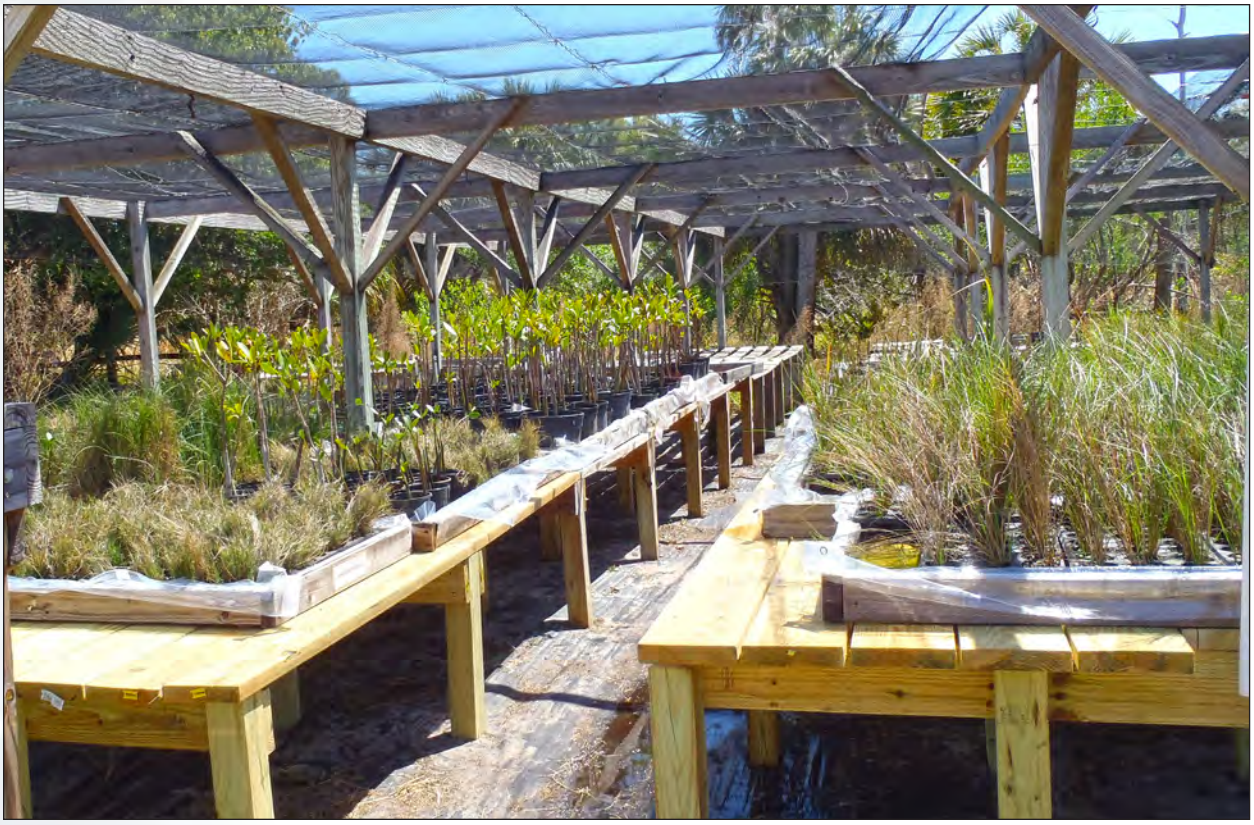
USFWS created a large oyster reef as part of the restoration of Pelican Island (Pelican Island NWR) in IR-Malabar to Vero Beach Aquatic Preserve. The oyster reef was designed as a breakwater to prevent further shoreline erosion. The project involved the initial installment of 34 cubic yards of fossilized oyster shell in 2000 followed by the installment of 206 cubic yards of fossilized oyster shell in 2006. USFWS is currently examining the feasibility of extending a naturally occurring oyster reef to further protect the island from wave action and address concerns of sea level rise (Scotto & Boughner, 2007).

St. Lucie County's oyster reef restoration program has focused its efforts in the vicinity of

Discarded monofilament fishing line can be detrimental to coastal birds. IRLAP staff and volunteers remove discarded line from trees and from entangled birds like this Caspian tern.

Least terns nest in colonies of over 100 pairs in the IRL System along sandy shorelines and spoil islands.

Living shoreline projects, like this one on spoil island BC47, help to stabilize eroding shorelines and increase biodiversity.



IRLAP staff maintain a Coastal Wetland Plant Nursery to grow and acclimate costal plants for use in the Shoreline Restoration and Spoil Island Enhancement Projects.

the Ft. Pierce Inlet. From mid-2009 to the end of 2010, St. Lucie County Coastal Management Services spearheaded the establishment of nearly 4,000 square feet of oyster reef along the perimeter of spoil island SL18B, located between the Ft. Pierce Inlet and the northern boundary of IR-Jensen Beach to Jupiter Inlet Aquatic Preserve. St. Lucie County is currently conducting oyster restoration at 11 permitted sites. Four of the restoration sites are located in the southern end of the IR-Vero Beach to Ft. Pierce Aquatic Preserve. The four sites are located immediately north and south of Riverside Marina, adjacent to the North Beach Causeway, and at the upper reaches of Wildcat Cove. The remaining sites are located south of the North Beach Causeway in between the IR-Vero Beach to Ft. Pierce and Jensen to Jupiter Inlet aquatic preserves (personal communication, J. Oppenborn, June 2013).

FOS in Martin County has been restoring oyster populations since 2005 through their Florida Oceanographic Oyster Restoration program. Oyster shells are collected at local restaurants, quarantined, and then bagged by staff and volunteers and deployed to create new oyster-shell reefs in the IRL and St. Lucie River estuaries. The reefs are then populated with oyster spat, grown from larvae at the FOS hatchery. Progress of restored reefs is monitored using acoustic technology.

To date, FOS has established 55 oyster reefs. The majority of the reefs are located outside aquatic preserves in the St. Lucie River. Three of the reefs are located within Jensen Beach to Jupiter Inlet Aquatic Preserve. These reefs cover approximately 200 square feet and were installed as part of a larger restoration project at Bird Island (MC2) in Martin County (personal communication, V. Ecomio, July 2013).

Since 2005, Martin County's Oyster Reef Restoration Program has constructed more than 30 acres of oyster habitat in the St. Lucie Estuary, upstream of Jensen Beach to Jupiter Inlet Aquatic Preserve. In 2009, NOAA awarded Martin County more than four million dollars in federal funding for the Oyster Reef Restoration Project as part of the American Recovery and Reinvestment Act of 2009. The project involved the placement of more than 30 million pounds of fossilized shell, limestone rock and recycled concrete rubble in the St. Lucie and Loxahatchee rivers. Martin County's latest project will add an additional four-acre oyster reef on the south side of the St. Lucie River, near downtown Stuart (Martin County, 2014).

The Nature Conservancy, in conjunction with NOAA, has been funding oyster restoration in the Mosquito Lagoon utilizing a protocol developed by the University of Central Florida. Since 2005, more than 42 reefs have been restored utilizing 18,000 volunteer hours. Restoration involves attaching individual oyster

shells to a mesh material which is anchored to the bottom of the lagoon. Currently, the Brevard Zoo is coordinating volunteer-based oyster restoration in the Mosquito Lagoon (Nature Conservancy, 2013).

IRLAP staff has assisted with the aforementioned oyster restoration projects whenever staff and resources are available. In 2013, IRLAP conducted a pilot oyster restoration project in conjunction with a SRP project at Bee Gum Point in IR-Malabar to Vero Beach Aquatic Preserve. The pilot project utilized oyster shell for cultch obtained from the Brevard Zoo. Eighty individual natural fiber coir bags were filled with approximately five gallons of oyster shell each and subsequently staked to the lagoon bottom and tied to adjacent bags. Approved funding for the SRP includes establishment of an additional oyster reef during 2014. The goal is to use oyster reefs in order to increase the stability of eroding shorelines and offer protection to planted project sites. Pending permit approval, an oyster reef will be placed waterward of a new or existing SRP site. The size and exact location of the reef will be site specific. Discarded oyster shells are being collected weekly by IRLAP staff from area seafood restaurants and amassed at the St. Sebastian River Preserve State Park field office for future projects. IRLAP staff are also researching cost-effective sources for fiber coir bags suitable for oyster restoration.

Indian River County is in the process of permitting a pilot oyster restoration project in IR-Malabar to Vero Beach Aquatic Preserve. The quarter-acre oyster reef pilot project will be located in the lagoon near Spoonbill Marsh, a manmade wetland designed to treat brine from the county's reverse-osmosis plant. The proposed reef will consist of wire mesh placed on the lagoon floor, held in place by concrete rubble recycled from construction projects (personal communication, V. Burke, August 2013).

Seagrass Transplanting

SJRWMD is overseeing work by Florida Atlantic University and Sebastian Inlet District scientists investigating the suitability of transplanting seagrass. The project's intention is two-fold: to evaluate why seagrass is not returning to areas where water quality is supportive; and to assess if transplanting seagrass is a viable option for recruiting and expanding grass beds in denuded areas of the lagoon. This is only a pilot study, with four recipient transplanting sites in the IR-Malabar to Vero Beach Aquatic Preserve, near the Sebastian Inlet and in Wabasso. In July 2013, each site received 30

IRLAP's Shoreline Restoration Project aims to stabilize eroding shorelines along the IRL and spoil islands by planting native vegetation. These two photos are of the same site before planting and 18 months after restoration.

IRLAP staff collects and quarantines donated oyster shell from local restaurants to be used in oyster reef restoration projects.

As part of the Shoreline Restoration Project, IRLAP staff conducts projects to stabilize eroding shorelines. Oyster reef restoration helps to attenuate wave action, provide habitat, and protect coastal plantings.

post-hole digger size plugs of shoal grass harvested outside of the aquatic preserve boundaries in the City of Vero Beach. After transplanting, the plan includes monitoring of the sites for two years to assess the survival, health, and rate of transplant growth/spread, which is critical for determining recovery potential (personal communication, T. Rice, July 2013). A final report of the entire project will include conclusions regarding the feasibility of planting seagrass as a large-scale recovery strategy.

Upcoming Restoration Projects

In 2013, eight projects designed to benefit the IRL ecosystem (see Table 10) have been approved for implementation as part of a multi-agency initiative administered by SFWMD. The projects were set to begin in the summer of 2013 and will deliver benefits that include salt marsh restoration, reduced estuary sediments and water quality improvement (SFWMD, 2013).

Recipient	Project
St. Lucie County	Harbor Branch Preserve project to restore tidal flow to 178-acre salt marsh
Fort Pierce Farms Water Control District	Canal 1 and 4 stormwater retrofit and erosion protection
Treasure Coast Resource Conservation and Development Council	Heathcote Park/Virginia Avenue Canal stormwater retrofit to implement Best Management Practices
Florida Oceanographic Society	Establish the Florida Oceanographic Coastal Center site for seagrass health monitoring
University of Florida/Institute of Food and Agricultural Sciences	Research nitrogen and phosphorus transport from agricultural fields to Indian River Lagoon
St. Lucie County	Research on beneficial use of muck sediment from St. Lucie County waterways
Groveland Utilities Public/Private Partnership	Grove Land Reservoir and Stormwater Treatment Area feasibility study
Florida Tech./Marine Resource Council	Collection of fertilizer nutrient data in Martin and St. Lucie counties

Table 10 | South Florida Water Management District 2013 Indian River Lagoon ecosystem projects.

Issue I / ***Water Quality*** (Continued from Water Quality issue in Ecosystem Science section.)

Goal 1 / Maintain and improve water quality within and entering the IRL System to meet the needs of the natural resources. (Continued from same goal in Ecosystem Science section.)

Objective 1.2 / Protect natural resources by restoring altered areas that contribute to reduced water quality within the IRL System.

Integrated Strategies:

1.2.1 / **Stabilize eroding shorelines using natural materials and appropriate native plants.** Aquatic preserve staff implement projects to reduce shoreline erosion through the SRP. Shoreline stabilization includes planting submergent and emergent vegetation followed by quarterly monitoring. An annual progress report is prepared for each stabilization site. This recurring strategy was initiated FY 1995 - 1996.

Performance Measures:
1. Track the number of implemented shoreline stabilization projects.
2. Produce annual progress reports.

1.2.2 / **Restore and establish oyster reef structure and function using natural, biodegradable materials.** Oyster reef restoration projects are being conducted throughout much of the IRL System by a variety of agencies and non-profit groups. One exception is Indian River County including portions of the IR-Malabar to Vero Beach and IR-Vero Beach to Ft. Pierce Inlet aquatic preserves. IRLAP staff will concentrate on implementing oyster restoration projects within Indian River County. FCO will support the use of natural oyster shell and natural biodegradable bags. This recurring strategy was initiated FY 2012 - 2013.

Performance Measure:
1. Produce annual progress reports that indicate the success of the project (for a minimum of three years).

1.2.3 / **Support restoration efforts that will promote reestablishment of submerged grasses.** Since 2009, there have been declines in seagrass coverage throughout the IRL System. Rates of seagrass loss are as high as 90 percent in northern portions of the IRL System. Supporting plans, including the IRL SWIM, IRL CCMP, and BMAPs, identify the need to improve water quality for the benefit of seagrasses. Current IRL System targets include expansion of seagrass beds to cover a minimum of 90 percent of historical levels. This recurring strategy was initiated FY 2002 – 2003

Performance Measure:
1. Compose letters of support, meeting summaries or active participation in water quality improvement projects within the IRL System and its watershed.

1.2.4 / **Support efforts to reconnect artificially isolated floodplain habitat (mosquito impoundments).** While many of the mosquito impoundments in the IRL System have been reconnected to the IRL System, there still remain isolated impoundments, mostly in private ownership. Furthermore, many reconnected impoundments still require restoration. St. Lucie County recently received funding to restore tidal flow to a 178-acre salt marsh adjacent to Harbor Branch. This recurring strategy was initiated FY 2002 - 2003.

Performance Measure:
1. Compose letters of support, meeting summaries or active participation in mosquito impoundment projects within the IRL System.

1.2.5 / **Support muck removal projects within the IRL System where appropriate.** Muck removal has the potential to improve water quality conditions and promote establishment and growth of oysters and seagrass. At the same time, muck removal has the potential to reintroduce legacy pollutant concentrations into the water column if not properly controlled. IRLAP staff will draft letters of support to agencies for removal of muck within the IRL System. This recurring strategy was initiated FY 2008 – 2009.

Performance Measure:
1. Compose letters of support to agencies for removal of muck in the IRL System.

1.2.6 / **Actively support CERP efforts that will benefit the IRL System.** A major component of CERP addresses water deliveries to the IRL. Proposed projects include improvement of water quality and creation of habitat, such as oyster reefs, that will improve the quality of water located within the southern IRL System. Aquatic preserve staff will work with partners to support proposed projects by attending

meetings, providing comments and recommendations, and drafting letters of support for restoration projects. This recurring strategy was initiated FY 2004 - 2005.

Performance Measure:

1. Compose letters of support or active participation in restoration projects identified by CERP.

1.2.7 / **Encourage incorporation of restoration strategies into other protective plans for the IRL System.** Aquatic preserve staff will review and comment on: 1) CERP documents that affect the southern IRL System, 2) TMDL refinement and BMAP reiteration for the IRL System, 3) urban and BMP documents, 4) IRL CCMP revisions, 5) local comprehensive plan revisions for Brevard, Indian River, St. Lucie, Martin and Palm Beach counties, and 6) other relevant plans that may arise. This recurring strategy was initiated FY 2006 - 2007.

Performance Measure:

1. Respond with formal comments encouraging the incorporation of IRL System restoration into relevant protective plans.

Objective 1.3 / Coordinate with regulatory programs, local government and land owners to reduce the impacts from development in the watershed.

Integrated Strategies:

1.3.1 / **Review and provide recommendations for local comprehensive plans that address development adjacent to the IRL System.** Aquatic preserve management plans and local comprehensive plans should work synergistically to protect the IRL System. A list of scheduled comprehensive plan updates and recommendation letters supported by the IRL System management plan and other related plans will be drafted. This strategy requires additional staffing.

Performance Measure:

1. Produce recommendation letters for local comprehensive plans that support the IRL System management plan and other related plans.

1.3.2 / **Comment on permit applications for construction activities on sovereign submerged lands within the IRL System.** Comments on environmental resource permit applications for construction activities within the IRL System will be submitted to DEP and SFWMD regulatory staff. It is important that these comments suggest ways to minimize impacts to the preserve and support eco-friendly engineering designs. A maintained list of high priority projects that could help applicants meet the public interest requirements outlined in the Aquatic Preserve Rule (Chapter 18-20 F.A.C.) will also be provided to regulatory staff. This recurring strategy was initiated FY 1986 - 1987.

Performance Measures:

1. Submit written comments to regulatory staff that suggests ways to minimize impacts to the aquatic preserve.
2. Produce a maintained list of high priority projects that would help proposed activities meet the public interest requirements within the aquatic preserve.

1**.3.3** / **Recommend use of soft, living shorelines to decrease erosion and protect the water quality and resources within the IRL System.** Most hardened shorelines within the IRL System are devoid of aquatic vegetation which is important for absorbing wave energy, improving water quality and providing habitat for aquatic species and birds. Staff will create GIS maps that show the extent of hardened shorelines within the aquatic preserves (which requires additional staff) and draft recommendations for the use of living shorelines to riparian homeowners and regulatory staff when shoreline erosion is a concern. If a structure is unavoidable, the use of upland retaining walls that use best management practices with the goal of establishing dense emergent vegetation planted on the seaward side to help provide the energy absorption, water quality and habitat benefits offered by unaltered shorelines will be supported. This recurring strategy was initiated FY 2013 - 2014.

Performance Measure:

1. Submit letters of recommendation for the use of living shorelines within the IRL System to riparian homeowners and regulatory staff.

Objective 1.4 / Reduce water quality impacts caused by stormwater and septic system sources within the IRL System watershed.

Integrated Strategies:

1.4.1 / **Encourage local governments to convert high priority areas to sewer**. HBOI is currently fingerprinting nutrient sources, including septic tanks, in the IRL System. IRLAP staff will coordinate with HBOI and local public health officials to identify high priority areas for conversion from septic to sewer,

document limiting factors that could prevent conversion, and help find solutions. This strategy requires additional staffing.

Performance Measures:

1. Identify high priority areas for conversion to sewer.
2. Provide summaries from meetings with local and state regulatory staff to discuss the need to convert high priority areas to sewer.

1.4.2 / **Support projects to enhance stormwater and sewage treatment in the IRL System.** In order to meet TMDLs in the newly adopted BMAPs, county and local municipalities will be implementing numerous stormwater and wastewater retrofits throughout the IRL Basin. This recurring strategy was initiated in FY 2013 - 2014.

Performance Measure:

1. Produce letters of support or active participation in stormwater and wastewater retrofits to meet TMDLs.

1.4.3 / **Support BMAPs including TMDLs and BMPs.** BMAPs have been adopted for the central IRL and the St. Lucie Estuary. TMDLs continue to be refined. BMPs are continually developed to control the impacts of urban stormwater upon water resources. This recurring strategy was initiated FY 2011 - 2012.

Performance Measures:

1. Participate in BMAP meetings.
2. Maintain list of available agricultural and urban BMPs scientifically demonstrated to improve water quality in the IRL System.

Objective 1.5 / **Protect lands to conserve the water quality and natural resources of the IRL System.**

Integrated Strategy:

1.5.1 / **Support acquisition of lands that will have a direct benefit on the IRL System's resources**. A multi-agency team has identified and ranked undeveloped or minimally-developed private parcels for acquisition through the Blueway Project. Preserve staff will draft letters of support for land acquisition projects along the IRL System. This recurring strategy was initiated FY 2008 - 2009.

Performance Measure:

1. Provide letters of support for land acquisition projects along the IRL System.

Issue II / **Loss of Natural Community Function and Species Diversity.** (Continued from same issue in Ecosystem Science section).

Goal 1 / Implement management practices that maintain or improve viable habitats and populations within the IRL System. (Continued from same goal in Ecosystem Science section.)

Objective 1.4 / Develop and implement conservation and restoration projects for key natural communities and species based on the best available scientific data and information.

Integrated Strategies:

1.4.1 / **Continue and expand SRP.** IRLAP staff began managing the IRL NEP-funded SRP in 2008. Since then, IRLAP staff has expanded the program to include saltmarsh planting, oyster reef restoration, the Adopt-A-Mangrove program, as well as implementing additional scientific monitoring. Funding has been secured for FY 2013-2014. The IRL NEP grant requires a minimum of 200 square feet of shoreline planting with 900 hours of volunteer help, quarterly advisory meetings, and an annual report. This strategy was initiated FY 2007 - 2008 and is recurring (grant dependent).

Performance Measures:

1. Measure the square footage of shoreline planted.
2. Track the number of volunteer hours coordinated.
3. Conduct quarterly meetings.
4. Prepare an annual report.

1.4.2 / **Continue and expand spoil island enhancement through SIP.** Routine, spoil island enhancement is accomplished with the assistance of volunteers through the SIP. Enhancement activities include shoreline stabilization, shoreline planting, exotic species removal, upland planting, recreational enhancements, trail clearing and debris removal. This strategy was initiated FY 2000 – 2001 and is recurring (grant dependent).

IRLAP's Shoreline Restoration Project aims to stabilize eroding shorelines along the IRL and spoil islands by planting native vegetation. Sites such as this two year-old planting are monitored routinely for success.

Performance Measures:

1. Track the number of volunteer hours coordinated.
2. Prepare an annual report.

1.4.3 / **Continue and expand oyster restoration projects.** IRLAP staff completed an oyster restoration pilot project in FY 2012 - 2013. An additional oyster restoration project has been funded for completion in FY 2013 - 2014. IRLAP staff will focus on expanding oyster reef restoration projects, specifically in Indian River County. This strategy was initiated FY 2011 - 2012, and is recurring (dependent on funding).

Performance Measures:

1. Track the number of newly-constructed oyster reefs.
2. Produce annual reports including monitoring results.

Objective 1.5 / **Reduce the abundance and diversity of non-native species within the IRL System.**

Integrated Strategies:

1.5.1 / **Conduct routine exotic plant species removal through regularly scheduled spoil island work days.** An important component of the SIP is the control of exotic plant species, specifically Australian pine and Brazilian pepper. During regularly scheduled spoil island work days, IRLAP staff and volunteers cut-stump treat both species with herbicide. Brazilian pepper is stacked into burn piles and Australian pine is sectioned and split for use as firewood at spoil island campsites. This recurring strategy was initiated FY 2008 - 2009.

Performance Measure:

1. Conduct routine exotic species removal and track efforts.

1.5.2 / **Assist other agencies in controlling non-native species.** DEP and FWC are the lead agencies for control and eradication of many non-native plants and animals. IRLAP staff will work with government agencies, non-profit organizations, and community groups to identify, inform and implement eradication strategies for non-native species, especially priority non-native species. This recurring strategy will be initiated FY 2014 - 2015.

Performance Measure:

1. Track staff time dedicated to working with government agencies, non-profit organizations, and community groups to implement non-native plant and animal control strategies within the IRL System.

4.4 / The Education and Outreach Management Program

The Education and Outreach Management Program components are essential management tools used to increase public awareness and promote informed stewardship by local communities. Education programs include on and off-site education and training activities. These activities include: field studies for students and teachers; the development and distribution of media; the distribution of information at local events; the recruitment and management of volunteers; and, training workshops for local citizens and decision-makers. The design and implementation of education programs incorporates the strategic targeting of select audiences. These audiences include all ages and walks of life; however, each represents key stakeholders and decision-makers. These efforts by the Education and Outreach Program allow the aquatic preserve to build and maintain relationships and convey knowledge to the community; invaluable components to successful management.

4.4.1 / Status of Education and Outreach in the Indian River Lagoon System

Education and Outreach programs for the IRL System focus on creating stewards who educate and engage others as well as promote responsible natural resource use. The majority of the IRL System's Education and Outreach is currently in the form of volunteer coordination and outreach.

Educational tools for the IRL System include GIS maps of the aquatic preserves and the surrounding watershed, children's aquatic preserve coloring books, plant and animal species identification posters, PowerPoint presentations, and educational materials regarding specific resources within the aquatic preserve (e.g. manatees, seagrasses, oysters, mangroves). Although formal educational programs are not incorporated into the IRL System's management plan, it is important that preserve staff support environmental education centers by providing support staff, boats, technical assistance, and educational materials produced through the IRLAP program to increase local knowledge of the IRL System. The primary educational programs currently supported by IRLAP staff are the IRL Envirothon and SRP.

The IRL Envirothon, Inc. is a non-profit organization established in 1993 to bring local environmental education into regional (St. Lucie, Martin, Indian River, Okeechobee

Spoil Island SL3 underwent large scale enhancement in 2010. All exotic plants were removed, the island was replanted with native vegetation, and the campsites were refurbished.

Spoil Island SL3 as seen 35 months after the initial enhancement.

Outreach displays, like this kiosk being built by volunteers, help educate visitors about the importance of the IRL System.

and Brevard counties) middle and high school classrooms. The SRP includes education through brochures, workshops, and public events. In partnership with the Brevard Zoo, IRLAP staff hold Adopt-A-Mangrove workshops for the public four times a year. Surveys are conducted at each workshop to gauge the knowledge participants have of the IRL before and after the workshop. Results have shown that participants learned important and new information on the IRL ecosystem that they did not previously know (leading to better practices while being out on the IRL). Throughout the year, presentations are given to schools on the SRP and the importance of the IRL, leading to having school groups come out and volunteer for planting events, as well as growing mangroves on their own, which are then donated to the SRP for planting. The "A Guide to Growing Mangroves" brochure was completed in September 2012, and is distributed to the public at Adopt-A-Mangrove workshops, as well as public events. Both the brochure and the Adopt-A-Mangrove workshops promote personal behavior changes that benefit the IRL through educating volunteers and the public on the impact that their actions can have on the IRL ecosystem.

The primary outreach programs established under management of the IRLAP office have been SIP and SRP through the coordination of volunteers. Additionally, IRLAP staff regularly attends outreach events with thousands of attending visitors including Oyster Appreciation Day and EcoFair at the Brevard Zoo, Pelican Island Festival, and NatureFest. During the last year, presentations were given to Merritt Island High School students, Florida Institute of Technology's Coastal Mitigation and Restoration course (OCN5601), and the Archie Carr NWR Working Group. The SRP coordinator attends and presents at the annual IRL Symposium and Florida Academy of Sciences Conference.

The SIP outreach programs include:

Volunteer Island Enhancement Workdays - Eight workdays per year are coordinated by IRLAP staff from September through April, one of which coincides with the International Annual Coastal Cleanup. A variety of activities may take place during a typical enhancement workday: non-native vegetation removal, native vegetation plantings, shoreline restoration and stabilization, trash cleanup and construction and maintenance of public facilities (grills, picnic tables and fire pits). Both FCO and the Florida Inland Navigation District provide funding for these activities. Volunteer groups that participate include neighbors of the IRL System, commercial businesses, high school groups, church groups, non-profits and other government partners.

Eagle Scout Program - This component facilitates and encourages the youth-oriented leadership and responsibility of Boy Scouts. In order to earn the Eagle Scout rank, a Boy Scout must fulfill requirements in the areas of leadership, service and outdoor skills. SIP provides an ideal opportunity for Boy Scouts to take a leading role in the enhancement of the spoil islands, helping them to meet the requirements for the Eagle Scout rank. Eagle Scout projects have included establishment of trails, construction of picnic tables, installation of grills and fire rings, exotic plant removal and clearing and establishment of camping sites and platforms.

Adopt-A-Spoil Island Program - This program provides groups in the community the opportunity to initiate scheduled maintenance of one or more adopted islands. Maintenance consists of removing debris and litter four times per year and may include habitat restoration projects or public access improvements. One cleanup date coincides with the annual International Annual Coastal Cleanup held each September.

The SRP outreach programs include:

Shoreline Planting – IRLAP staff plant a minimum of 200 square meters of shoreline vegetation annually with the assistance of volunteers. During 2012, SRP planting events reached more than 800 individuals from the region. Organized groups ranging from five to 35 volunteers attended various workdays.

Plant Nursery - Nursery volunteer maintenance days are typically held the first Saturday of the month. The need for maintenance days varies by season. In January 2012, volunteers from Sebastian River High School demolished broken nursery tables, cleaned ponds, weeded potted plants, and organized nursery supplies. In March 2012, students from the University of South Carolina alternative spring break group rebuilt demolished nursery tables, and assisted with receiving the year's supply of saltmarsh grasses. Other tasks completed during nursery days consist of weeding, mowing and filling the ponds with water.

In addition to active, volunteer-based planting, monitoring, and nursery maintenance, the SRP focuses on other, creative means to inform the public about the importance of natural shoreline habitat along the IRL. In 2010, the SRP joined into a partnership with the Brevard Zoo to reach a more diverse audience. A mangrove fostering program was implemented through the partnership, and in 2012, 150 mangroves were fostered by community volunteers and later donated to the SRP Coastal Wetland Plant Nursery.

It is estimated that 50 percent of the SRP coordinator's time is dedicated to community involvement, education and outreach.

Signage – Aquatic preserve signage has been posted at high traffic areas including three boat ramps and four spoil islands. Boat ramps include Round Island and the North Causeway in IR-Vero Beach to Fort Pierce Aquatic Preserve and Jacyee Park in Jensen Beach to Jupiter Inlet Aquatic Preserve. Signage on spoil islands include BC47 in IR-Malabar to Vero Beach Aquatic Preserve and IR36, IR43 and SL3 in IR-Vero Beach to Ft. Pierce Aquatic Preserve. Signage within and at access points to the IRL System can be vastly improved. Currently, three of the 39 major access points have signage posted that indicates that (part of) the waterway is an aquatic preserve. Future efforts to construct and raise educational kiosks that inform users about the aquatic preserves are a high priority for aquatic preserve staff. Aquatic preserve staff will work with volunteers, Eagle Scouts and managers of each access point to build and raise additional educational kiosks. Because of the lack of signage at many of the public access points, some visitors are unaware that a large portion of the IRL is an aquatic preserve. To address this, aquatic preserve staff will continue to work with FWC Division of Law Enforcement Boating and Waterways section to install signage on channel markers that inform boaters that they are entering an aquatic preserve.

4.4.2 / ***Education and Outreach Issues***

Issue I / **Water Quality** (Continued from Water Quality issue in Resource Management section.)

Goal 1 / Maintain and improve water quality within and entering the IRL System to meet the needs of the natural resources (Continued from Water Quality goal in Resource Management section.)

Objective 1.6 / Increase public awareness about water quality issues within the IRL System. (Numbering continued from last Water Quality objective in Resource Management section.)

Integrated Strategies:

1.6.1 / **Prioritize, develop, and implement water quality improvement education programs within the IRL System.** With the adoption of BMAPs, associated TMDLs, and continued refinement of BMPs, there are well documented management practices which will facilitate achievement of load reduction goals. Educational programs designed to help the public understand and implement these practices will be developed. Additional staffing is required for this strategy.

Performance Measure:

1. Track the number of IRLAP initiated or co-sponsored education programs targeting the IRL System watersheds' stakeholders on the topic of pollution load reduction goals and BMPs.

Objective 1.7 / **Facilitate knowledge and understanding of how activities in the watershed impact the IRL System.**

Integrated Strategies:

1.7.1 / **Deliver presentations to promote knowledge and stewardship of the IRL System to adults, children and students.** A PowerPoint presentation will be created to highlight the progression of watershed alteration including residential development and drainage projects, current urban and agricultural practices, how these actions directly affect the health of the system, species that utilize the IRL System, and recommendations for IRL-friendly alternatives to traditional practices. Urban interest groups will be targeted through the Association of Homeowners' Associations in Brevard, Indian River, St. Lucie and Martin counties. Agricultural interests will be targeted through University of Florida's Institute of Food and Agricultural Sciences. Presentations will also be delivered to appropriate businesses, academic institutions and environmental groups. This strategy requires additional staff.

Performance Measure:

1. Track number of PowerPoint presentations delivered to homeowners associations, businesses, academic institutions and environmental groups.

Issue II / **Loss of Natural Community Function and Species Diversity** (Continued from Loss of Natural Community issue in Resource Management section.)

Goal 1 / Implement management practices that maintain or improve viable habitats and populations within the IRL System (Continued from Loss of Natural Community goal in Resource Management section.)

Spoil islands serve as a scenic respite for both locals and visitors to the Indian River Lagoon area.

Objective 1.6 / Provide hands-on habitat restoration volunteer opportunities within the IRL System to promote knowledge through personal interactions. (Numbering continued from last Loss of Natural Community objective in Resource Management section.)

Integrated Strategy:

1.6.1 / **Coordinate increased volunteer participation in SRP**. Historically, the SRP has been required to document a minimum of 800 volunteer hours associated with the project. For FY 2013 - 2014, 900 volunteer hours will be required. This integrated strategy is recurring, dependent on grant funding availability.

Performance Measure:

1. Document the number of volunteer hours.

1.6.2 / **Coordinate volunteer participation in SIP.** IRLAP staff hosts SIP workdays from September to April each year in which volunteers and workgroup members visit select recreation islands for maintenance and enhancement of sites. Typical tasks include removal of exotic plants, addition of native plants, shoreline stabilization, recreational enhancements, trail clearing, and debris removal. This recurring strategy was initiated FY 2008 - 2009.

Performance Measure:

1. Document the number of volunteer hours.

1.6.3 / **Support the establishment of the Spoil Island Ambassador Citizen Support Organization**. Several active volunteers have approached IRLAP and requested staff support for establishment of a citizen support organization (CSO). The goal of the Spoil Island Ambassador CSO would be established to 1) promote awareness of the Aquatic Preserve Program, specifically the SIP, 2) foster stewardship in the volunteers and members, and 3) assist IRLAP staff with implementing the Spoil Island Management Plan. This recurring project was initiated in FY 2013 - 2014 and will continue until the CSO is established.

Performance Measure:

1. Actively participate in establishment of the CSO.

4.5 / *The Public Use Management Program*

The Public Use Management Program addresses the delivery and management of public use opportunities at the preserve. The components of this program focus on providing the public recreational opportunities within the site's boundaries which are compatible with resource management objectives. The goal for public access management in FCO managed areas is to promote and manage public use of our preserves and reserves that supports the research, education, and stewardship mission of FCO.

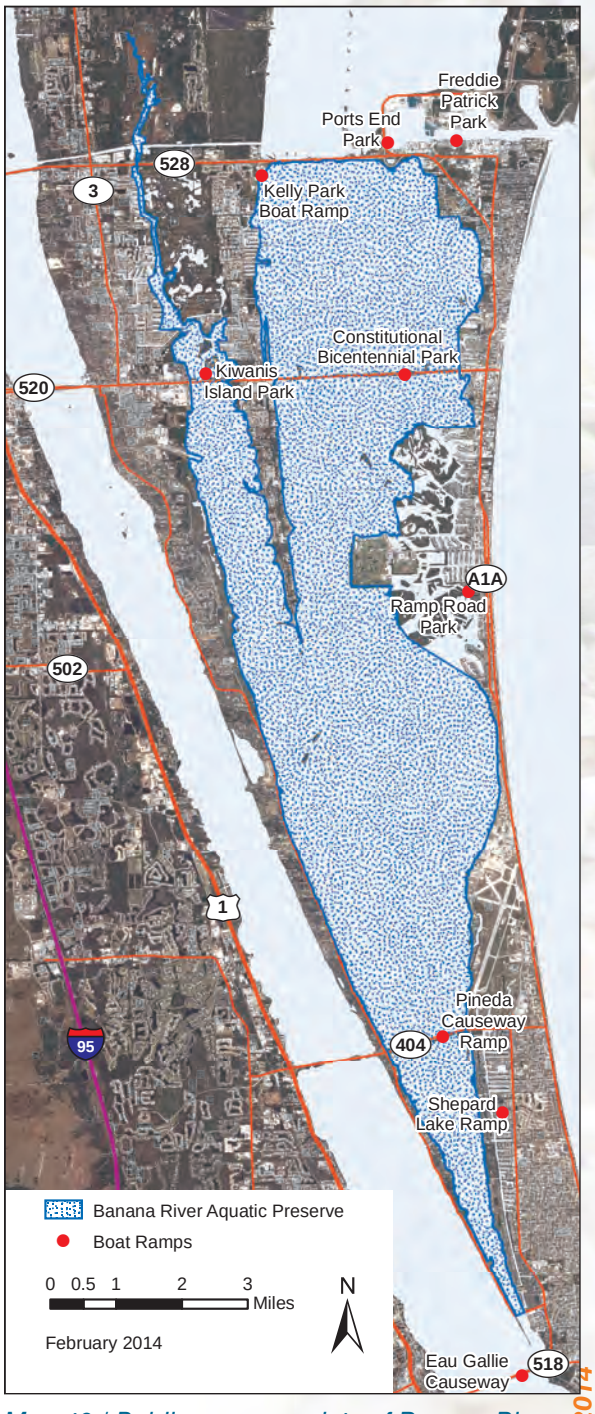
While access by the general public has always been a priority, the conservation of FCO's sites is the primary management concern for FCO. It is essential for staff to analyze existing public uses and define management strategies that balance these activities where compatible in a manner that protects natural, cultural and aesthetic resources. This requires gathering existing information on use, needs, and opportunities, as well as a thorough consideration of the existing and potential impacts to critical upland, wetland and submerged habitats. This includes the coordination of visitor program planning with social science research. One of FCO's critical management challenges during the next 10 years is balancing anticipated increases in public use with the need to ensure preservation of site resources. This section explains the history and current status of our Public Use efforts.

4.5.1 / *Status of Public Use in the IRL System*

One challenge for Florida's Aquatic Preserve Program is to promote sustainable use of the aquatic preserves while minimizing adverse user impacts to the natural resources. The success of government conservation programs is proportional to public support of those programs, and public support is most often derived from public use. Many users are not aware of how their daily activities impact preserve resources or other user groups. Therefore, many of the identified future needs within the Public Use Management Program overlap with that of the Education and Outreach Management Program.

Public Access

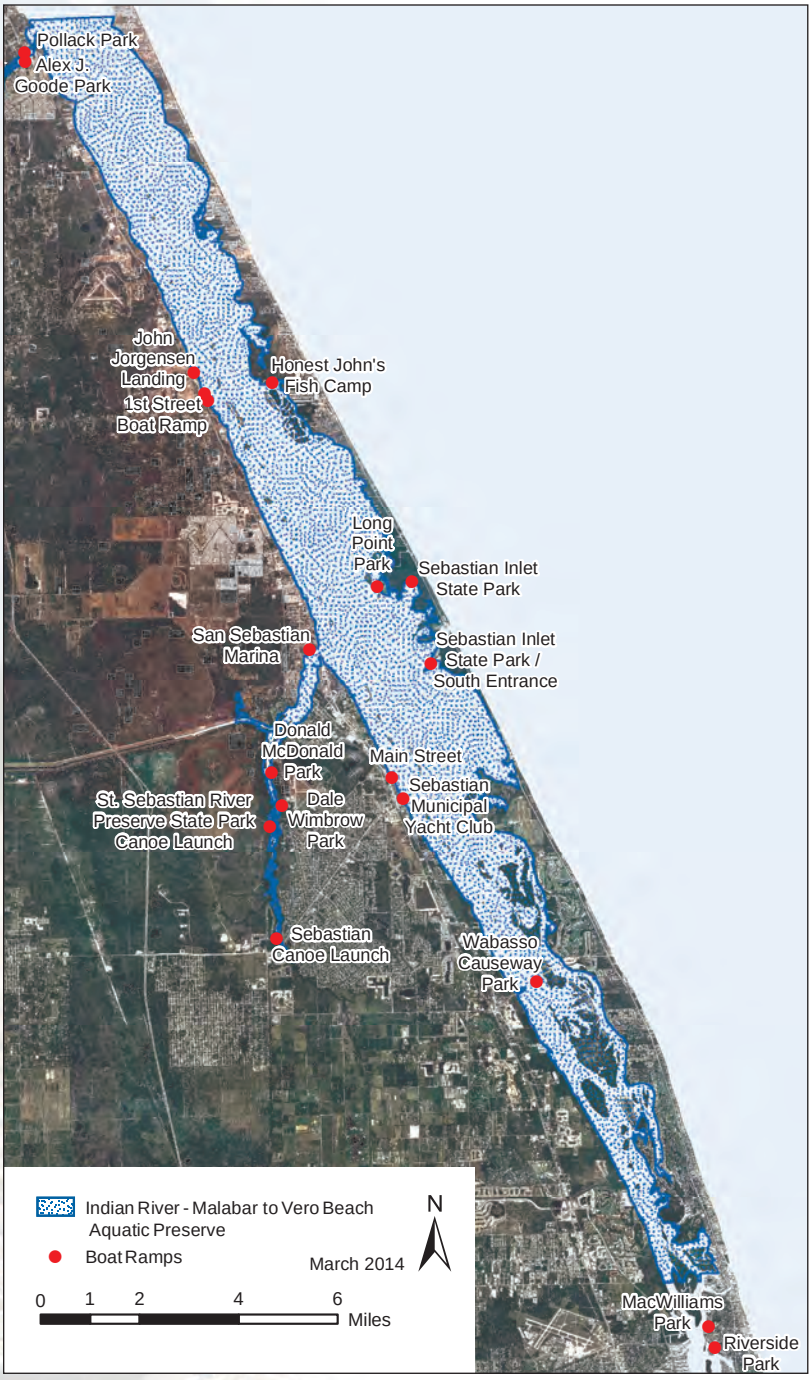
There are seven boat ramps in the vicinity of Banana River Aquatic Preserve, 15 boat ramps in the vicinity of IR-Malabar to Vero Beach Aquatic Preserve, eight boat ramps in the vicinity of IR-Vero Beach to Ft. Pierce Aquatic Preserve and eight boat ramps in the vicinity of Jensen Beach to Jupiter Inlet Aquatic Preserve. Public access is most restricted in Jensen Beach to Jupiter Inlet Aquatic Preserve. Despite the length of this aquatic preserve, the number of parks and boat ramps which provide direct public access is limited. FWC maintains an interactive website called *The Boat Ramp Finder* (http://myfwc.com/boating/boat-ramps-access). The website provides descriptive information, maps and photographs for hundreds of public boat ramps throughout Florida, including all publically and commercially maintained boat ramps in the IRL System.



Map 40 / Public access points of Banana River Aquatic Preserve.

Banana River Aquatic Preserve - Freddie Patrick Park and Kelly Park boat ramps are located on either side of the lagoon, just on the north side of State Road 528. Constitution Bicentennial Park and Kiwanis Island Park are located immediately north of State Road 520. Pineda Causeway, Sheppard Lake and Eau Gallie Causeway boat ramps provide easy access to the southern portion of the aquatic preserve.

Indian River-Malabar to Vero Beach Aquatic Preserve - In Palm Bay, boat ramps are located at Alex J. Goode Park and Pollack Park. John Jorgensen, Christenson's Landings and 1st Street Boat Ramp are located in Grant. The boat ramp at Honest John's Fish Camp is located on the west side of the aquatic preserve in Floridana. Long Point Park and Sebastian Inlet State Park also provide access to the east side of the aquatic preserve. In Sebastian, boat ramps are located at the east end of Main Street, the Sebastian Municipal Yacht Club and San Sebastian Marina. Those wishing to directly access the St. Sebastian River may do so at Dale Wimbrow and Donald MacDonald Park boat ramps. There is a canoe launch at the St. Sebastian River Buffer State Preserve. Further south, access to the aquatic preserve can be gained using boat ramps at the Wabasso Causeway, MacWilliams and Riverside Parks. Vessels travelling south in the Intracoastal Waterway (ICW) will encounter IR-Malabar to Vero Beach Aquatic Preserve near Channel Marker (CM) 13 and extending south to CM 135 near the Vero Beach City Marina.



Map 41 / Public access points of Indian River-Malabar to Vero Beach Aquatic Preserve.

Indian River- Vero Beach to Ft. Pierce Aquatic Preserve - Boat ramps at Oslo Road, Round Island and Village Marina provide access to the central portion of the aquatic preserve. Immediately south of the aquatic preserve, near the Ft. Pierce Inlet, boat ramps occur at Stan Blum, North Causeway Wayside, South Causeway Island Wayside, and Amphitheater Parks. A boat ramp is also located at Fisherman's Wharf. Vessels traveling south in the ICW will encounter IR-Vero Beach to Ft. Pierce Aquatic Preserve near Channel Marker 149 and extending south to the north U.S. Highway A1A draw bridge.

Jensen Beach to Jupiter Inlet Aquatic Preserve - Parks and boat ramps occur immediately north of the aquatic preserve near the Ft. Pierce Inlet (see IR-Vero Beach to Ft. Pierce Aquatic Preserve). In Jensen Beach, boat ramps are located at Jensen Beach North and South Causeway and Indian Riverside Parks. In Stuart, access to the aquatic preserve is available by boat ramps at Ocean Boulevard Causeway, Broward Street and Sandsprit parks. Jimmy Graham Park, in Hobe Sound has a boat ramp. Burt Reynolds Parks (East and West) both have boat ramps in Tequesta. Vessels travelling south in the ICW will encounter Jensen to Jupiter Inlet Aquatic Preserve at Channel Marker 189 and extending south to Channel Marker 1 where the ICW enters Jupiter Inlet.

Commercial Use (Consumptive)

Historically, public use of the IRL System has mainly been consumptive. Shellfish harvesting, fishing, and hunting game species were important consumptive uses from the beginnings of indigenous human occupation into the early 1900s. Lagoon waters were also the main travel corridor for early settlers. As

Species	County	Brevard	Indian River	St. Lucie	Martin
Mullet (black & silver)		281,993	66,471	138,747	144,406
Blue crab		389,795	13,495	70,249	4,439
Shrimp (white, brown & pink)		1,300,115	0	0	0
Clams		8,069	184	0	0
Oysters		288	0	0	0

Table 11 / Commercial harvest data (in pounds) of selected species for Brevard, Indian River, St. Lucie and Martin counties, 2012. Source: FWC - http://myfwc.com/media/2515025/sumcnty_12.pdf.

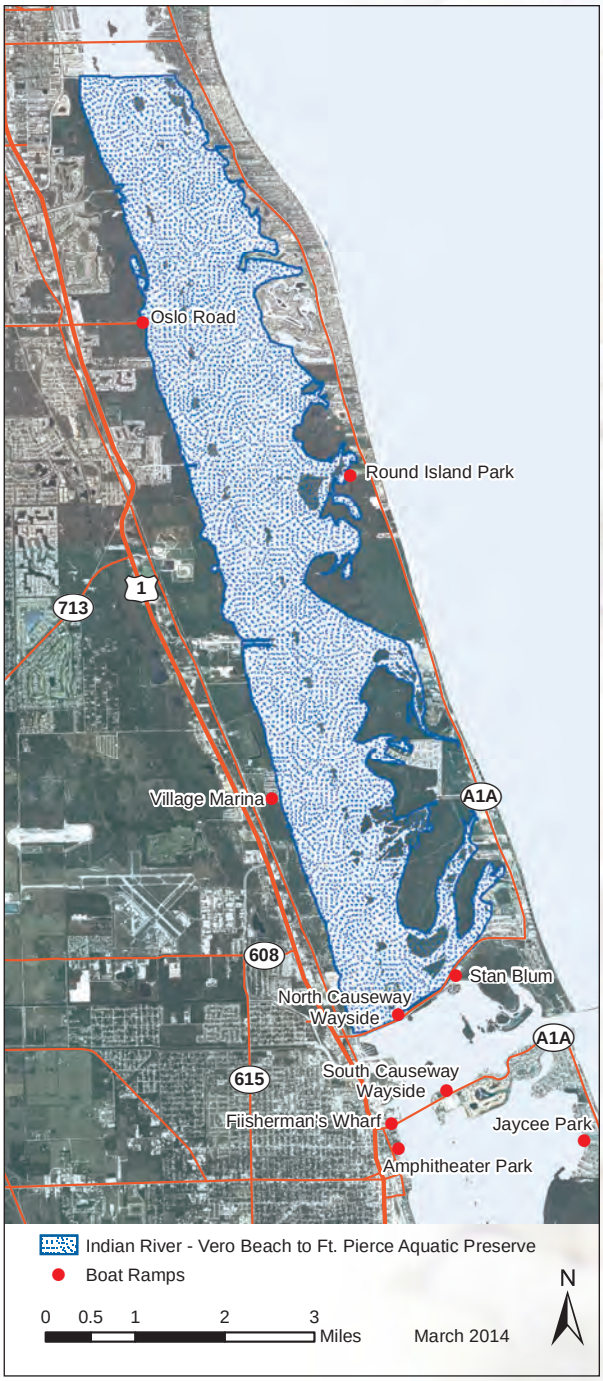
settlements grew, commercial uses of the lagoon became more important for harvest of seafood and transport of goods.

Important commercially-harvested marine species included shellfish, shrimp, and mullet. Commercial fishing continued as an important industry and component of the local economy until 1995 when the citizens of Florida passed a constitutional amendment banning the use of gill nets for commercial fishing. Commercial harvest of shrimp for food and bait, blue crab and cast-netting for mullet continue after the net ban; however, some harvest levels are greatly reduced. Statewide there were decreases in landings, numbers of fishermen and dockside value of fisheries after the net ban was in place (Smith et al., 1999).

There are several commercially-important aquatic species that spend at least a portion of their life cycle in the IRL System and are a significant source of revenue for the area. These include mullet (black and silver), blue crabs, shrimp (brown shrimp, pink shrimp, white shrimp), hard clams and oysters. Commercial harvest data of selected species for Brevard, Indian River, St. Lucie and Martin counties in 2012 are presented in Table 11.

Recreational Use

While somewhat dated, the last comprehensive study of recreational use in the IRL was conducted as part of the IRL Economic Assessment and Analysis Update for the IRL NEP (Hazen and Sawyer Environmental Engineers & Scientists, 2008). In 2007, residents and visitors to the five IRL counties totaled 10.9 million person-days. A person-day is one person participating in a recreation activity for all or part of one day. The most popular recreational activities are fin fishing, swimming or wading, and power boating. Other primary recreational activities include picnicking, canoeing or kayaking, and sailing. Less common recreational activities include birding, shrimping, shell fishing, parasailing and hunting. Estimated number of person-days spent in recreation activities on the IRL are presented in Table 12.



Map 42 / Public access points of Indian River-Vero Beach to Ft. Pierce Aquatic Preserve.

Fin fishing	3,985	37%
Power boating, including water skiing, tubing or cruising	1,380	13%
Picnicking	758	7%
Sailing on a boat	525	5%
Parasailing, windsurfing or kite sailing	197	2%
Waterfowl hunting	30	0.28%

Table 12 | Estimated number of person-days residents and visitors spent in recreation activities on the Indian River Lagoon in 2007. Source: Hazen and Sawyer Environmental Engineers & Scientists, 2008

The Indian River Lagoon is world renowned for its fishing opportunities.

Derelict vessels pose a hazard to the boating community and environment. IRLAP staff maintain a database of derelict vessels for removal as funding allows.

Future Public Use

Rapid population growth rates of coastal areas in Florida are expected to continue. Throughout the lifetime of this plan, decisions vital to the balance between sustainable resource protection and waterway management will need to be made by IRLAP managers working closely with other state entities and local governments. Mooring fields, live-aboards or anchorages pose few problems in the IRL System at present. With the ongoing trend of converting existing marinas to private use and the subsequent decrease in availability of wet slips, the movement of vessels into open water anchorages may increase. This could result in areas within the IRL System becoming unauthorized mooring fields. This trend could have additional impacts to the IRL System and adjacent waters due to the lack of marine sanitation device pumpout facilities, emergency clean-up capabilities and increased potential for derelict vessels.

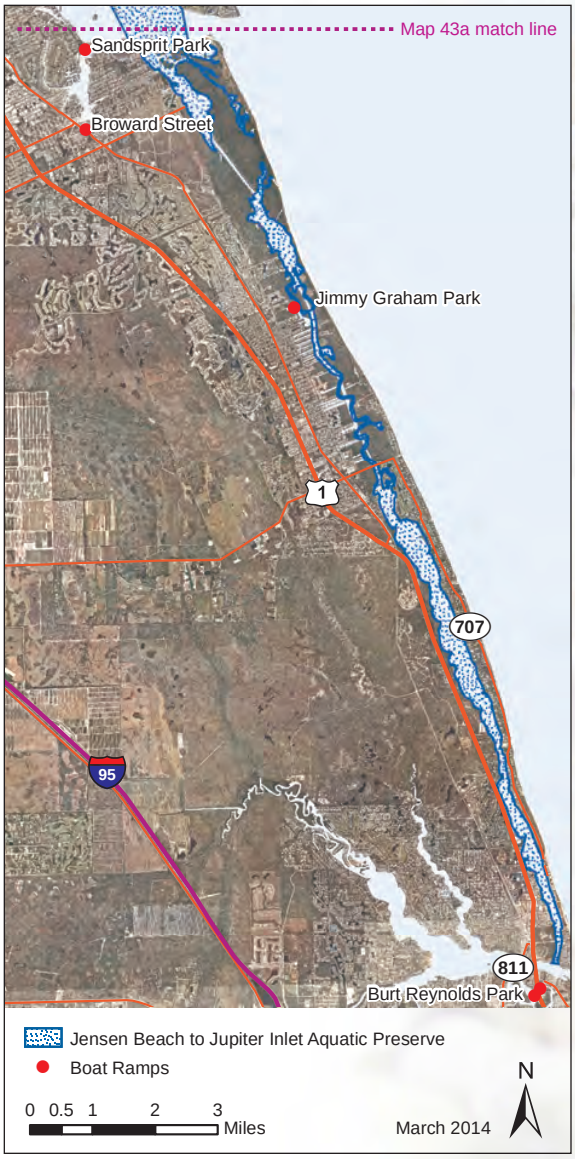
It is beneficial for staff to stay actively engaged in the local planning processes when new marine facilities such as boat ramps, marinas, mooring fields and similar siting decisions are being considered by local government and municipalities. IRLAP staff involvement early in planning processes for marine siting can aid local government by providing expertise in permitting requirements and result in less environmental impact to the IRL System. Efforts should be made to accommodate the small shallow-draft vessels historically used to access much of the IRL. However, providing increased public access or additional dredging through new marine facility siting may result in additional impacts to water quality and the valued habitats and resources found in the preserve. Facilities providing boater access, such as boat ramps and marinas, are portals to the IRL System and their impacts to the preserve and its resources

should be considered by local government and permitting agencies in the planning and permit review process for any new or expanded facilities.

Non-consumptive uses that could cause conflicts in the future include water based signage and advertising, commercial vending, movie production involving high speed activity or explosives, and boat races competing with the public for limited resources such as camping areas or boat launch sites. Existing state and FWC regulations may prohibit activities such as private advertising signs posted on or near the water (327.40 Florida Statute, 68D-23.101 Florida Administrative Code). Regulation of activities that can result in conflict or loss of enjoyment of other users should be considered.

Potential future uses should be considered when planning waterway management. In the IRL System, these future uses may include expansion of fishing (commercial and recreational), boating, and ecotourism and may also include a variety of new enterprises ranging from consumptive uses to the provision of various goods and services. Some of these future uses may not be consistent with the goals and objectives of the IRL System and may impact the resources that aquatic preserves were established to protect. Proactive planning, including setting aside areas within the IRL System where some categories of use are restricted or prohibited, may lessen future conflicts. Derelict vessels requiring removal continues, along with increased costs to natural resources due to spills, contaminants and debris.

Map 43a / Public access points of Jensen Beach to Jupiter Inlet Aquatic Preserve (north section).



Map 43b / Public access points of Jensen Beach to Jupiter Inlet Aquatic Preserve (south section).

*4.5.2 / **Public Use Issue***

Issue III / Sustainable Public Use

The IRL System is a popular destination for many recreational fishermen, boaters, kayakers, birders and a host of other user groups. The IRL System also supports several commercial uses including commercial fishing (fin fish and shellfish), fishing guides and several ecotourism operations. The aquatic preserves within the IRL System were designated for the primary purpose of preserving the biological resources in the area and maintaining these resources in an essentially natural condition for the benefit of future generations.

The main public use within the IRL System is water-dependent recreation activities: boating, commercial and recreational fishing, camping, sunbathing, nature-watching, swimming, clamming and oyster harvesting.

Perceived areas of concern identified at public meetings for future management of the IRL System include: [*to be included following public meetings*].

Projected commercial uses within the IRL System include: 1) expanded harvesting of resources by commercial fishing and shellfish harvesting; 2) increased or expanded commercial tourism such as fishing guides or ecotourism potentially resulting in crowding and conflicts at access points or disturbance to wildlife; and 3) increases in nontraditional uses such as vendors, crew rowing sculls, kite sailing and parasailing businesses (Hazen and Sawyer Environmental Engineers and Scientists, 2008). Proactive assessment and management of these activities is essential to ensure that they do not damage the sustainability of IRL System natural resources or impinge on the activities of traditional stakeholder groups.

By examining existing public use and natural resource patterns and trends, IRLAP staff can proactively identify potential conflicts and work with stakeholders to prioritize strategies to sustain a healthy ecosystem for the benefit of Florida residents and visitors. Ecological services derived from healthy ecosystems include aesthetics, water, food, carbon storage, storm buffers and pollution abatement that sustain human life and support social and economic prosperity (Turner, Brandon, Brooks, Constanza, Da Fonseca, & Portela, 2007). Raising public awareness for the valuable services that a healthy IRL provides is a priority objective to build stakeholder support to conserve and restore this important natural resource.

Campsites like this one provide a quiet escape.

Camp sites on spoil islands are created and maintained by volunteers through IRLAP hosted work days.

Goal 1 / Encourage user experiences and public recreation opportunities consistent with natural resources conservation.

Objective 1.1 / Inform local residents and visitors about actions they can take to conserve and restore resources of the IRL System.

Integrated Strategies:

1.1.1 / **Post educational signage at public access points.** Partnerships with public access managers will be formed to install educational kiosks at high-use public boat ramps within the IRL System. Aquatic preserve signage currently exists at only three public ramps. Informational and aesthetic displays that highlight spoil island designations as well as the ramifications improper use can have on fish and wildlife will be constructed at each of the high-use public boat ramps. Additional funding will be required. This strategy will be FY 2014 - 2015and last one year.

Performance Measure:

1. Display information about the Aquatic Preserve Program at high-use public boat ramps.

1.1.2 / **Coordinate community-based clean-up events in conjunction with the SIP.** Two community-based clean-up events are organized each year in the IRL System. The events are typically scheduled to coincide with International Coastal Clean-Up Day and National Estuaries Day. This recurring strategy will be initiated FY 2014.

Performance Measure:

1. Conduct two community-based clean-up events annually.

Objective 1.2 / Examine public use patterns and trends within the IRL System to proactively identify potential resource/public use conflicts and, working with key stakeholders, develop conservation strategies to minimize damage to the natural resources.

Integrated Strategies:

1.2.1 / **Develop and conduct spoil island user surveys**. In an effort to identify resource/public use conflicts and develop conservation strategies, IRLAP staff will create and implement a spoil island user survey. This recurring strategy was initiated FY 2012 - 2013.

Performance Measures:

1. Create and implement a spoil island user survey.
2. Produce annual summary reports.

1.2.2 / **Identify potential sites for designation as Critical Wildlife Areas**. Critical Wildlife Areas (CWAs) are established by FWC under a Florida Administrative Code rule to protect important wildlife concentrations from human disturbance during critical periods of their life cycles, such as nesting. For each CWA, the boundaries and periods of time when portions of the area may be posted and closed to entry by people are defined in the CWA establishment order. This strategy will be initiated FY 2014 and is recurring.

Performance Measure:

1. Identify potential CWAs.

Objective 1.3 / Encourage an increase in the amount and frequency of law enforcement and citizen patrol within the IRL System.

Integrated Strategy:

1.3.1 / **Facilitate regular communication with law enforcement for rapid response to illegal activities.** An annual meeting with local and state law enforcement officers will be organized to discuss speed limits, boater safety, derelict vessels, harassment or take of protected fish and wildlife, gill netting, mangrove impacts, user group conflicts, and other pertinent issues. Staff will produce quick-reference lists that identify local, state, and federal law enforcement points of contact in Brevard, Indian River, St. Lucie, Martin, and Palm Beach counties. This recurring strategy was initiated FY 2013 - 2014.

Performance Measures:

1. Produce meeting summaries.
2. Create and distribute quick-reference lists with points of contact for law enforcement.

Objective 1.4 / Promote low impact recreational opportunities.

Integrated Strategy:

1.4.1 / **Develop facilities on high use recreational spoil islands.** Recreation islands are identified as either “active” or “passive.” Active recreation islands are typically larger and may support overnight camping whereas passive recreation islands are smaller and are more suitable for picnicking. Facilities on high use active recreational spoil islands include picnic tables, grills, fire rings and tent platforms. This recurring strategy was initiated FY 2000.

Performance Measure:

1. Install appropriate facilities on high use recreational spoil islands.

Volunteers plant native grasses along the eroding shoreline of a spoil island.

Part Three

Additional Plans

Chapter Five

Administrative Plan

The mission of the Indian River Lagoon Aquatic Preserves (IRLAP) is to effectively implement the management plans for seven aquatic preserves under the charge of the Florida Coastal Office (FCO). These seven aquatic preserves are located within six adjacent counties and together total approximately 107,700 acres (436 km^2) of sovereign submerged lands extending a distance of more than 150 miles (241 km).

Through a community-based program, the field office strives to:

1. Implement FCO's programs consistent with all Florida Department of Environmental Protection (DEP) regulations, policies and procedures;
2. Accurately provide fiscal tracking;
3. Manage contracts and grants; and
4. Provide all pertinent information to the FCO Central Office in Tallahassee.

As of fiscal year (FY) 2013-2014 the IRLAP staff includes three full time equivalent (FTE) (permanent) positions and one full time Other Personal Services (OPS) position. The three FTE positions include: an Environmental Specialist III, serving as the aquatic preserve manager; an Environmental Specialist II overseeing education, volunteer coordination and the Spoil Island Project (SIP), and; an Environmental Specialist I supporting the resource management and monitoring programs. The full-time OPS position is funded through a grant and is responsible for implementing the Shoreline Restoration Project (SRP). One additional part-time, temporary, grant-funded OPS position supported the development of the management plan.

Having adequate staff is crucial to the success of the program. In order to accomplish the goals set out in this plan, the IRLAP must maintain a minimum of five positions. To attract and retain qualified and

dedicated staff, the full-time OPS position should be upgraded to FTE status. Maintaining sufficient support staff in the FCO Central Office to assist with grant management is also crucial to allow the aquatic preserves to take timely action on issues as they arise.

The IRLAP program maintains a program-wide planning horizon of five to 10 years. FCO has developed a three year budget and strategic work plan that addresses ongoing staffing needs by program area, a capital equipment replacement schedule and facility and program needs. Both the work plan and budget are revised on an annual basis. Equitable and dependable distribution of funding among the field offices is necessary to sustain FCO programs. Successful implementation of the strategies identified in this management plan will depend on consistent and appropriate level of funding to maintain staff.

To accomplish proper management of seven preserves, IRLAP staff rely on partners. The IRLAP has a Citizen Support Organization, the Friends of the St. Sebastian River, which assists staff and coordinates volunteers for various events. A strong citizen volunteer support group is also associated with the SIP and the SRP. A volunteer group was also formed from members of the IRL System Management Plan Advisory Committee. The IRL System Working Group consists of partners that share management responsibilities and similar management goals for areas which include one of the four aquatic preserves in the IRL System. These partners include private individuals and organizations, non-profits, and governmental agencies. A network approach incorporates the vast knowledge and experience that these partners possess, maximizing the effectiveness of limited programmatic resources to benefit the implementation of strategies identified within this plan. To carry out planned activities, staff is supplemented by regular partnership-based volunteer efforts. Successful implementation of the strategies identified in this plan depends on the dedication of working group members.

Recreation spoil islands provide many opportunities for residents and visitors to experience the Indian River Lagoon.

Chapter Six

Facilities Plan

Facilities - The Indian River Lagoon Aquatic Preserves' (IRLAP) primary field office is located in Ft. Pierce at the Miller-Wild tract, a subparcel managed by Savannas Preserve State Park. Office components consist of: one 1,456- square foot modular building with five offices, which was built in 2003 and has a design life of 30 years; three portable sheds purchased in 2001, 2002 and 2006, and; an open two-bay pole barn for boat storage built in 2004 that has a design life of 20 years. The office was not leveled properly when it was placed on the property in 2003. Due to this oversight, the sides of the office were settling and the building was separating down the ridge line. The office was relocated on-site in 2009 to remedy the situation, but it is unlikely that the building will meet the expected design life of 30 years.

The northern satellite field office is a 476 square foot modular building constructed in 1997 at St. Sebastian River Preserve State Park (SSRPSP) in Fellsmere and has been occupied by IRLAP staff since summer 2008. The state park has agreed to the use of a shared wet laboratory for calibrating water quality monitoring equipment located at the park's new SSRPSP Visitors Center. A 21-square foot chemical storage shed with cement pad and apron was constructed in 2006, near the modular office at SSRPSP. This structure with apron was designed to meet federal standards to retain potential chemical spills associated with herbicides. A second larger storage building was constructed in summer 2008 at the park to store materials and equipment for the Spoil Island Project (SIP).

A native plant nursery for the Shoreline Restoration Project (SRP) was rebuilt during 2008 at the southern entrance to SSRPSP in Indian River County. This nursery, manned by volunteers, reduces costs by growing and staging mangroves and other plants for the SRP and SIP restoration projects.

Future construction and maintenance needs include, but are not limited to:

1. regrade the dirt driveway to the compound in Ft. Pierce;
2. complete the open-air pole barn to include one enclosed bay;
3. repair and eventual replacement of the shingle roof on the pole barn;
4. maintain the septic tank and connect to St. Lucie County utilities when possible;
5. repair and replace well pump;

6. repair and replace central air and heating system;
7. maintain plumbing;
8. landscape (including stump grinding);
9. repair and eventual replacement of the three existing storage sheds;
11. vessel and vehicle replacement.

Vehicles and Vessels - As part of the program's strategic planning cycle, all vehicles and vessels in the program undergo routine inspection and maintenance by staff or an authorized vendor. The condition of all vehicles and vessels in the program are evaluated annually. The need to replace equipment is expected during the next ten years. The Florida Coastal Office is considering establishing a replacement-schedule policy based on vehicle mileage similar to other bureaus and divisions in the Florida Department of Environmental Protection. The annual cost for fuel and maintenance is approximately $1,000 for the four motorized vessels and $4,700 for the four vehicles. These costs are expected to increase with increasing cost of fuel and vessel and vehicle age.

Vessels and vessel functions:

19' Carolina Skiff with 115 horsepower Yamaha four-stroke engine - Acquired in 2001 for field work in shallow coastal waters within IRLAP. The Carolina Skiff has a wide (6 foot) beam and a side console which makes it an excellent vessel for hauling field equipment to monitoring and enhancement sites. The original 90 horsepower two-stroke mercury was replaced with the 115 Yamaha in 2008.

19' Twin Vee Bay Cat with 115 horsepower Yamaha four-stroke engine - Acquired in 2007 for field work in coastal waters in IRLAP and near shore reef environments within St. Lucie Inlet Preserve State Park.

18' Parker Center Console with 115 horsepower Mercury two-stroke engine – Acquired in 2001 for fieldwork throughout the Indian River Lagoon. The 115 horsepower two-stroke mercury engine has become unreliable and needs to be replaced as soon as funds are available.

11' Jon Boat with 15 horsepower Johnson four-stroke engine – Acquired in 2008 for support of the Shoreline Restoration Project and transporting equipment in narrow shallow waters.

Three kayaks, ranging in size from nine to ten feet – One acquired in 2006 and two acquired in 2013 for use in shallow or narrow waters.

Vehicles and vehicle functions:

GMC 3500 4x4 Dually Sierra (with winch) - Acquired in 2000 for boat towing and transfer of building supplies for the IRL SIP. The fuel efficiency of the GMC is poor and despite the low miles on the vehicle, it is unreliable and costly to maintain. At the beginning of 2014, the Sierra had 75,000 miles.

2007 Ford F-150, crew cab, 4x4 pickup (with topper) – Acquired in 2007 for IRLAP to transport up to four staff or volunteers, heavy equipment and/or towing boats. Used to support all programs, long-distance travel, training and coordination meetings (64,000 miles at the beginning of 2014).

Two 2002 Ford Explorers - Acquired in 2009 from Florida Fish and Wildlife Conservation Commission. One was acquired for IRLAP to transport up to four staff or volunteers, equipment and is used to support all programs, long-distance travel, training and coordination meetings (128,000 miles at the beginning of 2014). The other was acquired for the SRP (136,000 miles at the beginning of 2014).

Furniture and Office Equipment - Replacement of office furniture and other equipment such as cabinets, desks, and phones needs to occur as necessary. All fulltime staff were provided new computers in 2013 and 2014. A desktop was acquired for the office administrator and remains as a local data server to help offset the slow network connection, while field staff were provided laptops with docking capabilities at either office. The IRLAP staff shares a tablet computer for field data acquisition. This computer was also acquired in 2013.

Upon the approach of a hurricane, care of all vessels and vehicles of the aquatic preserve office will be secured following the procedures outlined in the IRLAP Hurricane Plan, which is updated annually.

List of Appendices

Appendix A

Legal Documents

*A.1 / **Aquatic Preserve Resolution***

WHEREAS, the State of Florida, by virtue of its sovereignty, is the owner of the beds of all navigable waters, salt and fresh, lying within its territory, with certain minor exceptions, and is also the owner of certain other lands derived from various sources; and

WHEREAS, title to these sovereignty and certain other lands has been vested by the Florida Legislature in the State of Florida Board of Trustees of the Internal Improvement Trust Fund, to be held, protected and managed for the long range benefit of the people of Florida; and

WHEREAS, the State of Florida Board of Trustees of the Internal Improvement Trust Fund, as a part of its overall management program for Florida's state-owned lands, does desire to insure the perpetual protection, preservation and public enjoyment of certain specific areas of exceptional quality and value by setting aside forever these certain areas as aquatic preserves or sanctuaries; and

WHEREAS, the ad hoc Florida Inter-Agency Advisory Committee on Submerged Land Management has selected through careful study and deliberation a number of specific areas of state—owned land having exceptional biological, aesthetic and scientific value, and has recommended to the State of Florida Board of Trustees of the Internal Improvement Trust Fund that these selected areas be officially recognized and established as the initial elements of a statewide system of aquatic preserves for Florida;

NOW, THEREFORE, BE IT RESOLVED by the State of Florida Board of Trustees of the Internal Improvement Trust Fund:

THAT it does hereby establish a statewide system of aquatic preserves as a means of protecting and preserving in perpetuity certain specially selected areas of state-owned land: and

THAT specifically described, individual areas of state-owned land may from time to time be established as aquatic preserves and included in the statewide system of aquatic preserves by separate resolution of the State of Florida Board of Trustees of the Internal Improvement Trust Fund; and

THAT the statewide system of aquatic preserves and all individual aquatic preserves established thereunder shall be administered and managed, either by the said State of Florida Board of Trustees of the Internal Improvement Trust Fund or its designee as may be specifically provided for in the establishing resolution for each individual aquatic preserve, in accordance with the following management policies and criteria:

(1) An aquatic preserve is intended to set aside an exceptional area of state-owned land and its associated waters for preservation essentially in their natural or existing condition by reasonable regulation of all human activity which might have an effect on the area.

(2) An aquatic preserve shall include only lands or water bottoms owned by the State of Florida, and such private lands or water bottoms as may be specifically authorized for inclusion by appropriate instrument from the owner. Any included lands or water bottoms to which a private ownership claim might subsequently be proved shall upon adjudication of private ownership be automatically excluded from the preserve, although such exclusion shall not preclude the State from attempting to negotiate an arrangement with the owner by which such lands or water bottoms might be again included within the preserve.

(3) No alteration of physical conditions within an aquatic preserve shall be permitted except: (a) minimum dredging and spoiling for authorized public navigation projects, or (b) other approved activity designed to enhance the quality or utility of the preserve itself. It is inherent in the concept of the aquatic preserve that, other than as contemplated above, there be: no dredging and filling to create land, no drilling of oil wells or excavation for shell or minerals, and no erection of structures on stilts or otherwise unless associated with authorized activity, within the confines of a preserve - to the extent these activities can be lawfully prevented.

(4) Specifically, there shall be no bulkhead lines set within an aquatic preserve. When the boundary of a preserve is intended to be the line of mean high water along a particular shoreline, any bulkhead line subsequently set for that shoreline will also be at the line of mean high water.

(5) All human activity within an aquatic preserve shall be subject to reasonable rules and regulations promulgated and enforced by the State of Florida Board of Trustees of the Internal Improvement Trust Fund and/or any other specifically designated managing agency Such rules and regulations shall not interfere unduly with lawful and traditional public uses of the area, such as fishing (both sport and commercial), hunting, boating, swimming and the like.

(6) Neither the establishment nor the management of an aquatic preserve shall infringe upon the lawful and traditional riparian rights o private property owners adjacent to a preserve. In furtherance of these

rights, reasonable improvement for ingress and egress, mosquito control, shore protection and similar purposes may be permitted by the State of Florida Board of Trustees of the Internal Improvement Trust Fund and other jurisdictional agencies, after review and formal concurrence by any specifically designated managing agency for the preserve in question.(7) Other uses of an aquatic preserve, or human activity within a preserve, although not originally contemplated, may be permitted by the State of Florida Board of Trustees of the Internal improvement Trust Fund and other jurisdictional agencies, but only after a formal finding of compatibility made by the said Trustees on the advice of any specifically designated managing agency for the preserve in question.

IN TESTIMONY WHEREOF, the Trustees for and on behalf of the State of Florida Board of Trustees of the Internal Improvement Trust Fund have hereunto subscribed their names and have caused the official seal of said State of Florida Board of Trustees of the Internal Improvement Trust Fund to be hereunto affixed, in the City of Tallahassee, Florida, on this the 24th day of November A. D. 1969.

CLAUDE R. KIRK, JR, Governor — TOM ADAMS, Secretary of State

EARL FAIRCLOTH, Attorney General — FRED O. DICKINSON, JR., Comptroller

BROWARD WILLIAMS, Treasurer — FLOYD T. CHRISTIAN, Commissioner of Education

DOYLE CONNER, Commissioner of Agriculture

As and Constituting the State of Florida Board of Trustees of the Internal Improvement Trust Fund

*A.2 / **Florida Statutes***

Florida Statutes, Chapter 253: State Lands
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0200-0299/0253/0253.html

Florida Statutes, Chapter 258: State Parks and Preserves
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0200-0299/0258/0258.html

Part II (Aquatic Preserves):
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&Search_String=&URL=0200-0299/0258/0258PARTIIContentsIndex.html

Florida Statutes, Chapter 259: Land Acquisitions for Conservation or Recreation
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0200-0299/0259/0259.html

Florida Statutes, Chapter 379: Fish and Wildlife Conservation
www.leg.state.fl.us/statutes/index.cfm?App_mode=Display_Statute&URL=0300-0399/0379/0379.html

Florida Statutes, Chapter 403: Environmental Control
(Statute authorizing DEP to create Outstanding Florida Waters is at 403.061(27))
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0400-0499/0403/0403.html

Florida Statutes, Chapter 597: Aquaculture
www.leg.state.fl.us/Statutes/index.cfm?App_mode=Display_Statute&URL=0500-0599/0597/0597.html

*A.3 / **Florida Administrative Codes***

Florida Administrative Code, Chapter 18-20: Florida Aquatic Preserves
www.dep.state.fl.us/legal/Rules/shared/18-20.pdf

Florida Administrative Code, Chapter 18-21: Sovereignty Submerged Lands Management
www.dep.state.fl.us/legal/Rules/shared/18-21.pdf

Florida Administrative Code, Chapter 62-302: Surface Water Quality Standards
(Rule designating Outstanding Florida Waters is at 62-302.700)
www.dep.state.fl.us/legal/Rules/shared/62-302/62-302.pdf

Martin County Spoil Island Dedication

TRUSTEES OF THE INTERNAL IMPROVEMENT FUND
OF THE STATE OF FLORIDA

DEDICATION

NO. 23810

KNOW ALL MEN BY THESE PRESENTS: That the Trustees of the Internal Improvement Fund of the State of Florida, in pursuance of authorization August 4, 1964, have dedicated, and by these presents do hereby dedicate, the following described sovereignty lands in Martin County, Florida, to-wit:

All of those islands created by the process of dredging navigation channels lying within Maintenance Spoil Areas M-1-A, M-1, M-2, and M-3, as heretofore granted by the Trustees of the Internal Improvement Fund to the United States of America, in Townships 37 and 38 South, Ranges 41 and 42 East, Martin County, Florida,

as and for public recreation and preservation of wildlife purposes, under the supervision and management of the Board of County Commissioners of Martin County, Florida.

SUBJECT, HOWEVER, to (1) all prior rights and easements granted to the United States of America, and (2) in the event the areas are to be used for spoil disposal purposes, the said County will be notified to vacate the premises and remove any improvements thereon which may interfere with such disposal operations, and any expense occasioned by such vacation of said premises to be the responsibility of said County.

IN TESTIMONY WHEREOF, the said Trustees have hereunto subscribed their names and affixed their seal and have caused the seal of the DEPARTMENT OF AGRICULTURE OF THE STATE OF FLORIDA to be hereunto affixed, at the Capitol, in the City of Tallahassee, on this the 24th day of August, A. D. 1964.

(SEAL)
Trustees I.I. Fund

(SEAL)
Dept. of Agri.

Governor (SEAL)

Comptroller (SEAL)

Treasurer (SEAL)

Attorney General (SEAL)

Commissioner of Agriculture (SEAL)

As and Constituting the Trustees of the Internal Improvement Fund of the State of Florida.

TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND
OF THE STATE OF FLORIDA

SECOND AMENDED LEASE NO. 310023304

THIS AGREEMENT, being an amended lease of the lease dated February 5, 1993, which was an extension of the lease dated May 23, 1968, by and between the BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND OF THE STATE OF FLORIDA hereinafter referred to as the TRUSTEES, their successors and assigns, and the UNITED STATES OF AMERICA, DEPARTMENT OF THE INTERIOR, FISH AND WILDLIFE SERVICE, acting by and through the Secretary of the Interior or his authorized representative, hereinafter referred to as the SERVICE;

WITNESSETH:

1. In consideration of the mutual benefits hereinafter specified, the Trustees by these presents do hereby demise and lease unto the Service, subject to the provisions hereinafter set forth, all of the lands and waters owned by them situate and being in the County of Indian River, Florida, which lie within the following described area:

T. 30 and 31 S., R. 39 E., TALLAHASSEE MERIDIAN:

Beginning at a point in the Indian River on the east right-of-way boundary line of the Intracoastal Waterway, opposite the first navigation light north of the causeway leading from Wabasso to Wabasso Beach, Indian River County Road 510; thence northwesterly with the east right-of-way line of the Intracoastal Waterway, a distance of 34,632 feet to a point opposite the navigation light which is located 3,331 feet southeasterly of the Indian River-Brevard County; thence due East, approximately 9,800 feet to a point in the bulkhead line established in 1963; thence with the same, S. 25° 14' 51'' E., approximately 9,200 feet to a pipe on the eastern shoreline of Indian River, at its intersection with the township line between T. 30 and 31 S., R. 39 E., being 1,216 feet west of the corner common to Sections 33, 34, 3 and 4, respectively, of said townships; thence with the bulkhead line approved in 1958, with, in order, the east shoreline of Indian River, a northerly extension of the line common to Government Lots 4 and 5, Section 4, T. 31 S., R. 39 E., (as shown on a plat titled "Township 31 South, Range 39 East, of the Tallahassee Meridian, Florida, Dependent Resurvey, Extension Survey and Survey of Islands, Sections 4, 5, 8, 9, and 10, prepared by the United States Department of the Interior, Bureau of Land Management, and dated March 29, 1968.) to its intersection with the south shore of Big Slough, then continuing southerly with the east shoreline of Indian River, the shoreline of Collins Hole, the east shoreline of Turtle Pen Slough, the east shoreline of Spratt Creek, and the east shoreline of East Channel to a point which is N. 45° E., approximately 560 feet from the point on the easterly right-of-way boundary line of the Intracoastal Waterway, heretofore described as the Point of Beginning; thence S. 45° W., 560 feet to the Point of Beginning. The above described tract contains 4,640 acres, more or less.

T. 31 S., R. 39 E., TALLAHASSEE MERIDIAN:

All of the lands located west of the 1859 meander line as depicted on the plat approved by the United States Department of the Interior, Bureau of Land Management on March 29, 1968, titled Township 31 South, Range 39 East, of the Tallahassee Meridian, Florida, Dependent Resurvey, Extension Survey and Survey of Islands, sections 4, 5, 8, 9, and 10.

Said land is more particularly described as:

Lots 7, 9, 12, and 14 of section 4.

Lots 4, 5, 8, and the northeast one-quarter of the northwest one-quarter of section 9.

The above described area, being shallow bay bottoms, spoil islands, and mangrove islands, is delineated on attached map Exhibit A.

LESS AND EXCEPT THE FOLLOWING DESCRIBED PARCELS:

PARCEL "A"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 5457.73 feet; thence S 89° 46' 44'' W, a distance of 8065.55 feet to the Point-of-Beginning; thence S 03° 38' 48'' E, a distance of 290.11 feet; thence S 86° 21' 12'' W, a distance of 1000.00 feet; thence N 03° 38' 48'' W, a distance of 290.11 feet; thence N 86° 21' 12'' E, a distance of 1000.00 feet to the Point-of-Beginning. Containing 6.66 acres, more or less;

PARCEL "B"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 5143.18 feet; thence S 89° 46' 44'' W, a distance of 8045.40 feet to the Point-of-Beginning; thence S 03° 38' 48'' E, a distance of 217.80 feet; thence S 86° 21' 12'' W, a distance of 1000.00 feet; thence N 03° 38' 48'' W, a distance of 217.80 feet; thence N 86° 21' 12'' E, a distance of 1000.00 feet to the Point-of-Beginning. Containing 5.00 acres, more or less;

PARCEL "C"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 4900.81 feet; thence S 89° 46' 44'' W, a distance of 8029.87 feet to the Point-of-Beginning; thence S 03° 38' 48'' E, a distance of 217.80 feet; thence S 86° 21' 12'' W, a distance of 1000.00 feet; thence N 03° 38' 48'' W, a distance of 217.80 feet; thence N 86° 21' 12'' E, a distance of 1000.00 feet to the Point-of-Beginning. Containing 5.00 acres, more or less;

PARCEL "D"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 4658.44 feet; thence S 89° 46' 44'' W, a distance of 8014.35 feet to the Point-of-Beginning; thence S 03° 38' 48'' E, a distance of 217.80 feet; thence S 86° 21' 12'' W, a distance of 1000.00 feet; thence N 03° 38' 48'' W, a distance of 217.80 feet; thence N 86° 21' 12'' E, a distance of 1000.00 feet to the Point-of-Beginning. Containing 5.00 acres, more or less;

PARCEL "E"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 5495.08 feet; thence S 89° 46' 44'' W, a distance of 7441.82 feet to the Point-of-Beginning; thence S 05° 11' 48'' E, a distance of 500.32 feet; thence S 60° 18' 22'' W, a distance of 682.89 feet; thence N 03° 38' 48'' W, a distance of 800.00 feet; thence N 86° 21' 11'' E, a distance of 600.00 feet to the Point-of-Beginning. Containing 9.078 acres, more or less;

PARCEL "F"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida and being more particularly described as follows: commence at the Southeast corner of Section 4, said Township and Range; thence N 0° 01' 11'' E, along the east line of said Section, a distance of 5622.13 feet; thence N 89° 46' 44'' W, a distance of 5469.68 feet to the Point-of-Beginning; thence S 07° 33' 49'' W, a distance of 433.67 feet; thence S 86° 22' 30'' W, a distance of 1369.40 feet; thence N 55° 09' 09'' W, a distance of 668.25 feet; thence N 86° 05' 40'' E, a distance of 1976.75 feet to the Point-of-Beginning. Containing 16.179 acres, more or less;

PARCEL "G"

A parcel of submerged land lying in the Indian River, Section 5, Township 31 South, Range 39 East, and Section 32, Township 30 South, Range 39 East, Tallahassee Base Meridian, Indian River County, Florida, and being more particularly described as the submerged lands lying within the polygon beginning at the northeast corner at 27° 49' 56" N, and 80° 49' 42" W, commencing south to the southeast corner at 27° 49' 44" N and 80° 26' 42" W, commencing west to the southwest corner at 27° 49' 39" N and 80° 27' 33" W, commencing north to the northwest corner at 27° 49' 54" N and 80° 27' 34" W, and commencing east to the point of beginning. Containing about 90 acres more or less.

The above described areas are delineated on Exhibit B.

2. The lands are subject to the following:

a. Easements, if any, for all roads, drainage ditches, and public utilities as may now be located on and across the premises.

b. The reservation by the Trustees of oil, gas and other mineral, together with the necessary rights of ingress and egress to explore for, mine, drill, and produce oil, gas, and other mineral resources.

3. The following terms and conditions shall govern the lease of said land and water areas as hereinbefore provided:

a. The said lease shall be for a 25-year period, commencing February 5, 1993, and shall expire on February 4, 2018, with option for renewal for an additional period of 25 years upon written agreement of both parties.

b. The consideration for this lease shall be the mutual benefits to be derived from the protection of fish and wildlife resources.

c. All facilities and appurtenances thereunto belonging placed on the land heretofore described and necessary to the exercise of the privileges granted by this lease shall remain the property of the Service and it shall have the privilege of removing same within 90 days after the termination of this lease, then the said facilities shall become the property of the Trustees.

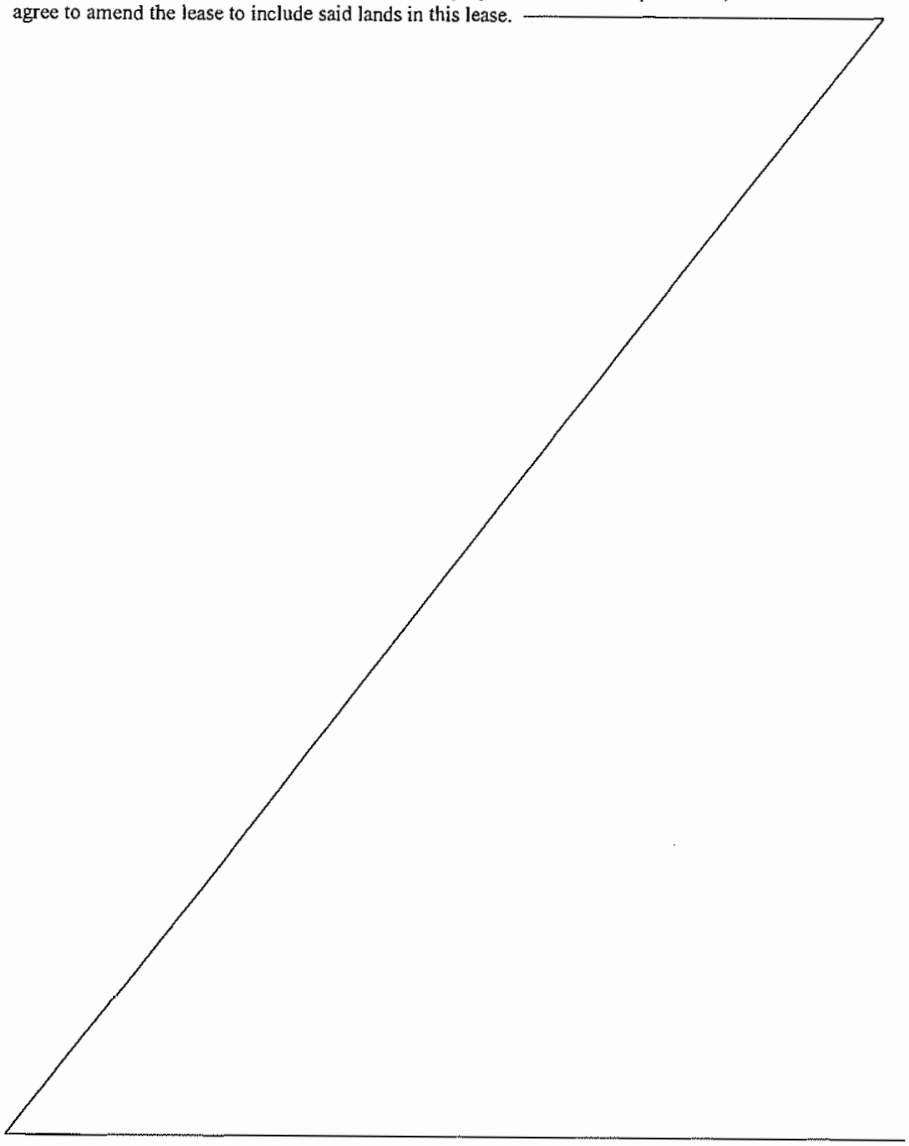
4. The said land and water areas shall be administered as part of the National Wildlife Refuge System. The right of the public to use the area for traditional navigation, boating, bathing, shell fishing, and commercial and sport fishing shall not be restricted, with the exception of a 410 foot buffer zone surrounding Pelican Island (Government Lot 3, Township 31 South, Range 39 East, Indian River County). This buffer zone is measured from the mean high water line of said Island and extending out into the Indian River.

5. The rights granted herein shall not infringe upon the valid riparian rights of adjacent private landowners including rights of access and navigation, as provided by applicable state laws and regulations.

6. It is further mutually agreed that no Member of or Delegate to Congress, or Resident Commissioner, after his election or appointment and either before or after he has qualified and during his continuance in office, shall be admitted to any share or part of this contract or agreement, or to any benefit to arise thereupon. Nothing, however, herein contained shall be construed to extend to any incorporated company, where such contract or agreement is made for the general benefit of such incorporation or company. (Section 3741, Revised Statutes, and Sections 114, 116, Act of March 4, 1919.)

7. That this contract shall not be assigned in whole or part without the written consent of the Trustees.

8. If the sovereignty submerged lands that have been less and excepted from paragraph (1) of this lease are no longer being used for the intended purpose of shellfish aquaculture, then the Trustees agree to amend the lease to include said lands in this lease.



IN WITNESS WHEREOF, the parties have caused this lease to be executed the day and year first above written.

WITNESSES:

Frank Votra
Original Signature

Frank Votra
Print/Type of Witness

M. Sue Jones
Original Signature

M. Sue Jones
Print/Type Name of Witness

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND OF THE STATE OF FLORIDA

(SEAL)

BY: Kirby B. Green III
Kirby B. Green III, Deputy Secretary, Department of Environmental Protection, as agent for and on behalf of the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida

"LESSOR"

STATE OF FLORIDA
COUNTY OF LEON

The foregoing instrument was acknowledged before me this 8th day of March, 2000 by Kirby B. Green III, Deputy Secretary, Department of Environmental Protection, as agent for and on behalf of the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida. He is personally known to me.

APPROVED AS TO FORM AND LEGALITY:

Sam. Hebi
DEP Attorney

Bobbie Rednour
Notary Public, State of Florida

Bobbie Rednour
Printed, Typed or Stamped Name

MY COMMISSION # CC809172 EXPIRES February 14, 2003 BONDED THRU TROY FAIN INSURANCE, INC.

My Commission Expires:

Commission/Serial No.

WITNESSES:

Ann J. Feltner
Original Signature

Anna L. Feltner
Typed/Printed Name of Witness

Christine Hewitt
Original Signature

Christine Hewitt
Typed/Printed Name of Witness

STATE OF Georgia

COUNTY OF Dekalb

The United States of America, Department of the Interior, Fish and Wildlife Service (SEAL)

BY Sam D. Hamilton
Original Signature of Executing Authority

Sam D. Hamilton

Regional Director, Southeast Region
Title of Executing Authority

"LESSSEE"

The foregoing instrument was acknowledged before me this 23rd day of February, 2000, by Sam D. Hamilton, as Regional Director, Southeast Region, for and on behalf of The United States of America, Department of the Interior, Fish and Wildlife Service. He is personally known to me ~~or who has produced _____, as identification~~.

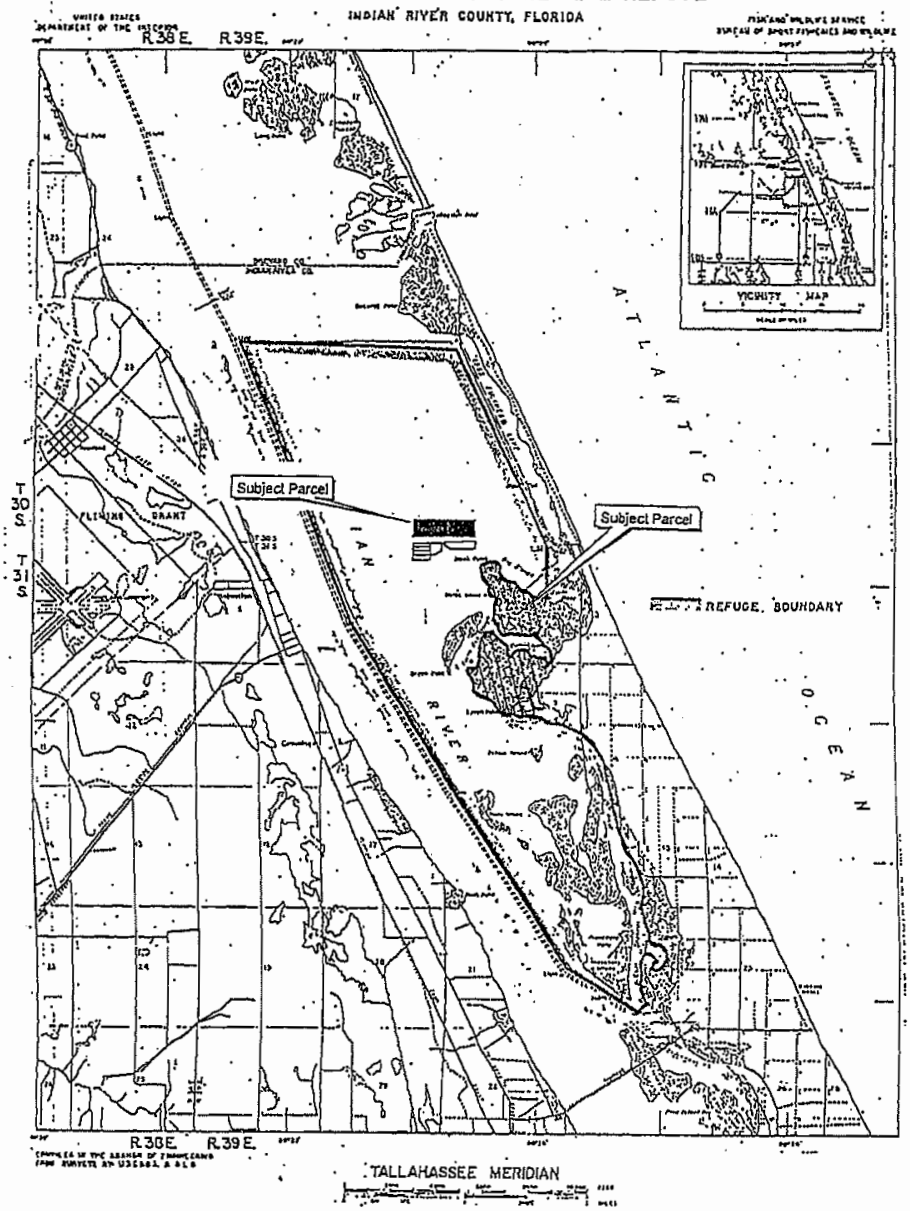
My Commission Expires:

November 23, 2003
Commission/Serial No.

Deborah A. Vess
Notary Public, State of Georgia

Printed, Typed or Stamped Name

DEBORAH A. VESS
NOTARY PUBLIC, CHEROKEE COUNTY, GA
MY COMMISSION EXPIRES ON NOVEMBER 23, 2003



Map showing the location of the aquaculture use zone within the Pelican Island National Wildlife Refuge

Legend

Parcels in Phase I of the Aquaculture Use Zone

Parcels in Phase II of the Aquaculture Use Zone

Proposed state-owned lands to be exchanged in Phase II

EXHIBIT A
Page 6 of 12 Pages
SSIL No. 310023304

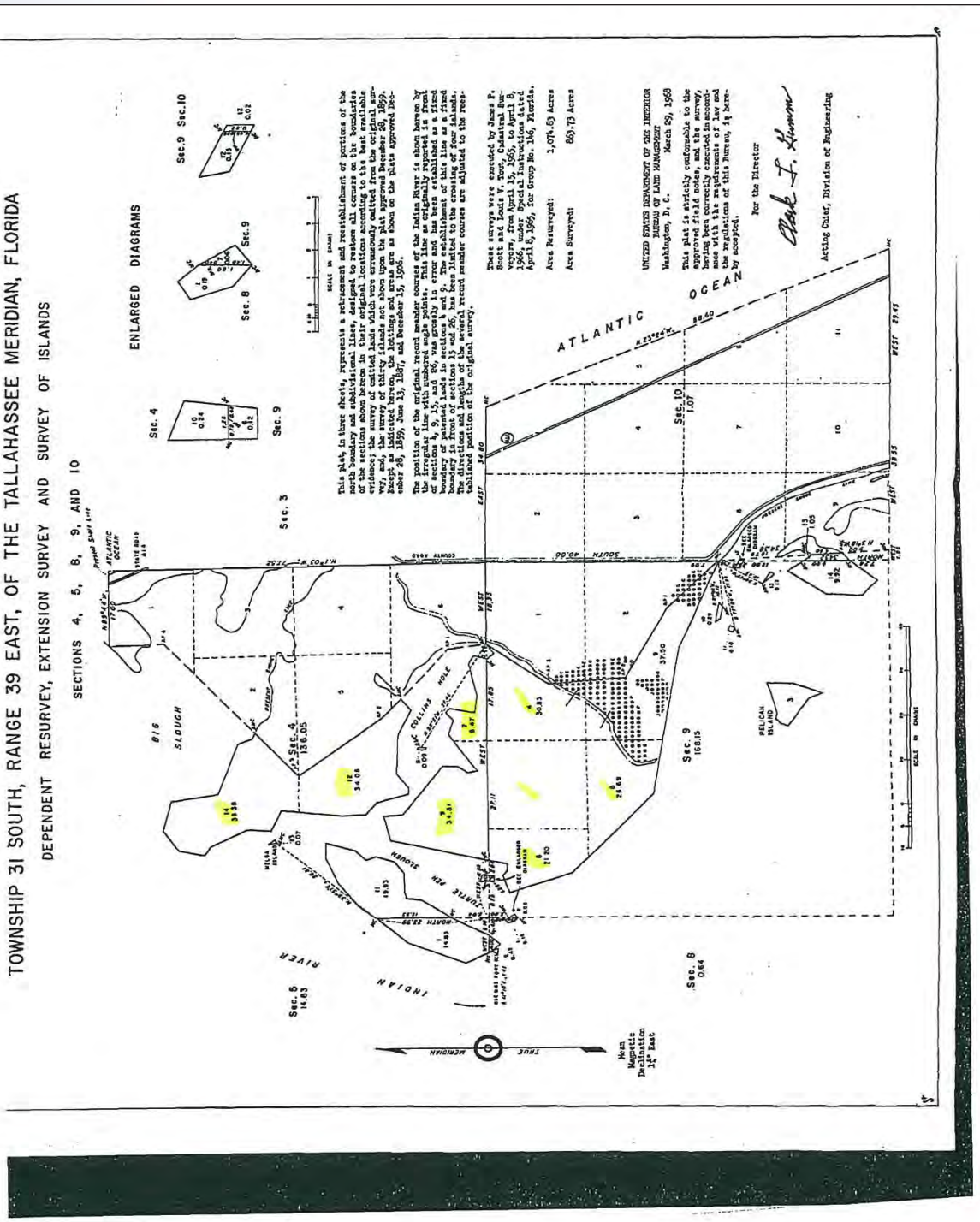


EXHIBIT A
Page 7 of 12 Pages
SSL No. 310023304

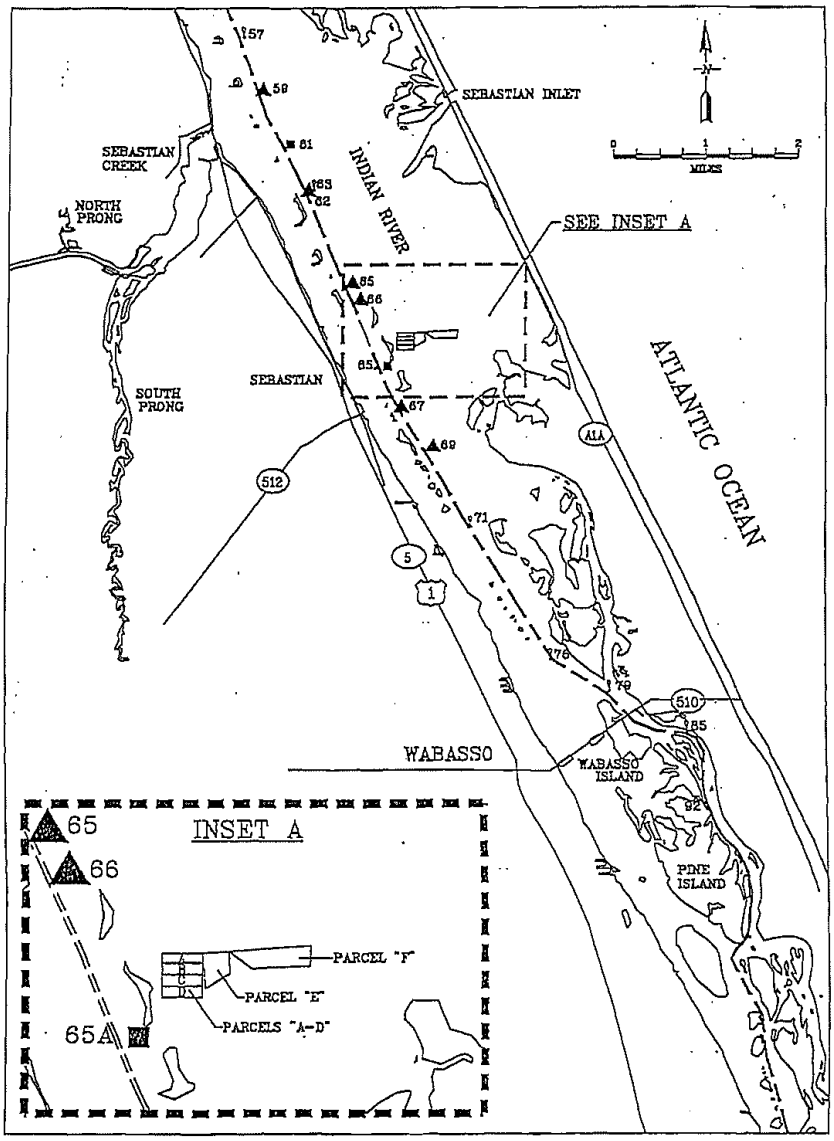
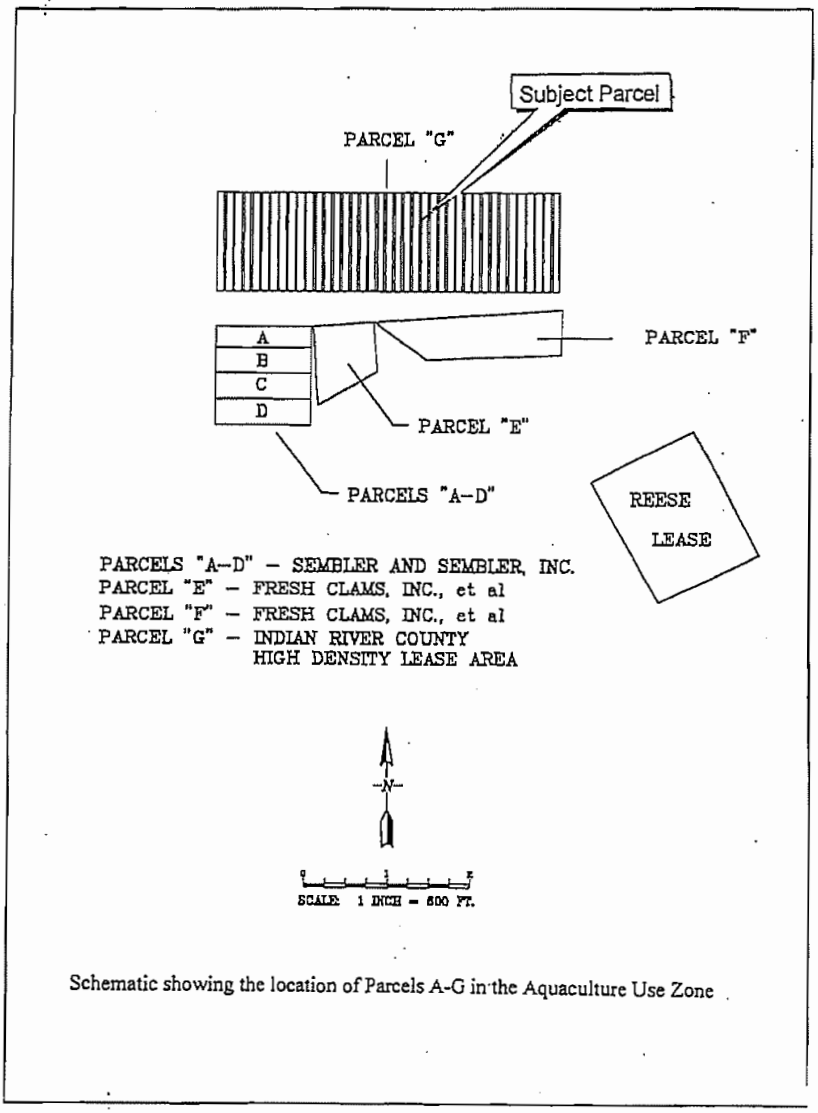


EXHIBIT B
Page 8 of 12 Pages
SSLL No. 310023304



Schematic showing the location of Parcels A-G in the Aquaculture Use Zone

EXHIBIT B
Page 9 of 12 Pages
SSIL No. 310023304

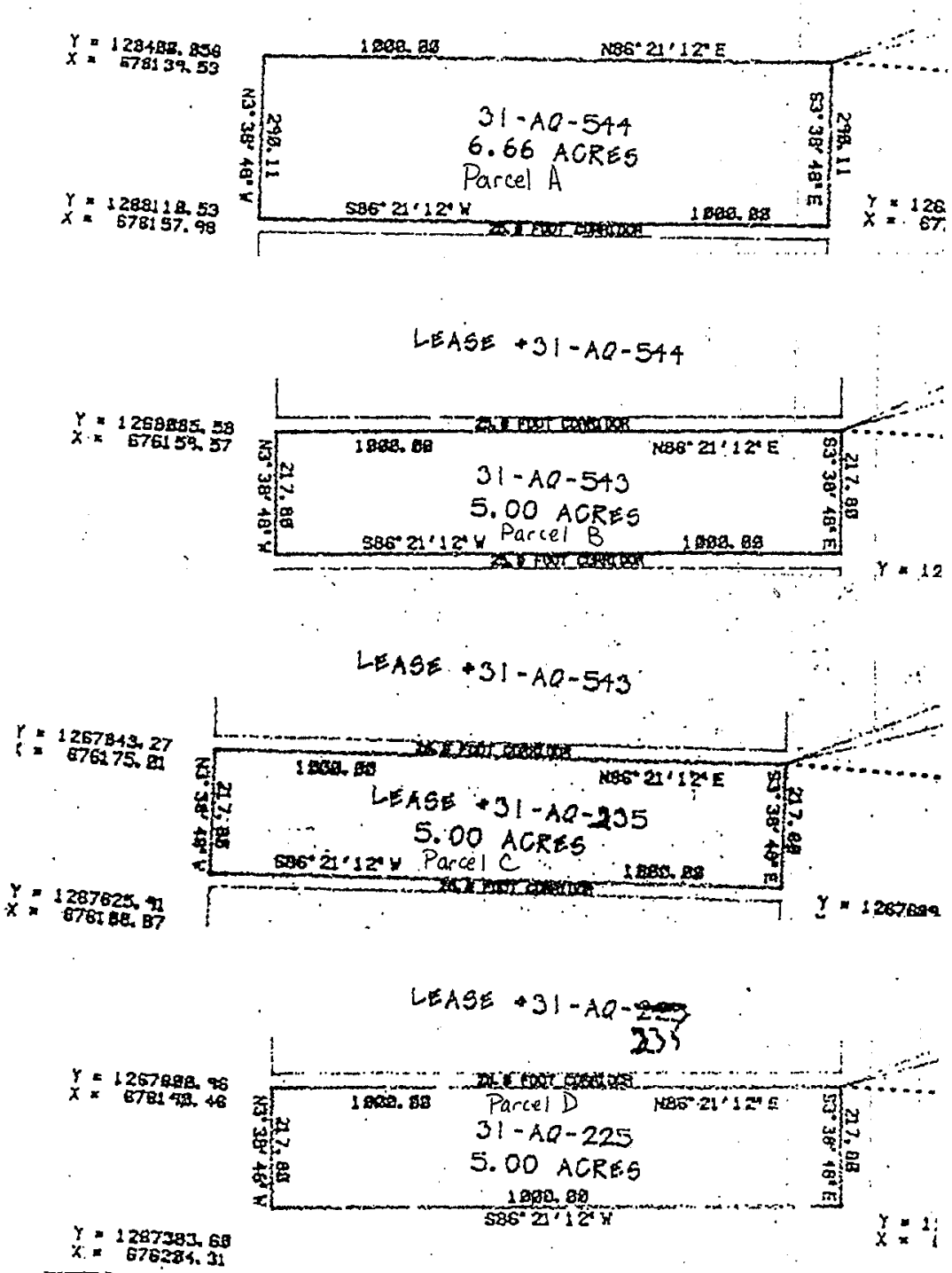


EXHIBIT B
Page 10 of 12 Pages
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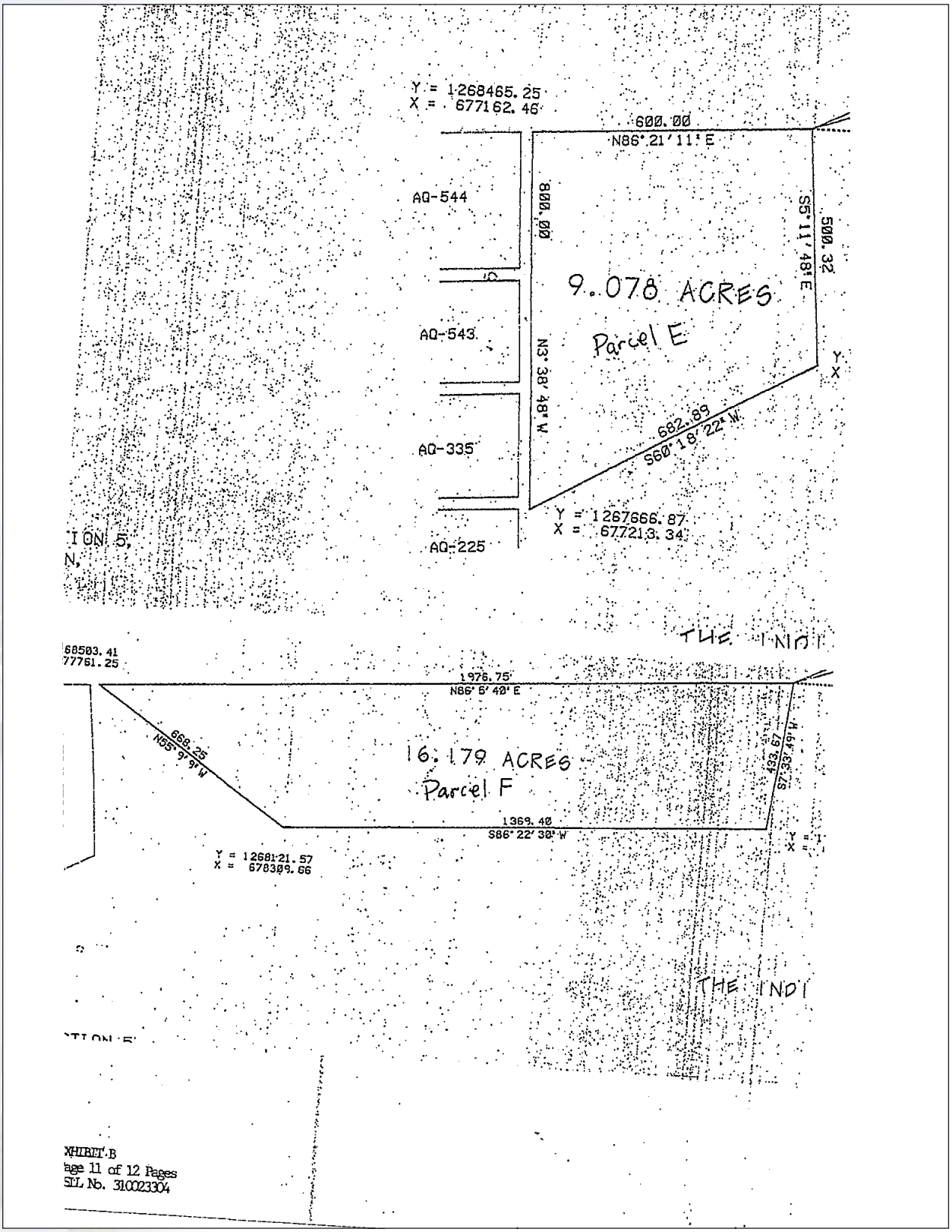
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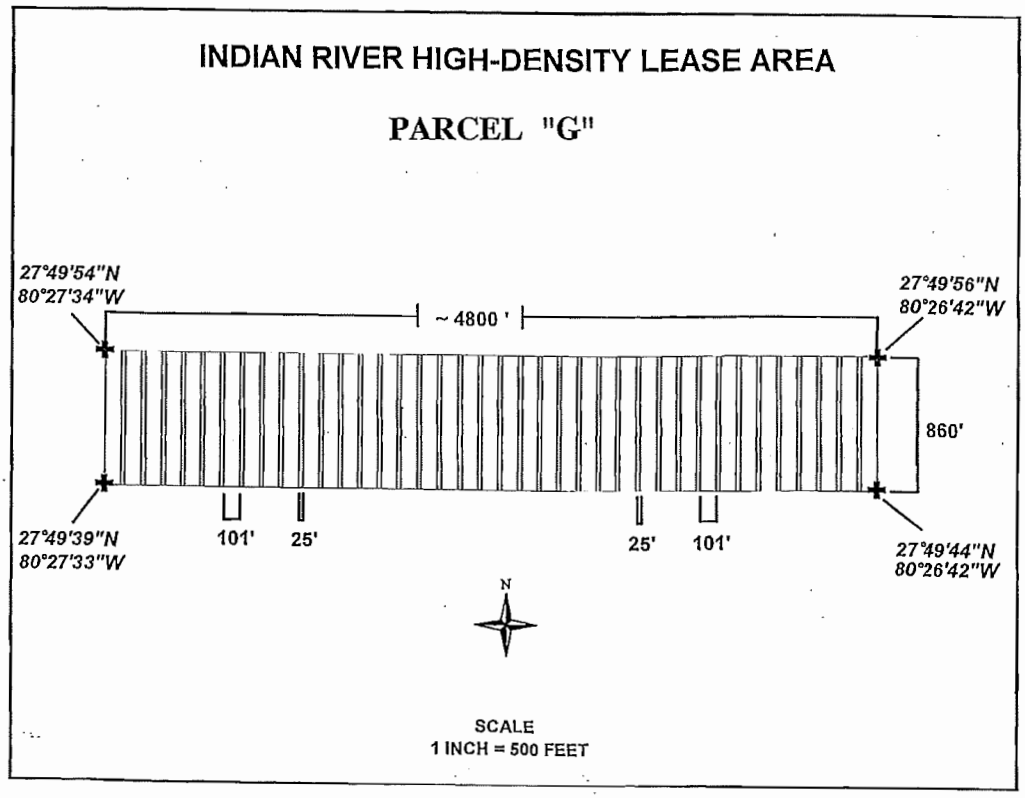
N55°9'9"W
16.179 ACRES
Parcel F
493.67
S7°33'49"E
1369.40
S86°22'38"W
Y = 12681.21.57
X = 678389.66
THE IND
XHIBIT B
age 11 of 12 Pages
SIL No. 310023304


INDIAN RIVER HIGH-DENSITY LEASE AREA
PARCEL "G"
27°49'54"N
80°27'34"W
~ 4800 '
27°49'56"N
80°26'42"W
860'
27°49'39"N
80°27'33"W
101'
25'
25'
101'
27°49'44"N
80°26'42"W
N
SCALE
1 INCH = 500 FEET

2058969
THIS DOCUMENT HAS BEEN
RECORDED IN THE PUBLIC RECORDS
OF INDIAN RIVER COUNTY FL
BK: 2412 PG:597, Page1 of 16
04/13/2010 at 03:53 PM,

JEFFREY K BARTON, CLERK OF COURT

This Instrument Prepared By:
Pattie J. Scott
Recurring Revenue Section
Bureau of Public Land Administration
3900 Commonwealth Boulevard
Mail Station No. 125
Tallahassee, Florida 32399

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND
OF THE STATE OF FLORIDA

SOVEREIGNTY SUBMERGED LANDS FEE WAIVED LEASE

BOT FILE NO.: 310345813
PA NO.:_____

THIS LEASE is hereby issued by the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida, hereinafter referred to as the Lessor.

WITNESSETH: That for and in consideration of the faithful and timely performance of and compliance with all terms and conditions stated herein, the Lessor does hereby lease to Indian River County, Florida, hereinafter referred to as the Lessee, the sovereignty lands described as follows:

A parcel of sovereignty submerged land in Section 13, Township 32 South, Range 39 East, in the Indian River, Indian River County, containing 40,846 square feet, more or less, as is more particularly described and shown on Attachment A, dated December 3, 2009.

TO HAVE THE USE OF the hereinabove described premises for a period of **5** years from January 25, 2010, the effective date of this lease. The terms and conditions on and for which this lease is granted are as follows:

1. USE OF PROPERTY: The Lessee is hereby authorized to operate three public access docks exclusively to be used for temporary mooring of recreational vessels in conjunction with an upland public recreational area on spoil island IR25, without fueling facilities, without a sewage pumpout facility and without liveaboards as defined in paragraph 24, as shown and conditioned in Attachment A. All of the foregoing subject to the remaining conditions of this lease.

2. AGREEMENT TO EXTENT OF USE: This lease is given to the Lessee to use or occupy the leased premises only for those activities specified herein. The Lessee shall not change or add to the approved use of the leased premises as defined herein (e.g., from commercial to multi-family residential, from temporary mooring to rental of wet slips, from rental of wet slips to contractual agreement with third party for docking of cruise ships, from rental of recreational pleasure craft to rental or temporary mooring of charter/tour boats, from loading/offloading commercial to rental of wet slips, etc.), shall not change activities in any manner that may have an environmental impact that was not considered in the original authorization or regulatory permit, or shall not change the type of use permitted by the Lessee's riparian upland easement that is more particularly described in Attachment B without first obtaining a regulatory permit/modified permit, if applicable, and, if applicable, the removal of any structures which may no longer qualify for authorization under the modified lease of the riparian uplands without first obtaining a regulatory permit/modified permit, if applicable, and the Lessor's written authorization in the form of a modified lease, the payment of additional fees, if applicable. If at any time during the lease term this lease no longer satisfies the requirements of subparagraph 18-21.011(1)(b)7., Florida Administrative Code, for a fee waived lease, the Lessee shall be required to pay an annual lease fee in accordance with Rule 18-21.011, Florida Administrative Code, and if applicable, remove any structures which may no longer qualify for authorization under this lease.

3. EXAMINATION OF LESSEE'S RECORDS: The Lessor is hereby specifically authorized and empowered to examine, for the term of this lease including any renewals, plus three (3) additional years, at all reasonable hours, the books, records, contracts, and other documents confirming and pertaining to the computation of annual lease payments as specified in paragraph two (2) above.

[02]

C - COUNTY ATTORNEY'S OFFICE
INDIAN RIVER COUNTY
1801 27th Street
Vero Beach, Florida 32960

4. MAINTENANCE OF LESSEE'S RECORDS: The Lessee shall maintain separate accounting records for: (i) gross revenue derived directly from the use of the leased premises, (ii) the gross revenue derived indirectly from the use of the leased premises, and (iii) all other gross revenue derived from the Lessee's operations on the riparian upland property. The Lessee shall secure, maintain and keep all records for the term of this lease and any renewals plus three (3) additional years. This period shall be extended for an additional two (2) years upon request for examination of all records and accounts for lease verification purposes by the Lessor.

5. PROPERTY RIGHTS: The Lessee shall make no claim of title or interest to said lands hereinbefore described by reason of the occupancy or use thereof, and all title and interest to said land hereinbefore described is vested in the Lessor. The Lessee is prohibited from including, or making any claim that purports to include, said lands described or the Lessee's leasehold interest in said lands into any form of private ownership, including but not limited to any form of condominium or cooperative ownership. The Lessee is further prohibited from making any claim, including any advertisement, that said land, or the use thereof, may be purchased, sold, or re-sold.

6. INTEREST IN RIPARIAN UPLAND EASEMENT: During the term of this lease, the Lessee shall maintain the Lessee's riparian upland easement that is more particularly described in Attachment B and by reference made a part hereof together with the riparian rights appurtenant to said riparian upland easement, and if such easement interest is terminated, the lease may be terminated at the option of the Lessor. Prior to sale and/or termination of the Lessee's easement interest over and across the riparian upland property, Lessee shall inform any potential buyer or transferee of: (a) the Lessee's easement over and across the riparian upland property; (b) and the existence of this lease and all its terms and conditions and shall complete and execute and documents required by the Lessor to effect an assignment of this lease, if consented to by the Lessor. Failure to do so will not relieve the Lessee from responsibility for full compliance with the terms and conditions of this lease which include, but are not limited to, payment of all fees and/or penalty assessments incurred prior to such act.

7. ASSIGNMENT OF LEASE: This lease shall not be assigned or otherwise transferred without prior written consent of the Lessor or its duly authorized agent. Such assignment or other transfer shall be subject to the terms, conditions and provisions of management standards and applicable laws, rules and regulations in effect at that time. Any assignment or other transfer without prior written consent of the Lessor shall be null and void and without legal effect.

8. INDEMNIFICATION/INVESTIGATION OF ALL CLAIMS: The Lessee shall investigate all claims of every nature at its expense. Each party is responsible for all personal injury and property damage attributable to the negligent acts or omissions of that party and the officers, employees and agents thereof. Nothing herein shall be construed as an indemnity or a waiver of sovereign immunity enjoyed by any party hereto, as provided in Section 768.28, Florida Statutes, as amended from time to time, or any other law providing limitations on claims.

9. VENUE: Lessee waives venue as to any litigation arising from matters relating to this lease and any such litigation between Lessor and Lessee shall be initiated and maintained only in Leon County, Florida.

10. NOTICES/COMPLIANCE/TERMINATION: The Lessee binds itself, its successors and assigns, to abide by the provisions and conditions herein set forth, and said provisions and conditions shall be deemed covenants of the Lessee, its successors and assigns. In the event the Lessee fails or refuses to comply with the provisions and conditions herein set forth, or in the event the Lessee violates any of the provisions and conditions herein set forth, and the Lessee fails or refuses to comply with any of said provisions or conditions within twenty (20) days of receipt of the Lessor's notice to correct, this lease may be terminated by the Lessor upon thirty (30) days written notice to the Lessee. If canceled, all of the above-described parcel of land shall revert to the Lessor. All costs and attorneys' fees incurred by the Lessor to enforce the provisions of this lease shall be paid by the Lessee. All notices required to be given to the Lessee by this lease or applicable law or administrative rules shall be sufficient if sent by U.S. Mail to the following address:

Indian River County, Florida
1801 - 27th Street
Vero Beach, Florida 32960

The Lessee shall notify the Lessor by certified mail of any change to this address at least ten (10) days before the change is effective.

11. TAXES AND ASSESSMENTS: The Lessee shall assume all responsibility for liabilities that accrue to the subject property or to the improvements thereon, including any and all drainage or special assessments or taxes of every kind and description which are now or may be hereafter lawfully assessed and levied against the subject property during the effective period of this lease.

12. NUISANCES OR ILLEGAL OPERATIONS: The Lessee shall not permit the leased premises or any part thereof to be used or occupied for any purpose or business other than herein specified unless such proposed use and occupancy are consented to by the Lessor and the lease is modified accordingly, nor shall Lessee knowingly permit or suffer any nuisances or illegal operations of any kind on the leased premises.

13. MAINTENANCE OF FACILITY/RIGHT TO INSPECT: The Lessee shall maintain the leased premises in good condition, keeping the structures and equipment located thereon in a good state of repair in the interests of public health, safety and welfare. No dock or pier shall be constructed in any manner that would cause harm to wildlife. The leased premises shall be subject to inspection by the Lessor or its designated agent at any reasonable time.

14. NON-DISCRIMINATION: The Lessee shall not discriminate against any individual because of that individual's race, color, religion, sex, national origin, age, handicap, or marital status with respect to any activity occurring within the area subject to this lease or upon lands adjacent to and used as an adjunct of the leased area. During the lease term, the Lessee shall post and maintain the placard furnished to the Lessee by the Lessor in a prominent and visible location on the leased premises or adjacent business office of the Lessee. It shall be the responsibility of the Lessee to post the placard in a manner which will provide protection from the elements, and, in the event that said placard becomes illegible at any time during the term of this lease (including any extensions thereof), to notify the Lessor in writing, so that a replacement may be provided.

15. ENFORCEMENT OF PROVISIONS: No failure, or successive failures, on the part of the Lessor to enforce any provision, nor any waiver or successive waivers on its part of any provision herein, shall operate as a discharge thereof or render the same inoperative or impair the right of the Lessor to enforce the same upon any renewal thereof or in the event of subsequent breach or breaches.

16. PERMISSION GRANTED: Upon expiration or cancellation of this lease all permission granted hereunder shall cease and terminate.

17. RENEWAL PROVISIONS: Renewal of this lease shall be at the sole option of the Lessor. Such renewal shall be subject to the terms, conditions and provisions of management standards and applicable laws, rules and regulations in effect at that time. In the event that Lessee is in full compliance with the terms of this lease, the Lessee may apply in writing for a renewal. Such application for renewal must be received by Lessor no sooner than 120 days and no later than 30 days prior to the expiration date of the original or current term hereof. The term of any renewal granted by the Lessor shall commence on the last day of the previous lease term. If the Lessee fails to timely apply for a renewal, or in the event the Lessor does not grant a renewal, the Lessee shall vacate the leased premises and remove all structures and equipment occupying and erected thereon at its expense. The obligation to remove all structures authorized herein upon termination of this lease shall constitute an affirmative covenant upon the Lessee's riparian upland easement that is more specifically described in Attachment B, which shall run with the title to said easement, and shall be binding upon Lessee and Lessee's successors in interest.

18. REMOVAL OF STRUCTURES/ADMINISTRATIVE FINES: If the Lessee does not remove said structures and equipment occupying and erected upon the leased premises after expiration or cancellation of this lease, such structures and equipment will be deemed forfeited to the Lessor, and the Lessor may authorize removal and may sell such forfeited structures and equipment after ten (10) days written notice by certified mail addressed to the Lessee at the address specified in Paragraph 8 or at such address on record as provided to the Lessor by the Lessee. However, such remedy shall be in addition to all other remedies available to the Lessor under applicable laws, rules and regulations including the right to compel removal of all structures and the right to impose administrative fines.

19. REMOVAL COSTS/LIEN ON RIPARIAN UPLAND PROPERTY: Subject to the noticing provisions of Paragraph 18 of this lease, any costs incurred by the Lessor in removal of any structures and equipment constructed or maintained on state lands shall be paid by Lessee and any unpaid costs and expenses shall constitute a lien upon the interest of the Lessee's riparian upland easement that is more particularly described in Attachment B. This lien shall be in its uplands enforceable in summary proceedings as provided by law.

20. RECORDATION OF LEASE: The Lessee, at its own expense, shall record this fully executed lease in its entirety in the public records of the county within which the lease site is located within fourteen (14) days after receipt, and shall provide to the Lessor within ten (10) days following the recordation a copy of the recorded lease in its entirety which contains the O.R. Book and pages at which the lease is recorded.

21. RIPARIAN RIGHTS/FINAL ADJUDICATION: In the event that any part of any structure authorized hereunder is determined by a final adjudication issued by a court of competent jurisdiction to encroach on or interfere with adjacent riparian rights, Lessee agrees to either obtain written consent for the offending structure from the affected riparian owner or to remove the interference or encroachment within 60 days from the date of the adjudication. Failure to comply with this paragraph shall constitute a material breach of this lease agreement and shall be grounds for immediate termination of this lease agreement at the option of the Lessor.

22. AMENDMENTS/MODIFICATIONS: This lease is the entire and only agreement between the parties. Its provisions are not severable. Any amendment or modification to this lease must be in writing, must be accepted, acknowledged and executed by the Lessee and Lessor, and must comply with the rules and statutes in existence at the time of the execution of the modification or amendment. Notwithstanding the provisions of this paragraph, if mooring is authorized by this lease, the Lessee may install boatlifts within the leased premises without formal modification of the lease provided that (a) the Lessee obtains any state or local regulatory permit that may be required; and (b) the location or size of the lift does not increase the mooring capacity of the facility.

23. ADVERTISEMENT/SIGNS/NON-WATER DEPENDENT ACTIVITIES/ADDITIONAL ACTIVITIES/MINOR STRUCTURAL REPAIRS: No permanent or temporary signs directed to the boating public advertising the sale of alcoholic beverages shall be erected or placed within the leased premises. No restaurant or dining activities are to occur within the leased premises. The Lessee shall ensure that no permanent, temporary or floating structures, fences, docks, pilings or any structures whose use is not water-dependent shall be erected or conducted over sovereignty submerged lands without prior written consent from the Lessor. No additional structures and/or activities including dredging, relocation/realignment or major repairs or renovations to authorized structures, shall be erected or conducted on or over sovereignty, submerged lands without prior written consent from the Lessor. Unless specifically authorized in writing by the Lessor, such activities or structures shall be considered unauthorized and a violation of Chapter 253, Florida Statutes, and shall subject the Lessee to administrative fines under Chapter 18-14, Florida Administrative Code. This condition does not apply to minor structural repairs required to maintain the authorized structures in a good state of repair in the interests of public health, safety or welfare; provided, however, that such activities shall not exceed the activities authorized by this agreement.

24. ACOE AUTHORIZATION: Prior to commencement of construction and/or activities authorized herein, the Lessee shall obtain the U.S. Army Corps of Engineers (ACOE) permit if it is required by the ACOE. Any modifications to the construction and/or activities authorized herein that may be required by the ACOE shall require consideration by and the prior written approval of the Lessor prior to the commencement of construction and/or any activities on sovereign, submerged lands.

25. COMPLIANCE WITH FLORIDA LAWS: On or in conjunction with the use of the leased premises, the Lessee shall at all times comply with all Florida Statutes and all administrative rules promulgated thereunder. Any unlawful activity which occurs on the leased premises or in conjunction with the use of the leased premises shall be grounds for the termination of this lease by the Lessor.

26. LIVEABOARDS: The term "liveaboard" is defined as a vessel docked at the facility and inhabited by a person or persons for any five (5) consecutive days or a total of ten (10) days within a thirty (30) day period. If liveaboards are authorized by paragraph one (1) of this lease, in no event shall such "liveaboard" status exceed six (6) months within any twelve (12) month period, nor shall any such vessel constitute a legal or primary residence.

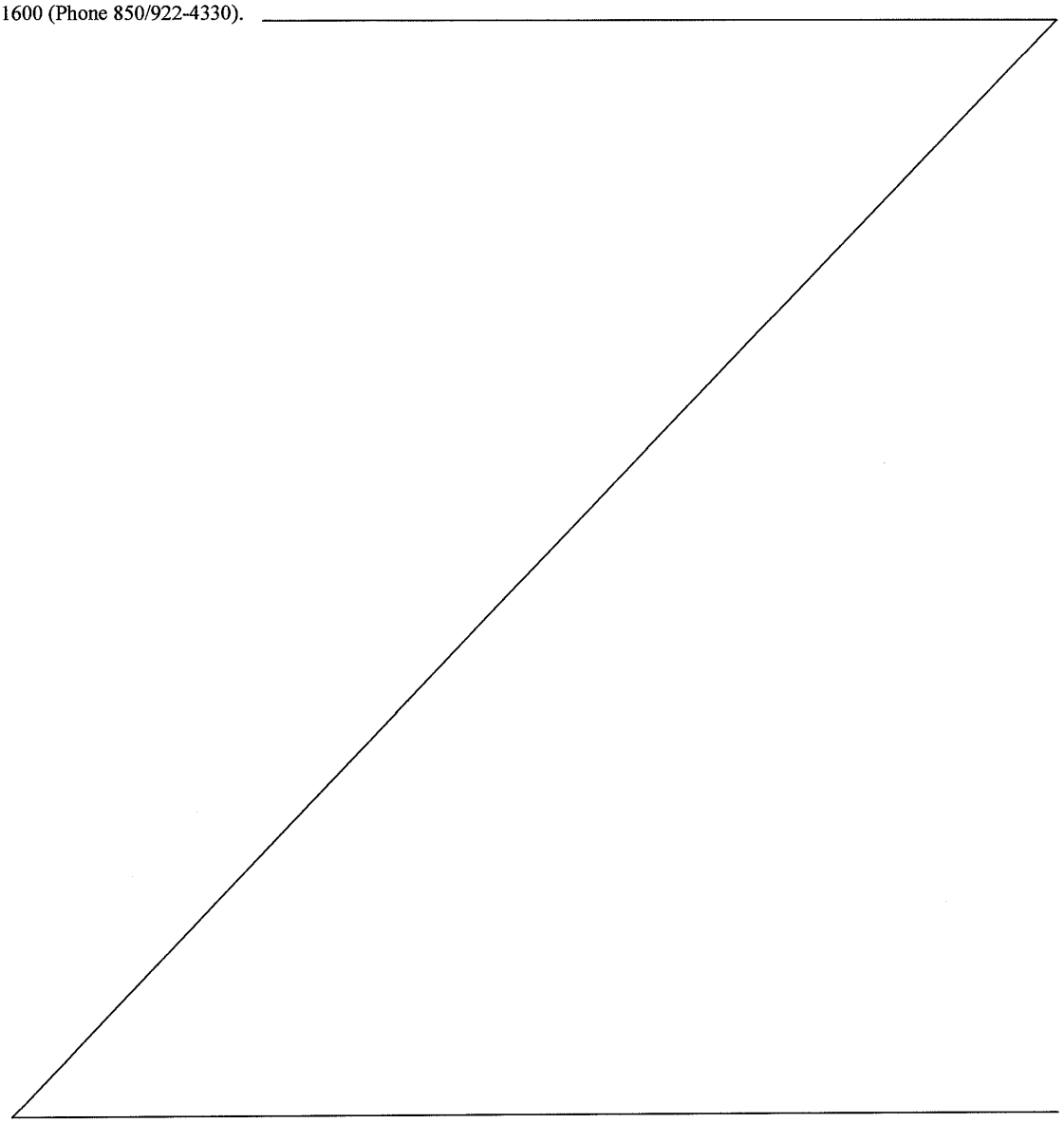
27. GAMBLING VESSELS: During the term of this lease and any renewals, extensions, modifications or assignments thereof, Lessee shall prohibit the operation of or entry onto the leased premises of gambling cruise ships, or vessels that are used principally for the purpose of gambling, when these vessels are engaged in "cruises to nowhere," where the ships leave and return to the state of Florida without an intervening stop within another state or foreign country or waters within the jurisdiction of another state or foreign country, and any watercraft used to carry passengers to and from such gambling cruise ships.

28. SPECIAL LEASE CONDITION FOR OTHER FEE WAIVED LEASES THAT ARE REVENUE GENERATING Within 30 days after each anniversary of the effective date of this lease, the Lessee shall submit annual certified financial records of income and expenses to the State of Florida Department of Environmental Protection, Division of State Lands, Bureau of Public Land Administration, 3900 Commonwealth Blvd, MS 130, Tallahassee, FL 32399. "Income" is defined in subsection 18-21.003(31), Florida Administrative Code. The submitted financial records shall be certified by a certified public accountant.

29. SPECIAL LEASE CONDITIONS:

A. Mooring between the hours of midnight and 5:00 a.m. is prohibited. Mooring at this facility is temporary and transient in nature. This facility shall be made available to the general public on a first come, first served basis each day when this facility opens.

B. Within 60 days after the Lessor's execution of this lease, Lessee shall install and display permanent manatee educational signs that provide information on the mannerisms of manatees and the potential threat to this endangered species from boat operation. Lessee shall maintain these signs during the term of this lease and all subsequent renewal periods and shall be required to replace the signs in the event they become faded, damaged or outdated. Lessee shall ensure that the view of the signs is not obstructed by vegetation or structures. The number, type, and procedure for installation of these signs shall be in accordance with the handout, "Permanent Manatee Signs," which can be obtained from the Florida Fish and Wildlife Conservation Commission, Imperiled Species Management Section, 620 S. Meridian Street – 6A, Tallahassee, Florida 32399-1600 (Phone 850/922-4330).



WITNESSES:

Original Signature

Print/Type Name of Witness

Original Signature

Print/Type Name of Witness

BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND OF THE STATE OF FLORIDA

(SEAL)

BY: _____

Jeffery M. Gentry, Operations and Management Consultant Manager, Bureau of Public Land Administration, Division of State Lands, State of Florida Department of Environmental Protection, as agent for and on behalf of the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida

"LESSOR"

STATE OF FLORIDA
COUNTY OF LEON

The foregoing instrument was acknowledged before me this 29th day of March, 2010, by Jeffery M. Gentry Operations and Management Consultant Manager, Bureau of Public Land Administration, Division of State Lands, State of Florida Department of Environmental Protection, as agent for and on behalf of the Board of Trustees of the Internal Improvement Trust Fund of the State of Florida. He is personally known to me.

APPROVED AS TO FORM AND LEGALITY:

DEP Attorney

Notary Public, State of Florida

Printed, Typed or Stamped Name

My Commission Expires:

Notary Public State of Florida
Kathy C Griffin
My Commission DD727692
Expires 10/30/2011

Commission/Serial No.

WITNESSES:

Original Signature

Typed/Printed Name of Witness

Original Signature

DARCY R. VASILAS
Typed/Printed Name of Witness

Indian River County, Florida (SEAL)
By its Board of County Commissioners

BY: _____
Original Signature of Executing Authority

Peter D. O'Bryan
Typed/Printed Name of Executing Authority

Chairman
Title of Executing Authority

"LESSEE"

APPROVED AS TO FORM AND LEGAL SUFFICIENCY
BY _____
GEORGE A. GLENN
ASSISTANT COUNTY ATTORNEY

STATE OF Florida

COUNTY OF Indian River County

The foregoing instrument was acknowledged before me this 9th day of March, 2010, by Peter D. O'Bryan as Chairman, for and on behalf of the Board of County Commissioners of Indian River County, Florida. He is personally known to me or who has produced N/A, as identification.

My Commission Expires: October 30, 2010

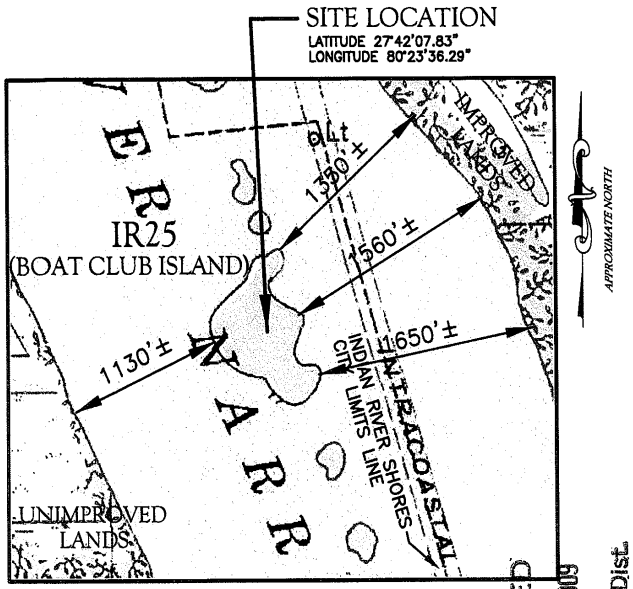
Notary Signature

Notary Public, State of Florida

Terri Collins-Lister
Printed, Typed or Stamped Name

Commission/Serial No. DD 609787

TERRI COLLINS-LISTER
MY COMMISSION # DD 609787
EXPIRES: October 30, 2010
Bonded Thru Budget Notary Services



LOCATION MAP
RIOMAR QUADRANGLE 1992
7.5 MINUTE SERIES (FOR INFORMATIONAL PURPOSES ONLY)

RECEIVED
DEC 07 2009
DEP Central Dist.

CERTIFIED TO:
1. BOARD OF TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND OF THE STATE OF FLORIDA
2. INDIAN RIVER COUNTY BOARD OF COUNTY COMMISSIONERS

SOVEREIGNTY LAND LEASE AREA
LEGAL DESCRIPTION (PER SURVEY)

COMMENCE AT A 4"x4" CONCRETE MONUMENT WITH IRON PIPE MARKING THE SOUTHEAST CORNER OF SECTION 13, TOWNSHIP 32 SOUTH, RANGE 39 EAST, SAID POINT LYING ON A PARCEL OF LAND CLOSE TO THE EASTERN SHORE OF THE INDIAN RIVER WITHIN THE CITY LIMITS OF INDIAN RIVER SHORES, FLORIDA, AND RUN N43°23'15"W, ACROSS THE INDIAN RIVER, A DISTANCE OF 5,673.61 FEET, MORE OR LESS, TO A POINT ON THE APPROXIMATE MEAN HIGH WATER LINE OF THE SOUTHERLY LIMITS OF SPOIL ISLAND "IR25", SAID POINT BEING THE POINT OF BEGINNING; THENCE FOLLOWING ALONG THE SAID APPROXIMATE MEAN HIGH WATER LINE OF SAID SPOIL ISLAND "IR25", RUN S72°30'38"W, ALONG THE SAID APPROXIMATE MEAN HIGH WATER LINE, A DISTANCE OF 30.28 FEET, MORE OR LESS, TO A POINT; THENCE CONTINUING ALONG SAID APPROXIMATE MEAN HIGH WATER LINE, RUN S87°46'00"W A DISTANCE OF 23.44 FEET, MORE OR LESS TO A POINT; THENCE, LEAVING SAID APPROXIMATE MEAN HIGH WATER LINE, RUN S59°16'02"W A DISTANCE OF 188.72 FEET TO A POINT; THENCE RUN N30°43'58"W A DISTANCE OF 118.99 FEET TO A POINT; THENCE RUN N59°16'02"E A DISTANCE OF 110.51 FEET, MORE OR LESS, TO A POINT ON THE APPROXIMATE MEAN HIGH WATER LINE OF SPOIL ISLAND "IR25"; THENCE RUN N59°38'03"E, ACROSS SPOIL ISLAND "IR25", A DISTANCE OF 242.13 FEET, MORE OR LESS, TO A POINT ON THE APPROXIMATE MEAN HIGH WATER LINE OF SAID SPOIL ISLAND "IR25"; THENCE RUN ALONG THE SAID APPROXIMATE MEAN HIGH WATER LINE OF SPOIL ISLAND "IR25" THE FOLLOWING 4 (FOUR) BEARINGS AND DISTANCES: RUN S10°45'15"E A DISTANCE OF 98.45 FEET, MORE OR LESS, TO A POINT; THENCE RUN S05°42'13"E A DISTANCE OF 40.95 FEET, MORE OR LESS, TO A POINT; THENCE RUN S46°34'02"W A DISTANCE OF 19.39 FEET, MORE OR LESS, TO A POINT; THENCE RUN S57°05'50"W A DISTANCE OF 44.00 FEET, MORE OR LESS, TO THE POINT OF BEGINNING.
CONTAINING 40,845.95 SQUARE FEET, MORE OR LESS, OR 0.94 ACRES.
NOW LYING IN INDIAN RIVER COUNTY.

SEE SOVEREIGNTY LAND LEASE AREA SKETCH–SHEET 2 OF 4
SEE TABULATIONS–SHEET 3 OF 4
SEE DOCK DETAILS–SHEET 4 OF 4

CERTIFICATION
SURVEYOR AND MAPPER IN RESPONSIBLE CHARGE

12/3/09
MICHAEL O'BRIEN P.S.M., C.F.M. DATE
FLORIDA REGISTRATION NO. 6118
INDIAN RIVER COUNTY SURVEYOR

NOT COMPLETE WITHOUT ALL SHEETS 1 THROUGH 4 AS CREATED

THIS IS NOT A BOUNDARY SURVEY

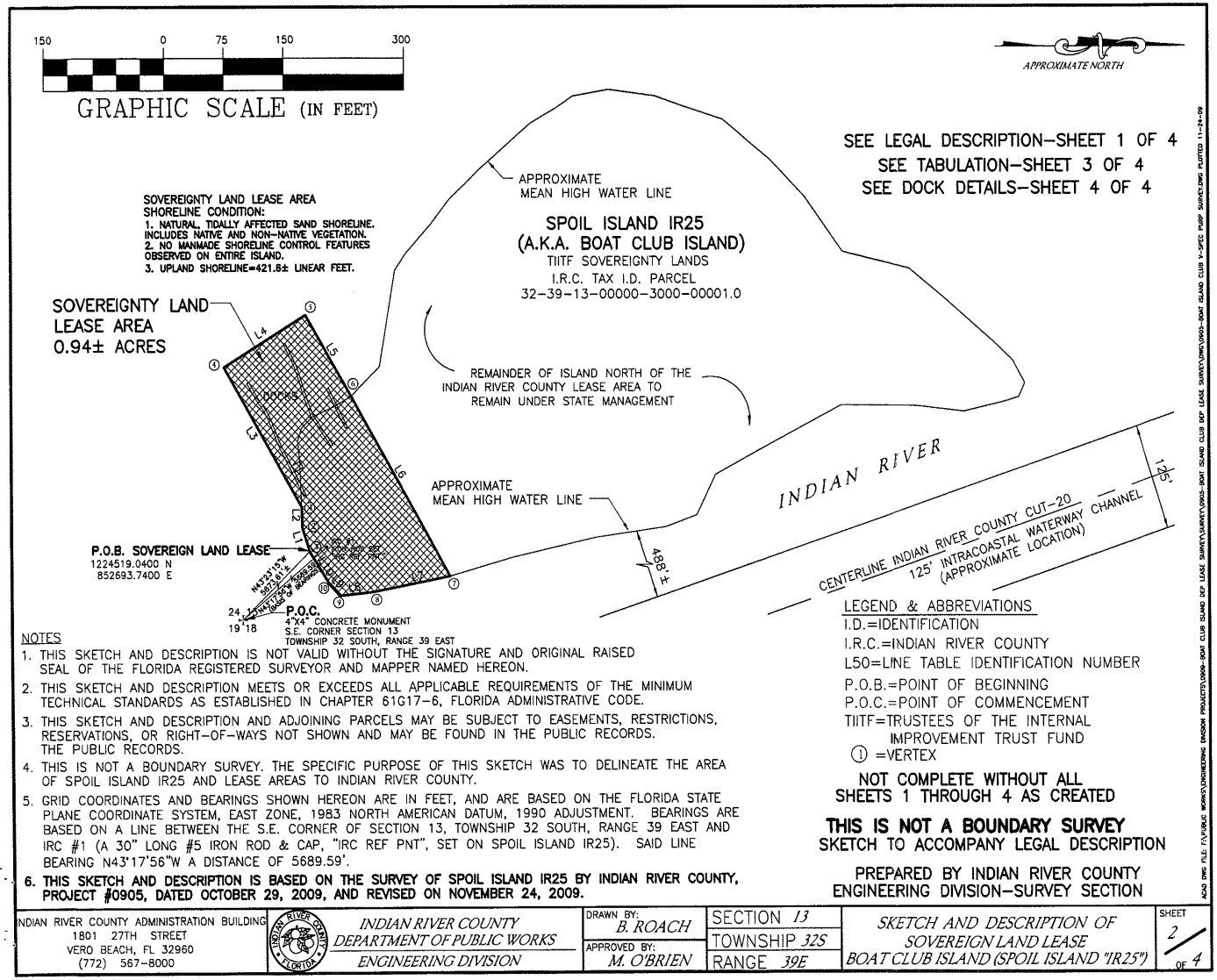
SKETCH TO ACCOMPANY LEGAL DESCRIPTION

PREPARED BY INDIAN RIVER COUNTY ENGINEERING DIVISION–SURVEY SECTION

INDIAN RIVER COUNTY ADMINISTRATION BUILDING 1801 27TH STREET VERO BEACH, FL 32960 (772) 567-8000	INDIAN RIVER COUNTY DEPARTMENT OF PUBLIC WORKS ENGINEERING DIVISION	DRAWN BY: B. ROACH APPROVED BY: M. O'BRIEN	SECTION 13 TOWNSHIP 32S RANGE 39E	SKETCH AND DESCRIPTION OF SOVEREIGNTY LAND LEASE BOAT CLUB ISLAND (SPOIL ISLAND "IR25")	SHEET 1 OF 4

ACAD DWG FILE: P:\PUBLIC WORKS\ENGINEERING DIVISION PROJECTS\2009-BOAT CLUB ISLAND DEP LEASE SURVEY\SURVEY\2009-BOAT ISLAND CLUB DEP LEASE SURVEY.DWG\2009-BOAT ISLAND CLUB Y-OFFICE PURP SURVEY.DWG PLOTTED 11-24-09

Attachment A
Page 7 of 16 Pages
SSLL No. 310345813



NOTES

1. THIS SKETCH AND DESCRIPTION IS NOT VALID WITHOUT THE SIGNATURE AND ORIGINAL RAISED SEAL OF THE FLORIDA REGISTERED SURVEYOR AND MAPPER NAMED HEREON.
2. THIS SKETCH AND DESCRIPTION MEETS OR EXCEEDS ALL APPLICABLE REQUIREMENTS OF THE MINIMUM TECHNICAL STANDARDS AS ESTABLISHED IN CHAPTER 61G17-6, FLORIDA ADMINISTRATIVE CODE.
3. THIS SKETCH AND DESCRIPTION AND ADJOINING PARCELS MAY BE SUBJECT TO EASEMENTS, RESTRICTIONS, RESERVATIONS, OR RIGHT-OF-WAYS NOT SHOWN AND MAY BE FOUND IN THE PUBLIC RECORDS. THE PUBLIC RECORDS.
4. THIS IS NOT A BOUNDARY SURVEY. THE SPECIFIC PURPOSE OF THIS SKETCH WAS TO DELINEATE THE AREA OF SPOIL ISLAND IR25 AND LEASE AREAS TO INDIAN RIVER COUNTY.
5. GRID COORDINATES AND BEARINGS SHOWN HEREON ARE IN FEET, AND ARE BASED ON THE FLORIDA STATE PLANE COORDINATE SYSTEM, EAST ZONE, 1983 NORTH AMERICAN DATUM, 1990 ADJUSTMENT. BEARINGS ARE BASED ON A LINE BETWEEN THE S.E. CORNER OF SECTION 13, TOWNSHIP 32 SOUTH, RANGE 39 EAST AND IRC #1 (A 30" LONG #5 IRON ROD & CAP, "IRC REF PNT", SET ON SPOIL ISLAND IR25). SAID LINE BEARING N43°17'56"W A DISTANCE OF 5689.59'.
6. **THIS SKETCH AND DESCRIPTION IS BASED ON THE SURVEY OF SPOIL ISLAND IR25 BY INDIAN RIVER COUNTY, PROJECT #0905, DATED OCTOBER 29, 2009, AND REVISED ON NOVEMBER 24, 2009.**

LEGEND & ABBREVIATIONS

I.D.=IDENTIFICATION
I.R.C.=INDIAN RIVER COUNTY
L50=LINE TABLE IDENTIFICATION NUMBER
P.O.B.=POINT OF BEGINNING
P.O.C.=POINT OF COMMENCEMENT
TIITF=TRUSTEES OF THE INTERNAL IMPROVEMENT TRUST FUND
① =VERTEX

NOT COMPLETE WITHOUT ALL SHEETS 1 THROUGH 4 AS CREATED

THIS IS NOT A BOUNDARY SURVEY
SKETCH TO ACCOMPANY LEGAL DESCRIPTION

PREPARED BY INDIAN RIVER COUNTY ENGINEERING DIVISION–SURVEY SECTION

ACAD DWG FILE: P:\PUBLIC WORKS\ENGINEERING DIVISION PROJECTS\0909-BOAT CLUB ISLAND BDP LEASE SURVEY\SURVEY\DWG\0905-BOAT ISLAND CLUB BDP LEASE SURVEY\DWG\0905-BOAT ISLAND CLUB X-SPEC PURP SURVEY.DWG PLOTTED 11-24-09

INDIAN RIVER COUNTY ADMINISTRATION BUILDING 1801 27TH STREET VERO BEACH, FL 32960 (772) 567-8000	INDIAN RIVER COUNTY DEPARTMENT OF PUBLIC WORKS ENGINEERING DIVISION	DRAWN BY: B. ROACH APPROVED BY: M. O'BRIEN	SECTION 13 TOWNSHIP 32S RANGE 39E	SKETCH AND DESCRIPTION OF SOVEREIGN LAND LEASE BOAT CLUB ISLAND (SPOIL ISLAND "IR25")	SHEET 2 OF 4

SOVEREIGNTY LAND LEASE AREA COORDINATE TABLE

Vertex	Northing	Easting
1	1224519.04	852693.74
2	1224509.94	852664.86
3	1224509.03	852641.44
4	1224412.58	852479.23
5	1224514.86	852418.42
6	1224571.34	852513.41
7	1224693.74	852722.32
8	1224597.02	852740.69
9	1224556.27	852744.76
10	1224542.94	852730.68

SOVEREIGNTY LAND LEASE AREA LINE TABLE

LINE #	BEARING	DISTANCE
L1	S72°30'38"W	30.28'
L2	S87°46'00"W	23.44'
L3	S59°16'02"W	188.72'
L4	N30°43'58"W	118.99'
L5	N59°16'02"E	110.51'
L6	N59°38'03"E	242.13'
L7	S10°45'15"E	98.45'
L8	S05°42'13"E	40.95'
L9	S46°34'02"W	19.39'
L10	S57°05'50"W	44.00'

CONTROL TABLE

MONUMENT	NORTHING	EASTING
GPS 163-RIOMAR (1992)	1,219,829.050	860,249.380
C.M. (S.E. CORNER SECTION 13)	1,220,395.900	856,591.114
I.R.C. #1 (#5 IRON ROD/CAP)	1,224,539.710	852,689.180

SEE LEGAL DESCRIPTION–SHEET 1 OF 4
SEE SOVEREIGNTY LAND LEASE AREA SKETCH–SHEET 2 OF 4
SEE DOCK DETAILS–SHEET 4 OF 4

CERTIFICATION

SURVEYOR AND MAPPER IN RESPONSIBLE CHARGE

MICHAEL O'BRIEN P.S.M., C.F.M. DATE
FLORIDA REGISTRATION NO. 6118
INDIAN RIVER COUNTY SURVEYOR

NOT COMPLETE WITHOUT ALL SHEETS 1 THROUGH 4 AS CREATED

THIS IS NOT A BOUNDARY SURVEY

SKETCH TO ACCOMPANY LEGAL DESCRIPTION

PREPARED BY INDIAN RIVER COUNTY ENGINEERING DIVISION–SURVEY SECTION

INDIAN RIVER COUNTY ADMINISTRATION BUILDING
1801 27TH STREET
VERO BEACH, FL 32960
(772) 567-8000

INDIAN RIVER COUNTY
DEPARTMENT OF PUBLIC WORKS
ENGINEERING DIVISION

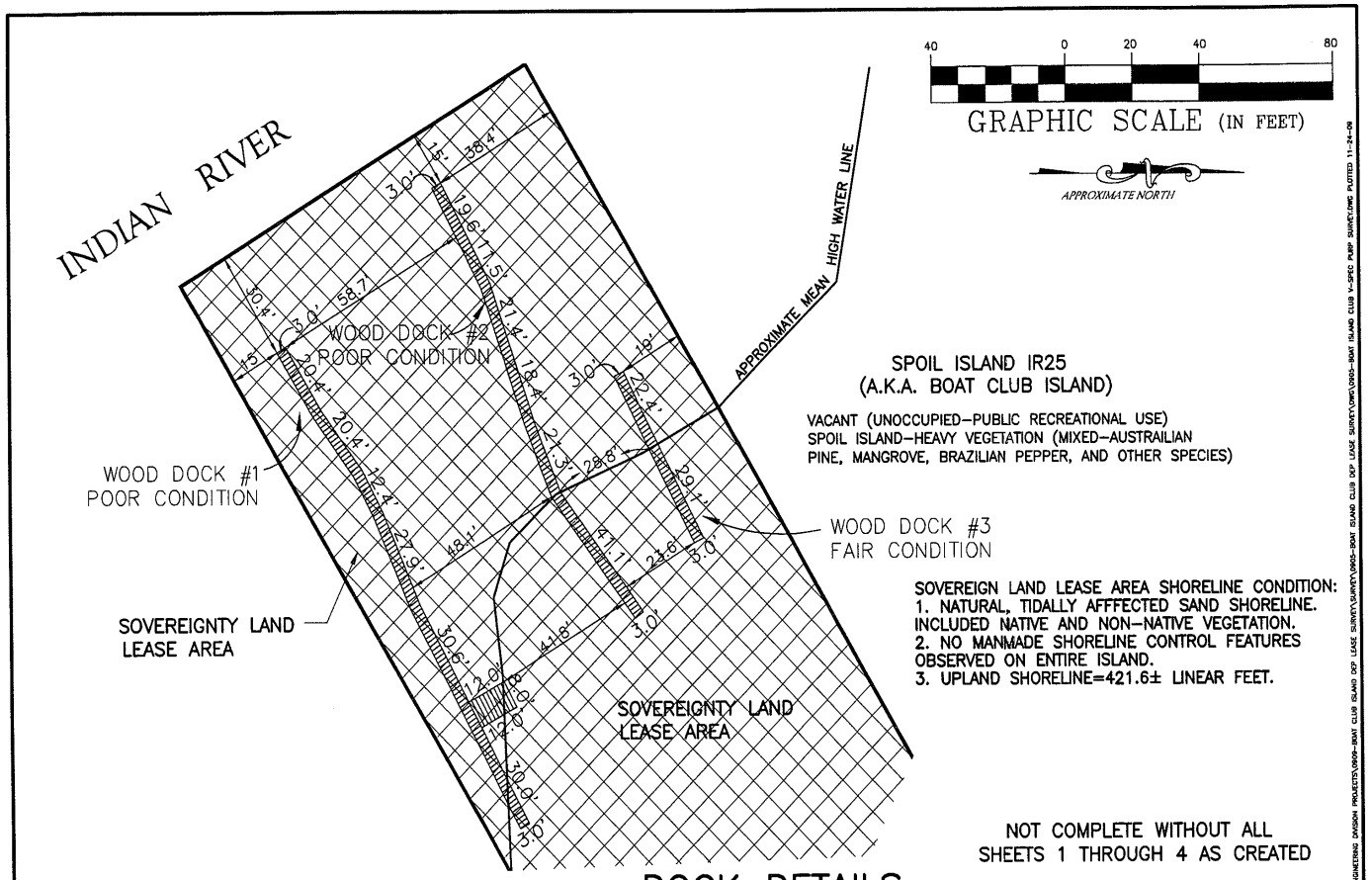
DRAWN BY: B. ROACH
APPROVED BY: M. O'BRIEN

SECTION 13
TOWNSHIP 32S
RANGE 39E

SKETCH AND DESCRIPTION OF
SOVEREIGNTY LAND LEASE
BOAT CLUB ISLAND (SPOIL ISLAND "IR25")

SHEET 3 OF 4

ACAD DWG FILE: P:\PUBLIC WORKS\ENGINEERING DIVISION PROJECTS\0959-BOAT CLUB ISLAND DEP LEASE SURVEY\SURVEY\0965-BOAT ISLAND CLUB DEP LEASE SURVEY\DWG\0965-BOAT ISLAND CLUB V-SPEC PURP SURVEY.DWG PLOTTED 11-24-09



SPOIL ISLAND IR25
(A.K.A. BOAT CLUB ISLAND)

VACANT (UNOCCUPIED–PUBLIC RECREATIONAL USE)
SPOIL ISLAND–HEAVY VEGETATION (MIXED–AUSTRAILIAN PINE, MANGROVE, BRAZILIAN PEPPER, AND OTHER SPECIES)

SOVEREIGN LAND LEASE AREA SHORELINE CONDITION:
1. NATURAL, TIDALLY AFFFECTED SAND SHORELINE. INCLUDED NATIVE AND NON–NATIVE VEGETATION.
2. NO MANMADE SHORELINE CONTROL FEATURES OBSERVED ON ENTIRE ISLAND.
3. UPLAND SHORELINE=421.6± LINEAR FEET.

NOT COMPLETE WITHOUT ALL SHEETS 1 THROUGH 4 AS CREATED

DOCK DETAILS

SEE LEGAL DESCRIPTION–SHEET 1 OF 4
SEE SOVEREIGN LAND LEASE AREA SKETCH–SHEET 2 OF 4
SEE TABULATIONS–SHEET 3 OF 4

THIS IS NOT A BOUNDARY SURVEY
SKETCH TO ACCOMPANY LEGAL DESCRIPTION

PREPARED BY INDIAN RIVER COUNTY ENGINEERING DIVISION–SURVEY SECTION

ACAD DWG FILE: P:\PUBLIC WORKS\ENGINEERING DIVISION PROJECTS\0909–BOAT CLUB ISLAND DEP LEASE SURVEY\SURVEY\0905–BOAT ISLAND CLUB DEP LEASE SURVEY\DWG\0905–BOAT ISLAND CLUB V–SPEC PUMP SURVEY.DWG PLOTTED 11–24–14

INDIAN RIVER COUNTY ADMINISTRATION BUILDING 1801 27TH STREET VERO BEACH, FL 32960 (772) 567–8000	INDIAN RIVER COUNTY DEPARTMENT OF PUBLIC WORKS ENGINEERING DIVISION	DRAWN BY: B. ROACH APPROVED BY: M. O'BRIEN	SECTION 13 TOWNSHIP 32S RANGE 39E	SKETCH AND DESCRIPTION OF SOVEREIGNTY LAND LEASE BOAT CLUB ISLAND (SPOIL ISLAND "IR25")	SHEET 4 OF 4

33.00

IN THE RECORDS OF
JEFFREY K. BARTON
CLERK CIRCUIT COURT
INDIAN RIVER CO., FLA.

TATE OF FLORIDA
NDIAN RIVER COUNTY
HIS IS TO CERTIFY THAT THIS IS
TRUE AND CORRECT COPY OF
HE ORIGINAL ON FILE IN THIS
FFICE.
JEFFREY K. BARTON, CLERK
Patricia Jones D.C.
ATE 3-12-96

DEPARTMENT OF THE ARMY
CONSENT TO EASEMENT
TO USE CORPS OF ENGINEERS RIGHT-OF-WAY

Consent No. DACW17-9-96-0028
Project: Intracoastal Waterway, Jacksonville to Miami, Indian River County, Florida
Tract No. 398

0929424

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OR 1094 PG 1056

THIS CONSENT TO EASEMENT AGREEMENT, made by and between the **UNITED STATES OF AMERICA, DEPARTMENT OF THE ARMY**, hereinafter referred to as the "Government", acting by and through the Chief, Real Estate Division, U.S. Army Corps of Engineers, Jacksonville District, hereinafter referred to as "said officer," and Board of County Commissioners, Indian River County, Florida, 1840 25th Street, Vero Beach, Florida 32960, hereinafter referred to as the "Grantee":

WHEREAS, the Government has acquired a perpetual easement over the above-numbered tract of land, which easement, by its terms, reserves to the Government, in perpetuity, the right to deposit dredged material in connection with construction, improvement, and maintenance of the Intracoastal Waterway, Jacksonville to Miami, Indian River County, Florida; and

WHEREAS, the Grantee has requested permission to operate and maintain a public recreational facility in, on, across, over, and under a portion of the lands identified as Tract No. 398, Section 13, Township 32 South, Range 39 East, Indian River County, Florida. The area comprising 12.00 acres, more or less, is shown in red on Exhibit "A" attached hereto and made a part hereof.

NOW THEREFORE, this consent is granted and accepted under the following conditions:

1. That it is understood that this consent is effective only insofar as the property rights of the Government in the land to be occupied are concerned, and that it does not relieve the Grantee from the necessity of obtaining grants from the owners of the fee and/or other interests, therein, nor does it obviate the requirement that the Grantee obtain State or local assent required by law for the activity authorized herein.

COUNTY ATTORNEY'S OFFICE
INDIAN RIVER COUNTY
1840 25th Street
Vero Beach, Florida 32960

Attachment A
Page 11 of 16 Pages
SSLL No. 310345813

2. That any proposed improvements or use authorized herein shall not be commenced until appropriate rights shall have been obtained by the Grantee from the record owners and encumbrancers of the fee title to the lands involved, or until the Grantee has obtained all Federal, State, or local permits required by law.

3. That the proposed improvements or use authorized herein shall be consistent with the terms and conditions of this Consent; and that any improvements or use not specifically identified and authorized shall constitute a violation of the terms and conditions of this Consent which may result in a revocation of this Consent and in the institution of such legal proceedings as the Government may consider appropriate, whether or not this Consent has been revoked or modified.

4. That the exercise of the privileges hereby consented to shall be without cost or expense to the Government and under the supervision of and subject to the approval of the said officer having immediate jurisdiction over the property and subject to such regulations as he may from time to time prescribe, including, but not limited to, the specific conditions, requirements, and specifications set forth in paragraph 14 below.

5. That the Grantee shall supervise and maintain the said improvements and cause it to be inspected at reasonable intervals, and shall immediately repair any damage found therein as a result of such inspection, or when requested by said officer to repair any defects. Upon completion of the installation of said improvements or the making of any repairs thereto, the premises shall be restored immediately by the Grantee, at the Grantee's own expense, to the same condition as that in which they existed prior to the commencement of such work, to the satisfaction of said officer.

6. That any property of the Government damaged or destroyed by the Grantee incident to the exercise of the privileges herein granted shall be promptly repaired or replaced by the Grantee to the satisfaction of the said officer, or in lieu of such repair or replacement, the Grantee shall, if so required by said officer and at his option, pay to the Government an amount sufficient to

OR 1094 PG 1057

compensate for the loss sustained by the Government by reason of damage to or destruction of Government property.

7. That the Government shall not be responsible for damages to the property or injuries to persons which may arise from or be incident to the exercise of the privileges herein granted, or for damages to the property of the Grantee, or for damages to the property or injuries to the person of the Grantee, or the persons of Grantee's officers, agents, servants, or employees, or others who may be on said premises at the invitation of the Grantee or the invitation of one of them, arising from Governmental activities on or in the vicinity of the said premises, and the Grantee shall hold the Government harmless from any and all claims.

8. That the Government shall in no case be liable for any damage to any improvements herein authorized which may be caused by any action of the Government, under the rights obtained in its easements, either hidden or known, or that may result from the future operations undertaken by the Government, and no claim or right to compensation shall accrue from such damage, and if further operations of the Government require the alteration or removal of any improvements herein authorized, the Grantee shall, upon due notice, from said officer, alter or remove said improvements without expense to the Government and subject to the supervision and approval of the said officer and no claim for damages shall be made against the Government on account of such alterations or removal.

9. That construction and/or operation, maintenance, and use of any improvements incident to the exercise of the privileges herein granted shall be in such a manner as not to conflict with the rights of the Government, nor to interfere with the operations by the Government under such rights nor to endanger lives and safety of the public.

10. That this Consent may be terminated by the Government or said officer upon reasonable notice to the Grantee if the Government or said officer shall determine that any improvements or use to which consent is herein granted interferes with the use of said land or any part thereof by the Government, and this Consent may be annulled and forfeited by the declaration of the Government or said officer for failure to comply with any or all of the

OR 1094 PG 1058

15. That this Consent may not be transferred to a third party without the prior written notice to the Chief, Real Estate Division, U.S. Army Corps of Engineers, Jacksonville District, Post Office Box 4970, Jacksonville, Florida 32232-0019, and by the transferee's written agreement to comply with and be bound by all the terms and conditions of this Consent. In addition, if the Grantee transfers the improvements authorized herein by conveyance of realty, the deed shall reference this Consent and the terms and conditions herein and the Consent shall be recorded along with the deed in the Registrar of Deeds or with other appropriate official.

This Consent is not subject to Title 10, United States Code, Section 2662.

IN WITNESS WHEREOF, I have hereunto set my hand, by authority of the Secretary of the Army, this 1st day of March 1996.

UNITED STATES OF AMERICA

BY: Bart J. Wivell

BART J. WIVELL
Chief, Real Estate Division
U.S. Army Engineer District
Jacksonville, Florida

BOARD OF COUNTY COMMISSIONERS,
INDIAN RIVER COUNTY, FLORIDA

BY: Fran B Adams
FRAN B. ADAMS, CHAIRMAN
2/20/96

ATTEST: Jeffrey R. Smith, Clerk
By: Patricia Blair, D.C.

Indian River County	Approved	Date
Adm...	BSC	2/14/96
Budget		2/14/96
Legal		2/14
Risk Mana...		
Department		2/6/96
Division		

OR 1094 PG 1060

Attachment A
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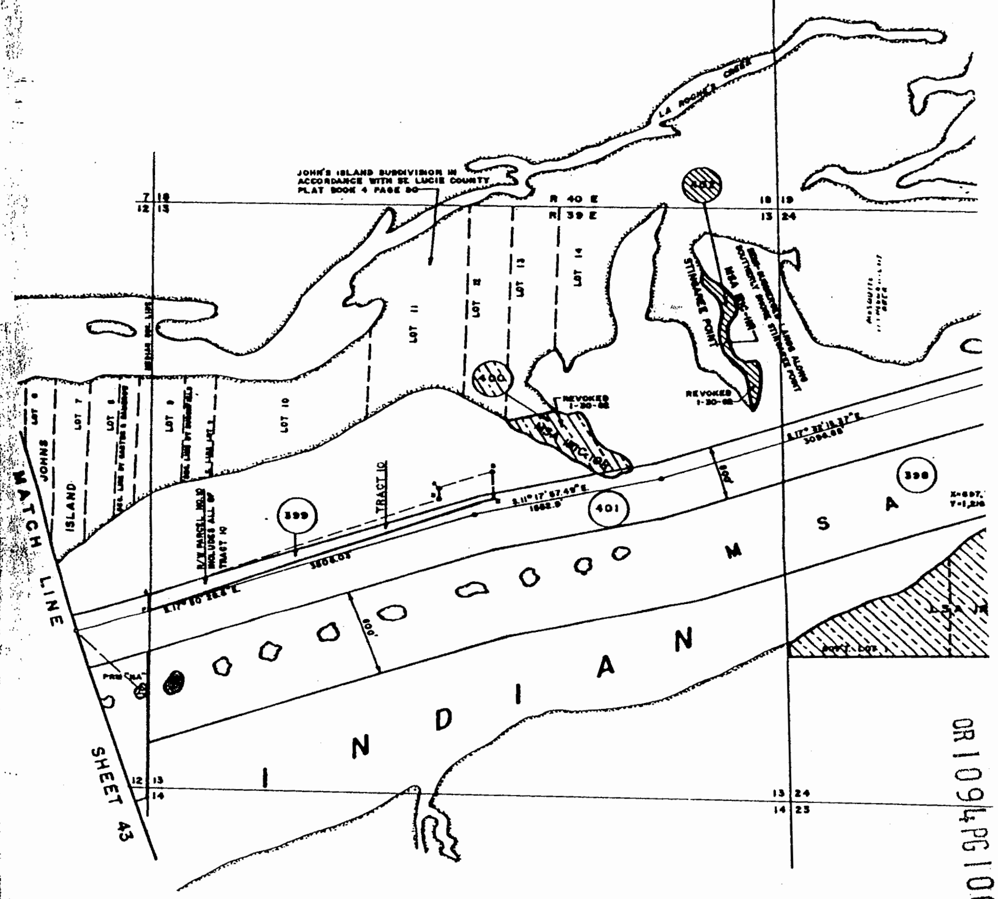
SSLL No. 310345813

		T.I.I.F.		.03	" " " " "
					SEE SHEET NO. 42
					" " "
					" " "
	DWN III-23	T.I.I.F.		93.24	[illegible]
	LSA III 40-32-1	E.C. WALKER & V.W. RUSSELL, ET VIR		56.25	TEMP. S/A EASE. FROM 8-28-58 TO 9-1-60
	LSA III 40-32-1H	" " " "		80.00	" " " " 9-20-58 " "
	LSA III 40-32-1A	G.F. REASON, ET UX & D.M. HEPNER, ET UX		20.87	" " " " 11-20-58 " "
		FRED R. TUERK, ET UX	14.92		DEED DATED 12-21-61
		" " " " "	12.09		" " "
	LSA III 40-32-2	M.A. GREGORY, R.B. WIGGINS & H.J. BINNINGTON		73.50	TEMP. S/A EASE. FROM 9-4-58 TO 9-1-60
	LSA III 40-32-2	" " " "		21.83	" " " " " " "
	LSA III 40-32-2B	A.C. MAC CONNELL, ET UX		60.00	" " " " 9-25-58 " "
	LSA III 40-32-3	A.F.G. LUCAS, ET UX		13.00	" " " " 9-25-58 " "
	LSA III 40-32-2A	T.E. MOODY, ET UX & E.W. KNIGHT, ET UX		24.67	" " " " 9-5-58 " 4-1-59
		F.I.N.D.		13.08	PERP. S/A AND P/L EASE. FROM 3-26-62
		"		11.18	" " " " " " "



OR 1094 PG 1061

EXHIBIT "A"

Attachment A
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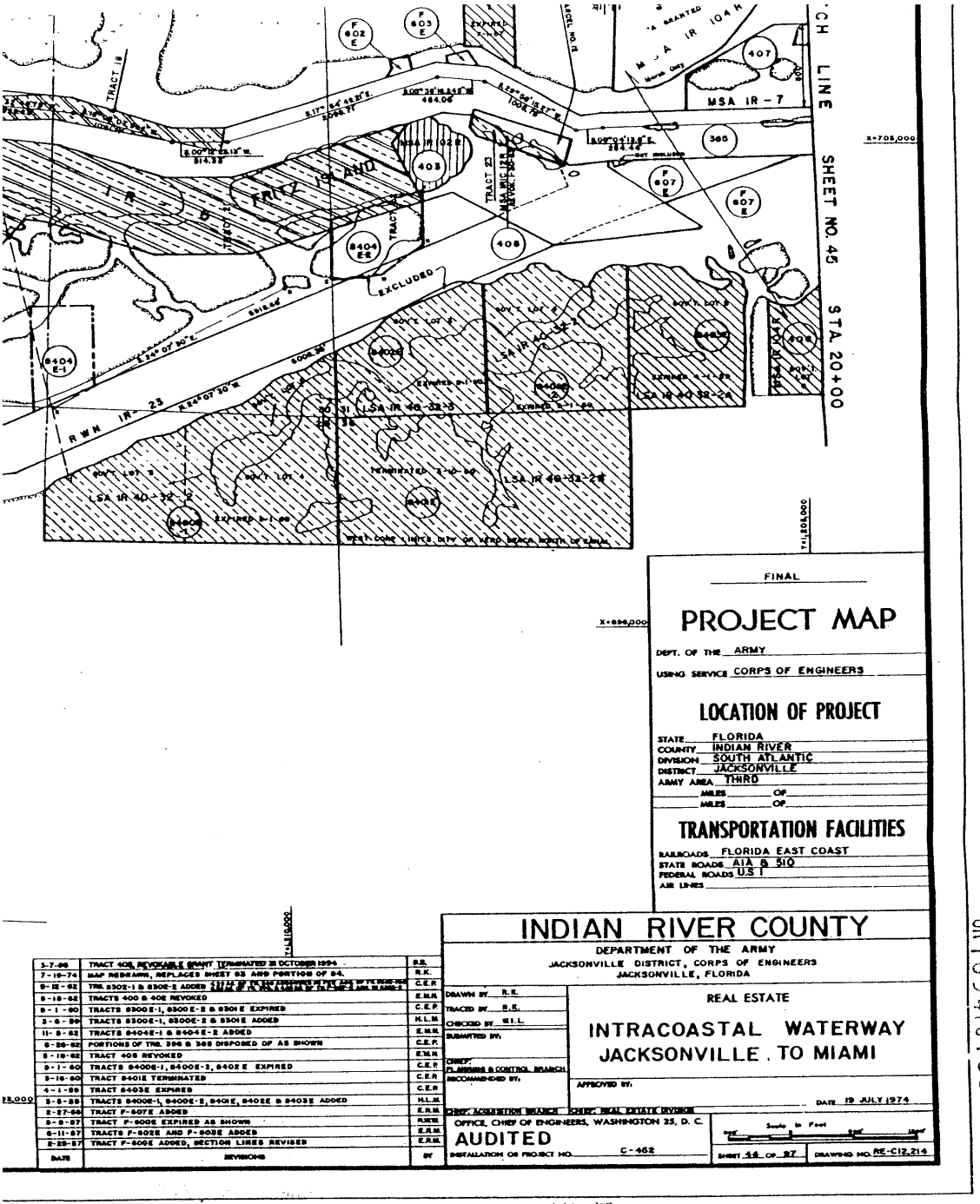

EXHIBIT "A"

Attachment A
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SSLL No. 310345813

Appendix B

Resource Data

B.1 / Glossary of Terms

aboriginal - the original biota of a geographical region (Lincoln, Boxshall & Clark, 2003).

acre-feet - the volume (as of irrigation water) that would cover one acre to a depth of one foot (Merriam-Webster's Collegiate Dictionary, 2005).

adaptive management - Adaptive management is a systematic management paradigm that assumes natural resource management policies and actions are not static, but are adjusted based on the combination of new scientific and socio-economic information. an continual process of planning, monitoring, research, evaluation and adjusting management to meet pre-defined goals (GreenFacts, 2013).

algal bloom - a mass of algae which develops rapidly in a water body as a result of eutrophication (Collin, 2004).

anaerobic - growing or occurring in the absence of molecular oxygen (Lincoln et al., 2003).

anoxic - referring to water which lacks oxygen (Collin, 2004).

anthropogenic - caused by or resulting from human activities (Collin, 2004).

aquaculture - the cultivation of aquatic organisms (Lincoln et al., 2003).

aquatic - referring to water (Collin, 2004).

aquifer - a body of porous rock or soil through which water passes and in which water gathers (Collin, 2004).

atmospheric pressure (barometric pressure) - the pressure exerted in every direction at any given point by the weight of the atmosphere (Merriam-Webster's Collegiate Dictionary , 2005).

basin/sub-basin - a large low-lying area of land, drained by a large river system or surrounding an ocean. *Thousands of tributaries drain into the Amazon basin* (Collin, 2004).

benthic - on or living on the bottom of the sea or of a lake (Collin, 2004).

berm - a mound or wall of earth or sand (Merriam-Webster's Collegiate Dictionary , 2005).

biodiversity - the range of species, subspecies or communities in a specific habitat such as a rainforest or a meadow (Collin, 2004).

biological integrity - biotic composition, structure and function at the genetic, organism and community levels consistent with natural conditions and the biological processes that shape genomes, organisms and communities (GreenFacts, 2005).

biota - the flora and fauna of a region (Collin, 2004).

biotic community - a community of organisms in a specific area (Collin, 2004).

bivalve - an invertebrate animal with a shell composed of two halves joined at one place. Bivalves such as oysters or mussels may live in fresh or salt water (Collin, 2004).

Blueway Program - land acquisition program with a goal to buy and preserve 26,000 acres of waterfront land from Volusia to Martin counties (Marine Resource Council, 2013).

buffer zones - land between a protected area such as a nature reserve and the surrounding countryside or town (Collin, 2004).

carapace - a bony or chitinous case or shield covering the back or part of the back of an animal such as a turtle or crab (Merriam-Webster's Collegiate Dictionary , 2005).

codify - to arrange laws and rules systematically (Neufeldt & Sparks, 1990).

coir - fiber from the outer husk of the coconut, used for making ropes and matting (Merriam-Websters Collegiate Dictionary, 2005).

community - a group of different organisms which live together in an area (Collin, 2004).

conservation - the maintenance of environmental quality and resources by the use of ecological knowledge and principles (Collin, 2004).

conservation easement - Easement restricting a landowner to land uses that that are compatible with long-term conservation and environmental values (U.S. Environmental Protection Agency [EPA], 1997).

consolidated substrate - consolidated substrates are solidified rock or shell conglomerates and include coquina, limerock or relic reef materials. (Florida Natural Areas Inventory, 2010).

cultch - waste material placed in the sea to act as a breeding ground for oysters (Collin, 2004).

cultural resource - Natural or manmade features having cultural or historical significance, such as structures, graves, religious sites, vistas, or bodies of water (EPA, 1997).

cumulative - produced by being added in small, regular amounts (Collin, 2004).

cuspate - a large triangular area of deposits made by the sea on a coast (Collin, 2004).

cyanobacteria - a bacterium of a large group that carry out photosynthesis (Collin, 2004).

database - an integrated collection of files of data stored in a structured form in a large memory, which can be accessed by one or more users at different terminals (Collin, 2004).

degradation - a reduction in the quality of something (Collin, 2004).

derelict - referring to a object which is neglected and in ruins (Collin, 2004).

detritus - Accumulated organic debris from dead organisms that is often an important source of food in a food web (EPA, 1997).

dinoflagelalte - A type of algae with long, whip-like structures called flagellates (EPA, 1997).

disseminate - to scatter widely or disperse (Collin, 2004).

diversity - the richness of the number of species (Collin, 2004).

drainage basin (catchment) - the area from which a surface watercourse or a groundwater system derives its water; watershed. (Allaby, 2005)

dredge - to remove silt and alluvial deposits from a river bed or other water course or channel (Collin, 2004).

ecological integrity - The condition of an unimpaired ecosystem as measured by combined chemical, physical (including physical habitat), and biological attributes (EPA, 1997).

ecology - the study of the relationships among organisms as well as the relationships between them and their physical environment (Collins, 2004).

ecosystem - a community of organisms and their physical environment interacting as an ecological unit (Lincoln et al., 2003).

ecosystem approach - a set of internationally agreed principles guiding the way in which the natural environment and wildlife should be managed (Collin, 2004).

ecosystem-based management - an environmental management approach that recognizes the full array of interactions within an ecosystem, including humans, rather than considering single issues, species, or ecosystem services in isolation (McLeod & Leslie, 2009).

ecotourism - a form of tourism that increases people's understanding of natural areas, without adversely affecting the environment, and gives local people financial benefits from conserving natural resources (Collin, 2004).

emergent - an aquatic plant having most of the vegetative parts above water; a tree which reaches above the level of the surrounding canopy. (Lincoln et al., 2003)

endangered species - an animal or plant species in danger of extinction throughout all or a significant portion of its range. (U.S. Fish and Wildlife Service [FWS], 2005)

endemic - native to, and restricted to, a particular geographical region. (Lincoln et al., 2003)

environment - the surroundings of any organism, including the physical world and other organisms (Collin, 2004).

ephemeral - having a very short life cycle (Hale & Margham, 1991).

epifauna - the animal life inhabiting a sediment surface or water surface. (Merriam-Webster's Collegiate Dictionary, 2005).

epiphyte - a plant that lives on another plant for physical support, but is not a parasite of it (Collin, 2004).

estuarine - referring to estuaries (Collin, 2004).

estuary - a part of a river where it meets the sea and is partly composed of salt water (Collin, 2004).

evapotranspiration - is the sum of evaporation and plant transpiration from the Earth's land surface to atmosphere (Merriam-Webster's Collegiate Dictionary, 2005).

extinction - the disappearance of a species from a given habitat (Lincoln et al., 2003).

fauna - the animal life of a given region, habitat or geological stratum (Lincoln et al., 2003).

flora - the plant life of a given region, habitat or geological stratum (Lincoln et al., 2003).

fouling organisms - an assemblage of organisms growing on the surface of floating or submerged man-made objects, that increases resistance to water flow or otherwise interferes with the desired operation of the structure.

geographic information system (GIS) - computer system supporting the collection, storage, manipulation and query of spatially referred data, typically including an interface for displaying geographical maps (Lincoln et al., 2003).

geology - the scientific study of the composition of the earth's surface and its underlying strata (Collin, 2004).

geomorphology - the study of the physical features of the Earth's surface, their development and how they are related to the core beneath (Collin, 2004).

habitat - the type of environment in which a specific organism lives (Collin, 2004).

habitat degradation - the process of transitioning from a higher quality to a lower quality wildlife habitat (EPA, 1997).

habitat fragmentation - A process during which larger areas of habitat are broken into a number of smaller patches of smaller total area, isolated from each other by a matrix of habitats unlike the original habitat (EPA, 1997).

harmful algal bloom - (HAB) a dense concentration (bloom) of a single-celled, plant like marine organism (phytoplankton) that produces toxins which are detrimental to plants and animals. An algal bloom can still kill fish and other aquatic life by decreasing sunlight available to the water and by using up all of the available oxygen in the water. A harmful algal bloom specifically produces harmful toxins (Phlips, 2002).

herbicide - a chemical that kills plants, especially used to control weeds (Collin, 2004).

heterogeneous - having different characteristics or qualities (Collin, 2004).

homogeneity - Characteristic of a medium in which material properties are identical throughout (EPA, 1997).

hydric - pertaining to water; wet (Lincoln et al., 2003).

hydrogeologic - The natural process recycling water from the atmosphere down to (and through) the earth and back to the atmosphere again (EPA, 1997).

hydrology - the study of water, its composition and properties and in particular the place of water in the environment (Collin, 2004).

hydroperiod - the period in which a soil area is waterlogged (Merriam-Webster's Collegiate Dictionary , 2005).

hypoxic - containing very little oxygen (Collin, 2004).

immunologic- the ability of a plant to resist disease through a protective covering on leaves, through the formation of protoplasts or through the development of inactive forms of viruses (Collin, 2004).

impaired waterbody - a waterbody that does not meet the criteria that support its designated use (EPA, 1997).

indicator species - a species which is very sensitive to particular changes in the environment and can show that environmental changes are taking place (Collin, 2004).

indigenous - native to a place (Collin, 2004).

infauna - the animal life within a sediment; epifauna (Lincoln et al., 2003) .

insolation - the radiation from the sun (Collin, 2004).

intertidal zone - the shore zone between the highest and lowest tides; littoral (Lincoln et al., 2003).

invasive exotic species - referring to a non-native organism that enters an area in large numbers that threatens an ecosystem, habitat or other species (Collin, 2004).

keystone species - a species that plays a significant role in helping to maintain the ecosystems that it is part of (Collin, 2004).

listed species - a species, subspecies, or distinct population segment that has been added to the Federal list of endangered and threatened wildlife and plants (FWS, 2005).

littoral - an area of water at the edge of a lake where plants grow; an area of the sea and shore between the high and low water marks (Collin, 2004).

mandate - an order or command; the will of constituents expressed to their representative, legislature, etc. (Neufeldt & Sparks, 1990).

mesic - pertaining to conditions of moderate moisture or water supply; used of organisms occupying moist habitats (Lincoln et al., 2003).

mesohaline - referring to water that contains a limited amount of salt (Collin, 2004).

midden - A mound or deposit containing shells, animal bones, and other refuse that indicates the site of a human settlement (Collin, 2004).

mitigation - actions taken to avoid, reduce, or compensate for the effects of environmental damage. Among the broad spectrum of possible actions are those which restore, enhance, create, or replace damaged ecosystems (EPA, 1997).

monitoring - a process of regular checking on the progress of something (Collin, 2004).

mosaic - an organism comprising tissues of two or more genetic types; usually used with reference to plants (Lincoln et al., 2003).

muck - earth made from decaying plant materials (EPA, 1997).

native - always having lived, grown or existed in a place (Collin, 2004).

nekton - swimming sea animals such as fish, as opposed to floating or drifting animals such as plankton (Collin, 2004).

neurotoxic - a toxin that has the capacity to prevent nerve impulses from working (Collin, 2004).

niche - a place in an ecosystem which a species has adapted to occupy (Collin, 2004).

non-point source pollution - a source of pollution not associated with a specific discharge point (Collin, 2004).

oligohaline - having traces of salt (Collin, 2004).

ooze - soft mud, especially at the bottom of a lake or the sea (Collin, 2004).

oviposition - to deposit or lay eggs, especially by means of an ovipositor (Collin, 2004).

paleophytes - Any prehistoric plant, especially one known only from fossils (Collin, 2004).

pelagic - referring to the top and middle layers of sea water (Collin, 2004).

pesticide - a chemical compound used to kill pests such as insects, other animals, fungi or weeds (Collin, 2004).

physiography - physical geography is one of the two major subfields of geography; focuses on understanding the processes and patterns in the natural environment, as opposed to the built environment which is the domain of human geography (Merriam-Webster's Collegiate Dictionary, 2005).

phytoplankton - microscopic plants that float in the sea or in a lake (NOTE: phytoplankton, formed mainly of diatoms and using the sunlight in the surface layers of the water to photosynthesize, are the basis of the food chain of almost all aquatic animals.) (Collin, 2004).

plankton - the microscopic animals and plants that drift near the surface of the water, belonging to two groups: zooplankton, which are microscopic animals, and phytoplankton, which are microscopic plants capable of photosynthesis (Collin, 2004).

pollution - the presence of unusually high concentrations of harmful substances in the environment, as a result of human activity or a natural process (Collin, 2004).

population - all individuals of one or more species within a prescribed area; a group of organisms of one species, occupying a defined area and usually isolated to some degree from other similar groups (Lincoln et al., 2003).

potable water - referring to water that is suitable for drinking (Collin, 2004).

reintroduction - the process of helping a species to live successfully again in an area it had formerly inhabited (Collin, 2004).

residence time - the amount of time during which something remains in the same place or in the same state until it is lost or transformed into something else (Collin, 2004).

restoration - the act or process of putting something back to a previous natural state (Collin, 2004).

rhizomes - a plant stem that lies on or under the ground and has leaf buds and adventitious roots (Collin,2004).

riparian - referring to the bank of a river (Collin, 2004).

ruderal - growing in rubbish or on wasteland (Collin, 2004).

runoff - part of precipitation that is not held in the soil but drains freely away (Lincoln et al., 2003).

saline - referring to salt (Collin, 2004).

salinity - a measure of the total concentration of dissolved salts in seawater (Lincoln et al., 2003).

sediment - a mass of solid particles, usually insoluble, that fall to the bottom of a liquid (Collin, 2004).

sedimentation - the process of formation of sedimentary rock; the process of solid particles falling to the bottom of a liquid, e.g. in the treatment of sewage (Collin, 2004).

sessile - non-motile; permanently attached at the base (Lincoln et al., 2003).

sovereignty submerged lands - Sovereignty submerged lands include, but are not limited to, tidal lands, islands, sandbars, shallow banks and lands waterward of the ordinary or mean high water line, beneath navigable fresh water or beneath tidally-influenced waters (EPA, 1997).

spat - juvenile oysters that have just attached to a hard surface (EPA, 1997).

spawn - a mass of eggs produced by a fish or reptile (Collin, 2004).

spawning aggregation - a group of individuals of a species living in close proximity during mating or reproductive cycles.

species - a group of organisms, minerals or other entities formally recognized as distinct from other groups; the basic unit of biological classification (Lincoln et al., 2003).

species abundance - The total number of individual of a species within a given area or community (Oceanlink, 2013).

species diversity - the range of species found in an area (Collin, 2004).

species of concern - an informal term referring to a species that might be in need of conservation action. This may range from a need for periodic monitoring of populations and threats to the species and its habitat, to the necessity for listing as threatened or endangered. Such species receive no legal protection and use of the term does not necessarily

imply that a species will eventually be proposed for listing. “Imperiled species” is another general term for listed as well as unlisted species that are declining (FWS, 2005).

species of special concern - those species about which NOAA’s National Marine Fisheries Service (NMFS) has some concerns regarding status and threats, but for which insufficient information is available to indicate a need to list the species under the Endangered Species Act (FWS, 2005).

stakeholder - any person or organization who has an interest in the actions discussed or is affected by the resulting outcomes of a project or action (FWS, 2005).

sterol - any of a group of naturally occurring unsaturated steroid alcohols, typically waxy solids (Hale and Margham, 1991).

submerged aquatic vegetation - aquatic vegetation, such as sea grasses, that cannot withstand excessive drying and therefore live with their leaves at or below the water surface. SAVs provide an important habitat for young fish and other aquatic organisms (EPA, 1997).

substrate - the matter or surface on which an organism lives (Collin, 2004).

subtidal - environment which lies below the mean low water level (Allaby, 2005).

succession - a series of stages, one after the other, by which a group of organisms living in a community reaches its final stable state or climax (Collin, 2004).

supratidal - the zone on the shore above mean high tide level (Lincoln et al., 2003).

surficial aquifer - shallow beds of shells and sand that lie less than 100 feet underground. They are separated from the Floridan aquifer by a confining bed of soil (Scott, 2001).

threatened species - an animal or plant species likely to become endangered within the foreseeable future throughout all or a significant portion of its range (FWS, 2005).

topography - the study of the physical features of a geographical area (Collin, 2004).

total maximum daily load (TMDL) - the amount, or load, of a specific pollutant that a waterbody can assimilate and still meet the water quality standard for its designated use. For impaired waters the TMDL reduces the overall load by allocating the load among current pollutant loads (from point and nonpoint sources), background or natural loads, a margin of safety, and sometimes an allocation for future growth (EPA, 1997).

transect - a line used in ecological surveys to provide a way of measuring and showing the distribution of organisms (Collin, 2004).

trawl - a very long net with a wide mouth tapering to a pointed end, towed behind a fishing boat at any depth in the sea (Collin, 2004).

turbid - cloudy; opaque with suspended matter (Lincoln et al., 2003).

unconsolidated substrate - unsolidified material including coralgal, marl, mud, mud/sand, sand or shell (FNAI, 2010).

upland - land elevated above other land. (Neufeldt & Sparks, 1990)

vegetation - plant life or cover in an area; also used as a general term for plant life (Lincoln et al., 2003).

water column - the vertical column of water in a sea or lake extending from the surface to the bottom (Lincoln et al., 2003).

watershed - an elevated boundary area separating tributaries draining in to different river systems; drainage basin (Lincoln et al., 2003).

wetland - an area of low lying land, submerged or inundated periodically by fresh or saline water (Lincoln et al., 2003).

wetlands - an area of land where the soil surface is almost level with the water table and where specially adapted vegetation has developed (Collin, 2004).

wildlife - any undomesticated organisms; wild animals (Allaby, 2005).

zooplankton - microscopic animals that live and drift in water (Collin, 2004).

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Common Name	Species Name	Status (FDACS, 2010; FWC, 2013)
Legend: FT = Federally- and State-Designated Threatened • **FE** = Federally-and State-Designated Endangered **ST** = State-Designated Threatened • **SE** = State-Designated Endangered • **SSC** = State Species of Special Concern **(S/A)** = listed due to similarity of appearance • **CE**= commercially exploited		
Kingdom Fungi (fungi)		
Division Mycophycophyta (lichens)		
Reindeer moss	*Cladonia* sp.	
Kingdom Plantae (plants)		
Division Pterophyta (ferns)		
Giant leather fern	*Acrostichum danaeifolium*	
Swamp fern	*Blechnum serrulatum*	
Strap fern	*Campyloneurum phyllitidis*	
Water horn fern	*Ceratopteris thalictroides*	
Boston fern	*Nephrolepis exaltata*	
Hand fern	*Ophioglossum palmatum*	SE
Cinnamon fern	*Osmunda cinnamomea*	CE
Royal fern	*Osmunda regalis*	CE
Golden polypody	*Phlebodium aureum*	
Resurrection fern	*Polypodium polypodioides*	
Whisk fern	*Psilotum nudum*	
Pineland braken fern	*Pteridium aquilinum*	
Water fern	*Salvinia rotundifolia*	
Wood fern	*Thelypteris interrupta*	
Marsh fern	*Thelypteris palustris*	
Shoestring fern	*Vittaria lineata*	
Chain fern	*Woodwardia virginica*	
Division Pinophyta (cone-bearing plants)		
Sand pine	*Pinus clausa*	
South Florida slash pine	*Pinus elliotti* var. *densa*	
Division Magnoliophyta (flowering plants)		
Class Liliopsida (Grass-like flowering plants)		
Yellow joyweed	*Alternanthera flavescens*	
Beach chaff-flower	*Alternanthera maritima*	
Wiregrass (threeawn)	*Aristida beyrichiana*	
Samphfire	*Blutaparon vermiculare*	
Many-flowered grass-pink	*Calopogon multiflorus*	ST
Swamp grass	*Carex* sp.	
Dayflower	*Commelina erecta*	
Swamp lily	*Crinum americanum*	
Sedge	*Cyperus* sp.	
Durban crowfoot grass	*Dactyloctenium aegyptium*	
Saltgrass	*Distichlis spicata*	
Butterfly orchid	*Encyclia tampensis*	CE
Pipewort	*Eriocaulon decangulare*	
Ground orchid	*Habenaria* sp.	
Shoal grass	*Halodule wrightii*	
Paddle grass	*Halophila decipiens*	
Star grass	*Halophila engelmannii*	
Johnson's seagrass	*Halophila johnsonii*	FT
Spider lily	*Hymenocallis latifolia*	
Black needle rush	*Juncus roemerianus*	
Rush	*Juncus* sp.	

Common Name	Species Name	Status (FDACS, 2010; FWC, 2013)
Legend: FT = Federally- and State-Designated Threatened • **FE** = Federally-and State-Designated Endangered **ST** = State-Designated Threatened • **SE** = State-Designated Endangered • **SSC** = State Species of Special Concern **(S/A)** = listed due to similarity of appearance • **CE**= commercially exploited		
Redroot	*Lachnanthes caroliniana*	
Pine lily	*Lilium catesbaei*	ST
Muhly grass	*Muhlenbergia capillaris*	
Celestial Lily	*Nemastylis floridana*	SE
Florida beargrass	*Nolina atopocarpa*	ST
Prickly-pear cactus	*Opuntia humifusa*	
Bitter panic grass	*Panicum amarum*	
Panic grass	*Panicum joorii*	
Seashore paspalum	*Paspalum vaginatum*	
Spoonflower	*Peltandra sagittifolia*	
Arrow arum	*Peltandra virginica*	
Yellow fringeless orchid	*Platanthera integra*	SE
Giant orchid	*Pteroglossaspis ecristata*	ST
Whitetop	*Rhynchospora colorata*	
Star rush	*Rhynchospora latifolia*	
Widgeon grass	*Ruppia maritima*	
Cabbage (sabal) palm	*Sabal palmetto*	
Arrowhead	*Sagittaria* sp.	
Glasswort	*Salicornia* spp.	
Spike moss	*Selaginella arenicola*	
Saw palmetto	*Serenoa repens*	
Sea purslane	*Sesuvium portulacastrum*	
Yellow blue-eyed grass	*Sisyrinchium exile*	
Greenbrier	*Smilax auriculata*	
Saw greenbrier	*Smilax bona-nox*	
Catbrier	*Smilax laurifolia*	
Smooth cordgrass	*Spartina alterniflora*	
Cordgrass	*Spartina bakeri*	
Saltmeadow cordgrass	*Spartina patens*	
Seashore dropseed	*Sporobolus virginicus*	
Manatee grass	*Syringodium filiforme*	
Northern needleleaf	*Tillandsia balbisiana*	ST
Air pine	*Tillandsia fasciculata*	SE
Twisted airplant	*Tillandsia flexuosa*	ST
Twisted wild-pine	*Tillandsia paucifolia*	
Ball moss	*Tillandsia recurvata*	
Needle-leaf airplant	*Tillandsia setacea*	
Manatee River airplant	*Tillandsia simulata*	
Small's airplant	*Tillandsia smalliana*	
Spanish moss	*Tillandsia usneoides*	
Giant air pine	*Tillandsia utriculata*	SE
Leatherleaf airplant	*Tillandsia variabilis*	
Cattail	*Typha latifolia*	
Yellow-eyed grass	*Xyris* sp.	
Spanish bayonet	*Yucca aloifolia*	
Adam's needle	*Yucca filamentosa*	
Class Magnoliopsida (Woody flowering plants)		
Red maple	*Acer rubrum*	
Coastal ragweed	*Ambrosia hispida*	
Bastard indigo	*Amorpha fruiticosa*	
Pond apple	*Annona glabra*	
Marlberry	*Ardisia escallonioides*	

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Swamp milkweed	*Asclepias incarnata*	
Climbing aster	*Aster caroliniensis*	
Black mangrove	*Avicennia germinans*	
Saltbush	*Baccharis angustifolia*	
Saltbush (sea myrtle)	*Baccharis halimifolia*	
Water hyssop	*Bacopa monnieri*	
Tarflower	*Befaria racemosa*	
Spanish needle	*Bidens alba*	
False nettle	*Boehmeria cylindrica*	
Sea oxeye daisy	*Borrichia* spp.	
Gumbo limbo	*Bursera simaruba*	
American beautyberry	*Callicarpa americana*	
Florida bluebell	*Campanula floridana*	
Beach bean	*Canavalia rosea*	
Deer-tongue	*Carphephorous paniculatus*	
Water hickory	*Carya aquatica*	
Scrub hickory	*Carya floridana*	
Showy partridge pea	*Cassia chamaecrista*	
Partridge pea	*Cassia fasciculata*	
Love vine	*Cassytha filiformis*	
Buttonbush	*Cephalanthus occidentalis*	
Partridge pea	*Chamaecrista* spp.	
Dune spurge	*Chamaesyce* spp.	
Green cocoplum	*Chrysobalanus icaco*	
Water hemlock	*Cicuta mexicana*	
Sawgrass	*Cladium jamaicensis*	
Seagrape	*Coccoloba uvifera*	
Buttonwood	*Conocarpus erectus*	
Argeratum	*Conoclinium coelestinum*	
Large-flowered conradina	*Conradina grandiflora*	ST
Tickseed	*Coreopsis leavenworthii*	
Stiff cornel dogwood	*Cornus foemina*	
Beach croton	*Croton punctatus*	
Coin vine	*Dalbergia ecastophyllum*	
Persimmon	*Diospyros virginiana*	
Varnish leaf	*Dodonaea viscosa*	
Pink sundew	*Drosera capillaris*	
Devil's potato	*Echites umbellata*	
Golden creeper	*Ernodia littoralis*	
Fragrant eryngium	*Eryngium aromaticum*	
Coral bean	*Erythrina herbacea*	
White stopper	*Eugenia axillaris*	
Dog fennel	*Eupatorium* sp.	
Erect scrub spurge	*Euphorbia polyphylla*	
Seaside gentian	*Eustoma exaltatum*	
Strangler fig	*Ficus aurea*	
Florida privet	*Forestiera segregata*	
Pop ash	*Fraxinus caroliniana*	
Blanket flower	*Gaillardia pulchella*	
Galactia	*Galactia regularis*	
Southern guara	*Gaura angustifolia*	
Coastal vervain; beach verbena	*Glandularia maritima*	SE

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Verbena	*Glandularia tampensis*	SE
Loblolly bay	*Gordonia lisianthus*	
Dune sunflower	*Helianthus debilis*	
Marsh pennywort	*Hydrocotyle umbellata*	
St. Andrews cross	*Hypericum hypericoides*	
St. Johns wort	*Hypericum reductum*	
Dahoon holly	*Ilex cassine*	
Moonflower	*Ipomoea alba*	
Beach morning glory	*Ipomoea imperati*	
Railroad vine	*Ipomoea pes-caprae*	
Standing cypress	*Ipomopsis rubra*	
Beach elder	*Iva imbricata*	
White mangrove	*Laguncularia racemosa*	
Atlantic coast Florida lantana	*Lantana depressa* var. *floridana*	SE
Nodding pinweed	*Lechea cernua*	ST
Pine pinweed	*Lechea divaricata*	SE
Peppergrass	*Lepidium virginicum*	
Blazing star	*Liatris barberi*	
Gopher apple	*Licania michauxii*	
Sweetgum	*Liquidambar styraciflua*	
Primrose willow	*Ludwigia peruviana*	
Staggerbush	*Lyonia fruticosa*	
Sweet bay	*Magnolia virginiana*	
Barbara's button	*Marshallia tenuifolia*	
Florida spiny-pod	*Matelea floridana*	SE
Climbing hempweed	*Mikania scandens*	
Dotted horsemint	*Monarda punctata*	
Red mulberry	*Morus rubra*	
Simpson stopper	*Myrcianthes frangrans*	
Wax myrtle (southern bayberry)	*Myrica cerifera*	
Myrsine	*Myrsine guianensis*	
Yellow water lily (spatterdock)	*Nuphar lutea*	
American white water lily	*Nymphaea odorata*	
Seaside evening primrose	*Oenothera humifusa*	
Prickly-pear cactus	*Opuntia* sp.	
Virginia creeper	*Parthenocissus quinquefolia*	
Purple passionflower	*Passiflora incarnata*	
Corkystem passionflower	*Passiflora suberosa*	
Wild allamanda	*Pentalinon luteum*	
Swamp bay	*Persea palustris*	
Pennyroyal	*Piloblephis rigida*	
Goldenaster	*Pityopsis graminifolia*	
Camphorweed	*Pluchea rosea*	
Drumheads	*Polygala cruciata*	
Tall milkwort	*Polygala cymosa*	
Wild bachelor's button	*Polygala nana*	
Yellow bachelor's button	*Polygala rugelii*	
Tiny polygala (tiny milkwort)	*Polygala smallii*	FE
Knotweed; smartweed	*Polygonum* sp.	
Shiny-leaved wild coffee	*Psychotria nervosa*	
Soft-leaved wild coffee	*Psychotria sulzneri*	
Wild coffee	*Psychotria undata*	

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Blackroot	*Pterocaulon virgatum*	
Sand live oak	*Quercus geminata*	
Laurel oak	*Quercus laurifolia*	
Myrtle oak	*Quercus myrtifolia*	
Water oak	*Quercus nigra*	
Live oak	*Quercus virginiana*	
Mangrove rubber vine	*Rhabdadenia biflora*	
Meadow beauty	*Rhexia nashii*	
Red mangrove	*Rhizophora mangle*	
Shiny sumac	*Rhus copallina*	
Mexican clover	*Richardia brasiliensis*	
Large-flowered sabatia	*Sabatia grandiflora*	
Rosegentian	*Sabatia* sp.	
Saltwort	*Salicorniabigelovii*	
Glasswort	*Salicornia depressa*	
Coastal plain willow	*Salix caroliniana*	
Tropical sage	*Salvia coccinea*	
Elderberry	*Sambucus simpsonii*	
Water pimpernel	*Samolus parviflorus*	
White vine	*Sarcostemma clausa*	
Lizard's tail	*Saururus cernuus*	
Sensitive briar	*Schrankia microphylla*	
Pine barren goldenrod	*Solidago fistulosa*	
Twistleaf goldenrod	*Solidago tortifolia*	
Necklace pod	*Sophora tomentosa*	
Wire plant	*Stipulicida setacea*	
Trailing morning glory	*Stylisma patens*	
Bay cedar	*Suriana maritima*	
Poison ivy	*Toxicodendron radicans*	
Shiny blueberry	*Vaccinium myrsinites*	
Ironweed	*Vernonia* sp.	
Southern fox grape	*Vitis munsoniana*	
Muscadine grape	*Vitis rotundifolia*	
Calusa grape	*Vitis shuttleworthii*	
Tallow-wood (hog plum)	*Ximenia americana*	
Wild lime	*Zanthoxylum fagara*	
Kingdom Animalia (animals)		
Subphylum Vertebrata (vertebrates)		
Class Aves (birds)		
Cooper's hawk	*Accipiter cooperii*	
Sharp-shinned hawk	*Accipiter striatus*	
Spotted sandpiper	*Actitis macularia*	
Red-winged blackbird	*Agelaius phoeniceus*	
Bachman's sparrow	*Aimophila aestivalis*	
Wood duck	*Aix sponsa*	
Henslow's sparrow	*Ammodramus henslowii*	
Seaside sparrow	*Ammodramus maritimus*	
Grasshopper sparrow	*Ammodramus savannarum*	
Northern pintail	*Anas acuta*	
American widgeon	*Anas americana*	
Northern shoveler	*Anas clypeata*	

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Green-winged teal	*Anas crecca*	
Blue-winged teal	*Anas discors*	
Mottled duck	*Anas fulvigula*	
Eurasian wigeon	*Anas penelope*	
Mallard	*Anas platyrhynchos*	
American black duck	*Anas rubripes*	
Gadwall	*Anas strepera*	
Anhinga	*Anhinga anhinga*	
Water pipit	*Anthus spinoletta*	
Florida scrub-jay	*Aphelocoma coerulescens*	ST
Limpkin	*Aramus guarauna*	SSC
Ruby-throated hummingbird	*Archilochus colubris*	
Great egret	*Ardea alba*	
Great blue heron	*Ardea herodias*	
Ruddy turnstone	*Arenaria interpres*	
Short-eared owl	*Asio flammeus*	
Lesser scaup	*Aythya affinis*	
Redhead	*Aythya americana*	
Ring-necked duck	*Aythya collaris*	
Greater scaup	*Aythya marila*	
Canvasback	*Aythya valisineria*	
Upland sandpiper	*Bartramia longicauda*	
Cedar waxwing	*Bombycilla cedrorum*	
American bittern	*Botaurus lentiginosa*	
Brant	*Branta bernicla*	
Canada goose	*Branta canadensis*	
Great horned owl	*Bubo virginianus*	
Bufflehead	*Bucephala albeola*	
Common goldeneye	*Bucephala clangula*	
Red-tailed hawk	*Buteo jamaicensis*	
Red-shouldered hawk	*Buteo lineatus*	
Broad-winged hawk	*Buteo platypterus*	
Swainson's hawk	*Buteo swainsoni*	
Green heron	*Butorides virescens*	
Sanderling	*Calidris alba*	
Dunlin	*Calidris alpina*	
Red knot	*Calidris canutus*	
White-rumped sandpiper	*Calidris fuscicollis*	
Stilt sandpiper	*Calidris himantipus*	
Western sandpiper	*Calidris mauri*	
Pectoral sandpiper	*Calidris melanotos*	
Least sandpiper	*Calidris minutilla*	
Semipalmated sandpiper	*Calidris pusilla*	
Chuck-will's widow	*Caprimulgus carolinensis*	
Whip-poor-will	*Caprimulgus pelagica*	
Northern cardinal	*Cardinalis cardinalis*	
Pine siskin	*Carduelis pinus*	
American goldfinch	*Carduelis tristis*	
Turkey vulture	*Cathartes aura*	
Veery	*Catharus fuscescens*	
Gray-cheeked thrush	*Catharus minimus*	
Swainson's thrush	*Catharus ustulatus*	

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Willet	*Catoptrophorus semipalmatis*	
Belted kingfisher	*Ceryle alcyon*	
Chimney swift	*Chaetura pelagica*	
Piping plover	*Charadrius melodus*	FT
Semipalmated plover	*Charadrius semipalmatus*	
Killdeer	*Charadrius vociferus*	
Wilson's plover	*Charadrius wilsonia*	
Snow goose	*Chen caerulescens*	
Black tern	*Chlidonias niger*	
Lark sparrow	*Chondestes grammacus*	
Common nighthawk	*Chordeiles minor*	
Bonaparte's gull	*Chroicocephalus philadelphia*	
Northern harrier (marsh hawk)	*Circus cyaneus*	
Marsh wren	*Cistothorus palustris*	
Sedge wren	*Cistothorus platensis*	
Oldsquaw	*Clangula hyemalis*	
Yellow-billed cuckoo	*Coccyzus americanus*	
Black-billed cuckoo	*Coccyzus erythropthalmus*	
Northern flicker	*Colaptes auratus*	
Northern bobwhite	*Colinus virginianus*	
Rock dove	*Columba livia*	
Common ground-dove	*Columbina passerina*	
Black vulture	*Coragyps atratus*	
Common crow	*Corvus brachyrhynchos*	
Fish crow	*Corvus ossifragus*	
Smooth-billed ani	*Crotophaga ani*	
Blue jay	*Cyanocitta cristata*	
Fulvous whistling-duck	*Dendrocygna bicolor*	
Black-throated blue warbler	*Dendroica caerulescens*	
Bay-breasted warbler	*Dendroica castanea*	
Yellow-rumped warbler	*Dendroica coronata*	
Prarie warbler	*Dendroica discolor*	
Florida prairie warbler	*Dendroica discolor paludicola*	
Yellow-throated warbler	*Dendroica dominica*	
Blackburnian warbler	*Dendroica fusca*	
Magnolia warbler	*Dendroica magnolia*	
Palm warbler	*Dendroica palmarum*	
Chestnut-sided warbler	*Dendroica pensylvanica*	
Yellow warbler	*Dendroica petechia*	
Pine warbler	*Dendroica pinus*	
Blackpoll warbler	*Dendroica striata*	
Cape May warbler	*Dendroica tigrina*	
Black-throated green warbler	*Dendroica virens*	
Bobolink	*Dolichonyx oryzivorus*	
Pileated woodpecker	*Dryocopus pileatus*	
Gray catbird	*Dumetella carolinensis*	
Little blue heron	*Egretta caerulea*	SSC
Reddish egret	*Egretta rufescens*	SSC
Snowy egret	*Egretta thula*	SSC
Tricolor heron	*Egretta tricolor*	SSC
Swallow-tailed kite	*Elanoides forficatus*	
Alder flycatcher	*Empidonax alnorum*	

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Least flycatcher	*Empidonax minimus*	
Flycatcher	*Empidonax* sp.	
Acadian flycatcher	*Empidonax virescens*	
White ibis	*Eudocimus albus*	SSC
Rusty blackbird	*Euphagus carolinus*	
Merlin	*Falco columbarius*	
Peregrine falcon	*Falco peregrinus*	
Southeastern kestrel	*Falco sparverius paulus*	ST
Magnificent frigatebird	*Fregata magnificens*	
American coot	*Fulica americana*	
Common snipe	*Gallinago gallinago*	
Common gallinule; common moorhen	*Gallinula chloropus*	
Common loon	*Gavia immer*	
Red-throated loon	*Gavia stellata*	
Common yellowthroat	*Geothlypis trichas*	
Florida sandhill crane	*Grus canadensis pratensis*	ST
Blue grosbeak	*Guiraca caerulea*	
American oystercatcher	*Haematopus palliatus*	SSC
Bald eagle	*Haliaeetus leucocephalus*	
Worm-eating warbler	*Helmitheros vermivorum*	
Black-necked stilt	*Himantopus mexicanus*	
Barn swallow	*Hirundo rustica*	
Wood thrush	*Hylocichla mustelina*	
Yellow-breasted chat	*Icteria virens*	
Northern oriole	*Icterus galbula*	
Orchard oriole	*Icterus spurius*	
Least bittern	*Ixobrychus exilis*	
Loggerhead shrike	*Lanius ludovicianus*	
Herring gull	*Larus argentatus*	
Laughing gull	*Larus atricilla*	
Ring-billed gull	*Larus delawarensis*	
Great black-back gull	*Larus marinus*	
Black rail	*Laterallus jamaicensis*	
Short-billed dowitcher	*Limnodromus griseus*	
Swainson's warbler	*Limnothlypis swainsonii*	
Marbled godwit	*Limosa fedoa*	
Northern phalarope	*Lobipes lobatus*	
Hooded merganser	*Lophodytes cucullatus*	
Red-bellied woodpecker	*Melanerpes carolinus*	
Red-headed woodpecker	*Melanerpes erthrocephalus*	
White-winged scoter	*Melanitta fusca*	
Black scoter	*Melanitta nigra*	
Surf scoter	*Melanitta perspicillata*	
Wild turkey	*Meleagris gallopavo*	
Swamp sparrow	*Melospiza georgiana*	
Lincoln's sparrow	*Melospiza lincolnii*	
Song sparrow	*Melospiza melodia*	
Red-breasted merganser	*Mergus serrator*	
Northern mockingbird	*Mimus polyglottos*	
Black-and-white warbler	*Mniotilta varia*	
Brown-headed cowbird	*Molothrus ater*	
Northern gannet	*Morus bassanus*	

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Wood stork	*Mycteria americana*	FE
Great crested flycatcher	*Myiarchus crinitus*	
Long-billed curlew	*Numenius americanus*	
Whimbrel	*Numenius phaeopus*	
Yellow-crowned night heron	*Nyctanassa violacea*	
Black-crowned night heron	*Nycticorax nycticorax*	
Wilson's storm-Petrel	*Oceanites oceanicus*	
Connecticut warbler	*Oporornis agilis*	
Kentucky warbler	*Oporornis formosus*	
Eastern screech-owl	*Otus asio*	
Ruddy duck	*Oxyura jamaicensis*	
Osprey	*Pandion haliaetus*	SSC
Northern parula	*Parula americana*	
Tufted titmouse	*Parus bicolor*	
House sparrow	*Passer domesticus*	
Savannah sparrow	*Passerculus sandwichensis*	
Fox sparrow	*Passerella iliaca*	
Painted bunting	*Passerina ciris*	
Indigo bunting	*Passerina cyanea*	
American white pelican	*Pelecanus erythrorhynchos*	
Brown pelican	*Pelecanus occidentalis*	SSC
Cliff swallow	*Petrochelidon pyrrhonota*	
Double-crested cormorant	*Phalacrocorax auritus*	
Wilson's phalarope	*Phalaropus tricolor*	
Rose-breasted grosbeak	*Pheucticus ludovicianus*	
Greater flamingo	*Phoenicopterus ruber*	
Downy woodpecker	*Picoides pubescens*	
Hairy woodpecker	*Picoides villosus*	
Eastern towhee; rufous-sided towhee	*Pipilo erythrophthalmus*	
Towhee	*Pipilo* sp.	
Scarlet tanager	*Piranga olivacea*	
Summer tanager	*Piranga rubra*	
Roseate spoonbill	*Platalea ajaja*	SSC
Glossy ibis	*Plegadis falcinellus*	
Black-bellied plover	*Pluvialis squatarola*	
Horned grebe	*Podiceps auritus*	
Pied-billed grebe	*Podilymbus podiceps*	
Blue-gray gnatcatcher	*Polioptila caerulea*	
Vesper sparrow	*Pooecetes gramineus*	
Purple gallinule	*Porphyrio martinica*	
Sora	*Porzana carolina*	
Purple martin	*Progne subis*	
Prothonotary warbler	*Protonotaria citrea*	
Greater shearwater	*Puffinus gravis*	
Audubon's shearwater	*Puffinus lherminieri*	
Boat-tailed grackle	*Quiscalus major*	
Common grackle	*Quiscalus quiscula*	
King rail	*Rallus elegans*	
Virginia rail	*Rallus limicola*	
Clapper rail	*Rallus longirostris*	
American avocet	*Recurvirostra americana*	
Ruby-crowned kinglet	*Regulus calendula*	

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Bank swallow	*Riparia riparia*	
Black-legged kittiwake	*Rissa tridactyla*	
Black skimmer	*Rynchops niger*	SSC
Eastern phoebe	*Sayornis phoebe*	
American woodcock	*Scolopax minor*	
Woodcock	*Scolopax* sp.	
Ovenbird	*Seiurus aurocapillus*	
Louisiana waterthrush	*Seiurus motacilla*	
Northern waterthrush	*Seiurus noveboracensis*	
American redstart	*Setophaga ruticilla*	
Eastern bluebird	*Sialia sialis*	
Yellow-bellied sapsucker	*Sphyrapicus varius*	
Dickcissel	*Spiza americana*	
Chipping sparrow	*Spizella passerina*	
Field sparrow	*Spizella pusilla*	
Northern rough-winged swallow	*Stelgidopteryx serripennis*	
Parasitic jaeger	*Stercorarius parasiticus*	
Pomarine jaeger	*Stercorarius pomarinus*	
Bridled tern	*Sterna anaethetus*	
Caspian tern	*Sterna caspia*	
Roseate tern	*Sterna dougallii*	ST
Forster's tern	*Sterna forsteria*	
Sooty tern	*Sterna fuscata*	
Common tern	*Sterna hirundo*	
Royal tern	*Sterna maxima*	
Gull-billed tern	*Sterna nilotica*	
Sandwich tern	*Sterna sandvicensis*	
Least tern	*Sternula antillarum*	ST
Barred owl	*Strix varia*	
Eastern meadowlark	*Sturnella magna*	
European starling	*Sturnus vulgaris*	
Tree swallow	*Tachycineta bicolor*	
Carolina wren	*Thryothorus ludovicianus*	
Brown thrasher	*Toxostoma rufum*	
Lesser yellowlegs	*Tringa flavipes*	
Greater yellowlegs	*Tringa melanoleuca*	
Solitary sandpiper	*Tringa solitaria*	
House wren	*Troglodytes aedon*	
American robin	*Turdus migratorius*	
Gray kingbird	*Tyrannus dominicensis*	
Western kingbird	*Tyrannus verticalis*	
Common barn owl	*Tyto alba*	
Orange-crowned warbler	*Vermivora celata*	
Golden-winged warbler	*Vermivora chrysoptera*	
Tennessee warbler	*Vermivora peregrina*	
Blue-winged warbler	*Vermivora pinus*	
Nashville warbler	*Vermivora ruficapilla*	
Black-whiskered vireo	*Vireo altiloquus*	
Yellow-throated vireo	*Vireo flavifrons*	
White-eyed vireo	*Vireo griseus*	
Red-eyed vireo	*Vireo olivaceus*	
Solitary vireo	*Vireo solitarius*	

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Hooded warbler	*Wilsonia citrina*	
Wilson's warbler	*Wilsonia pusilla*	
Mourning dove	*Zenaida macroura*	
White-throated sparrow	*Zonotrichia albicollis*	
Class Mammalia (mammals)		
Least shrew	*Cryptotis parva*	
Opossum	*Didelphis marsupialis*	
Pocket gopher	*Geomys pinetis*	
Eastern yellow bat	*Lasiurus intermedius*	
River otter	*Lutra canadensis*	
Bobcat	*Lynx rufus*	
Striped skunk	*Mephitis mephitis*	
Florida long-tailed weasel	*Mustela frenata peninsulae*	
Round-tailed muskrat	*Neofiber alleni*	
Evening bat	*Nycticeius humeralis*	
White-tailed deer	*Odocoileus virginianus*	
Rice rat	*Oryzomys palustris*	FE
Southeastern beach mouse	*Peromyscus polionotus niveiventris*	FT
Florida mouse	*Podomys floridanus*	SSC
Racoon	*Procyon lotor*	
Eastern mole	*Scalopus aquaticus*	
Eastern gray squirrel	*Sciurus carolinensis*	
Sherman's fox squirrel	*Sciurus niger shermani*	SSC
Southeastern shrew	*Sorex longerostris*	
Eastern spotted skunk	*Spilogale putorius*	
Cottontail rabbit	*Sylvilagus floridanus*	
Marsh rabbit	*Sylvilagus palustris*	
Mexican free-tailed bat	*Tadarida brasiliensis*	
West Indian manatee	*Trichechus manatus*	FE
Atlantic bottlenose dolphin	*Tursiops truncatus*	
Common gray fox	*Urocyon cinereoargenteus*	
Black bear	*Ursus americanus*	
Class Amphibia (frogs, toads,salamanders)		
Florida cricket frog	*Acris gryllus*	
Two-toed amphiuma	*Amphiuma means*	
Oak toad	*Bufo quercicus*	
Southern toad	*Bufo terrestris*	
Dwarf salamander	*Eurycea quadridigitata*	
Eastern narrow-mouthed toad	*Gastrophryne carolinensis*	
Green treefrog	*Hyla cinerea*	
Barking treefrog	*Hyla gratiosa*	
Squirrel treefrog	*Hyla squirella*	
Little grass frog	*Limnaoedus ocularis*	
Gopher frog	*Lithobates capito*	SSC
Peninsula newt	*Notophthalmus viridescens*	
Narrow-striped dwarf siren	*Pseudobranchus axanthus*	
Pig frog	*Rana grylio*	
Southern leopard frog	*Rana utricularia*	
Eastern spadefoot toad	*Scaphiopus holbrooki*	
Greater siren	*Siren lacertina*	
Siren	*Siren* sp.	
Class Reptilia (reptiles)		

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Florida cottonmouth	*Agkistrodon piscivorus*	
American alligator	*Alligator mississippiensis*	FT(s/a)
Green anole	*Anolis carolinensis*	
Loggerhead sea turtle	*Caretta caretta*	FT
Green sea turtle	*Chelonia mydas*	FE
Snapping turtle	*Chelydra serpentine*	
Florida red-bellied turtle	*Chrysemys nelsoni*	
Six-lined racerunner	*Cnemidophorus sexlineatus*	
Southern black racer	*Coluber constrictor*	
Eastern diamondback rattlesnake	*Crotalus adamanteus*	
Leatherback	*Dermochelys coriacea*	FE
Southern ring-necked snake	*Diadophis punctatus*	
Eastern indigo snake	*Drymarchon corais couperi*	FT
Hawksbill sea turtle	*Eretmochelys imbricata*	FE
Peninsula mole skink	*Eumeces egregious onocrepis*	
Southeastern five-lined skink	*Eumeces inexpectatus*	
Gopher tortoise	*Gopherus polyphemus*	ST
Striped mud turtle	*Kinosternon baurii*	ST
King snake	*Lampropeltis* sp.	
Kemp's ridley sea turtle	*Lepidochelys kempii*	FE
Diamondback terrapin	*Malaclemys terrapin tequesta*	
Eastern coachwhip snake	*Masticophis flagellum flagellum*	
Eastern coral snake	*Micrurus fulvius*	
Atlantic salt marsh snake	*Nerodia clarkii taeniata*	FT
Florida water snake	*Nerodia fasciata*	
Florida banded water snake	*Nerodia fasciata pictiventris*	
Rough green snake	*Opheodrys aestivus*	
Rat snake	*Pantherophis alleghaniensis*	
Corn snake	*Pantherophis guttatus*	
Yellow rat snake	*Pantherophis obsoleta quadrivittata*	
Florida pine snake	*Pituophis melanoleucus mugitus*	SSC
Florida scrub lizard	*Sceloporus woodi*	
Ground skink	*Sciencella lateralis*	
Dusky pigmy rattlesnake	*Sistrurus miliarius*	
Common musk turtle	*Sternotherus odoratus*	
Florida brown snake	*Storeria dekayi victa*	ST
Coastal dunes crowned snake	*Tantilla relicta pamlica*	
Florida box turtle	*Terrapene carolina bauri*	
Eastern ribbon snake	*Thamnophis sauritus*	
Eastern garter snake	*Thamnophis sirtalis*	
Florida softshell	*Trionyx ferox*	
Class Chondrichthyes (cartilaginous fishes)		
Spotted eagle ray	*Aetobatus narinari*	
Bull shark	*Carcharhinus leucas*	
Blacktip shark	*Carcharhinus limbatus*	
Sandbar shark	*Carcharhinus plumbeus*	
Atlantic stingray	*Dasyatis americana*	
Southern stingray	*Dasyatis sabina*	
Bluntnose stingray	*Dasyatis sayi*	
Smooth butterfly ray	*Gymnura micrura*	
Lemon shark	*Negaprion brevirostris*	
Smalltooth sawfish	*Pristis pectinata*	FE

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Cownose ray	*Rhinoptera bonasus*	
Scalloped hammerhead	*Sphyrna lewini*	
Superclass Osteichthyes (bony fishes)		
Sergeant major	*Abudefduf saxatilis*	
Lined sole	*Achirus lineatus*	
Atlantic sturgeon	*Acipenser oxyrinchus oxyrinchus*	FE
Mountain mullet	*Agonostomus monticola*	
Bonefish	*Albula vulpes*	
Blueback herring	*Alosa aestivalis*	
Orange filefish	*Aluterus schoepfi*	
Brown bullhead	*Ameiurus nebulosus*	
Bowfin (mudfish)	*Amia calva*	
Cuban anchovy	*Anchoa cubana*	
Striped anchovy	*Anchoa hepsetus*	
Dusky anchovy	*Anchoa lyolepis*	
Bay anchovy	*Anchoa mitchilli*	
Longnose anchovy	*Anchoa nasuta*	
American eel	*Anguilla rostrata*	
Sheepshead	*Archosargus probatocephalus*	
Hardhead catfish	*Arius felis*	
Southern stargazer	*Astroscopus y-graccum*	
River goby	*Awaous banana*	
Gafftopsail catfish	*Bagre marinus*	
Silver perch	*Bairdiella chrysura*	
Gray triggerfish	*Balistes capriscus*	
Triggerfish, juvenile	*Balistidae*	
Frillfin goby (molly miller)	*Bathygobius soporator*	
Yellowfin menhaden	*Brevoortia smithi*	
Atlantic menhaden	*Brevoortia tyrannus*	
Yellow jack	*Caranx bartholomaei*	
Blue runner	*Caranx crysos*	
Crevalle jack	*Caranx hippos*	
Horse-eye jack	*Caranx latus*	
Swordspine snook	*Centropomus ensiferus*	
Fat snook	*Centropomus parallelus*	
Tarpon snook	*Centropomus pectinatus*	
Common snook	*Centropomus undecimalis*	
Rock sea bass	*Cetropristis philadelphica*	
Atlantic spadefish	*Chaetodipterus faber*	
Florida blenny	*Chasmodes saburrae*	
Striped burrfish	*Chilomycterus schoepfi*	
Atlantic bumper	*Chloroscombrus chrysurus*	
Gulf whiff	*Citharichthys macrops*	
Bay whiff	*Citharichthys spilopterus*	
Herring, juvenile	*Clupeidae*	
Spotted seatrout	*Cynoscion nebulosus*	
Silver seatrout	*Cynoscion nothus*	
Weakfish	*Cynoscion regalis*	
Sheepshead minnow	*Cyprinodon variegatus*	
Irish pompano	*Diapterus auratus*	
Sand perch	*Diplectrum formosum*	
Silver porgy	*Diplodus argenteus*	

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Spotted pinfish	*Diplodus holbrooki*	
Fat sleeper	*Dormitator maculates*	
Gizzard shad	*Dorosoma cepedianum*	
Threadfin shad	*Dorosoma petenense*	
Sharksucker	*Echeneis naucrates*	
Whitefin sharksucker	*Echeneis neucratoides*	
Spinycheek sleeper	*Eleotris pisonis*	
Sleeper	*Eleotris* sp.	
Ladyfish	*Elops saurus*	
Anchovy, juvenile	*Engraulidae*	
Bluespotted sunfish	*Enneacanthus gloriosus*	
Goliath grouper	*Epinephelus itajara*	
Red grouper	*Epinephelus morio*	
Nassau grouper	*Epinephelus striatus*	
Lake chubsucker	*Erimyzon sucetta*	
Emerald sleeper	*Erotelis smaragdus*	
Fringed flounder	*Etropus crossotus*	
Spotfin mojarra	*Eucinostomus argenteus*	
Silver jenny	*Eucinostomus gula*	
Tidewater mojarra	*Eucinostomus harengulus*	
Striped mojarra	*Eugerres plumieri*	
Lyre goby	*Evorthodus lyricus*	
Bluespotted cornetfish	*Fistularia tabacaria*	
Goldspotted killifish	*Floridichthys carpio*	
Golden topminnow	*Fundulus chrysotus*	
Marsh killifish	*Fundulus confluentus*	
Gulf killifish	*Fundulus grandis*	
Mummichog	*Fundulus heteroclitus*	
Seminole killifish	*Fundulus seminolis*	
Longnose killifish	*Fundulus similis*	
Sea catfish	*Galeichthys felis*	
Mosquitofish	*Gambusia affinis*	
Eastern mosquitofish	*Gambusia holbrooki*	
Yellowfin mojarra	*Gerres cinereus*	
Sand stargazer	*Gillellus* sp.	
Skilletfish	*Gobiesox strumosus*	
Bigmouth sleeper	*Gobiomorus dormitor*	
Violet goby	*Gobioides broussonnetti*	
Darter goby	*Gobionellus boleosoma*	
Slim goby	*Gobionellus gracillimus*	
Sharptail goby	*Gobionellus hastatus*	
Small-scaled goby	*Gobionellus oceanicus*	
Slashcheek goby	*Gobionellus pseudofasciatus*	
Emerald goby	*Gobionellus smaragdus*	
Spottail goby	*Gobionellus stigmaturus*	
Naked goby	*Gobiosoma bosci*	
Code goby	*Gobiosoma robustum*	
French grunt	*Haemulon flavolineatum*	
Sailor's choice	*Haemulon parra*	
White grunt	*Haemulon plumieri*	
Bluestriped grunt	*Haemulon sciurus*	
Grunt	*Haemulon* sp.	

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Slippery dick	*Halichoeres bivittatus*	
Scaled sardine	*Harengula jagauna*	
Least killifish	*Heterandria formosa*	
Lined seahorse	*Hippocampus erectus*	
Northern seahorse	*Hippocampus hudsonius*	
Seahorse	*Hippocampus* sp.	
Dwarf seahorse	*Hippocampus zosterae*	
Sargassumfish	*Histrio histrio*	
Crested blenny	*Hypleurochilus geminatus*	
Halfbeak	*Hyporhamphus unifasciatus*	
White catfish	*Ictalurus catus*	
Yellow bullhead	*Ictalurus natalis*	
Channel catfish	*Ictalurus punctatus*	
Flagfish	*Jordanella floridae*	
Brook silverside	*Labidesthes sicculus*	
Hairy blenny	*Labrisomus nuchipinnis*	
Trunkfish	*Lactophrys trigonus*	
Smooth trunkfish	*Lactophrys triqueter*	
Smooth puffer	*Lagocephalus laevigatus*	
Pinfish	*Lagodon rhomboides*	
Spot	*Leiostomus xanthurus*	
Spotted gar	*Lepisosteus platyrhincus*	
Gar	*Lepisosteus* sp.	
Warmouth	*Lepomis gulosus*	
Bluegill	*Lepomis macrochirus*	
Dollar sunfish	*Lepomis marginatus*	
Redear sunfish	*Lepomis microlophus*	
Spotted sunfish	*Lepomis punctatus*	
Tripletail	*Lobotes surinamensis*	
Crested goby	*Lophogobius cyprinoides*	
Bluefin killifish	*Lucania goodei*	
Rainwater killifish	*Lucania parva*	
Highfin blenny	*Lupinoblennius nicholsi*	
Mutton snapper	*Lutjanus analis*	
Schoolmaster	*Lutjanus apodus*	
Gray snapper	*Lutjanus griseus*	
Mahogany snapper	*Lutjanus mahogoni*	
Lane snapper	*Lutjanus synagris*	
Tarpon	*Megalops atlanticus*	
Rough silverside	*Membras martinica*	
Inland silverside	*Menidia beryllina*	
Tidewater silverside	*Menidia peninsulae*	
Silverside	*Menidia* sp.	
Southern kingfish	*Menticirrhus americanus*	
Northern kingfish	*Menticirrhus saxatilis*	
Clown goby	*Microgobius gulosus*	
Green goby	*Microgobius thalassinus*	
Opossum pipefish	*Microphis brachyurus lineatus*	
Atlantic croaker	*Micropogonias undulatus*	
Largemouth bass	*Micropterus salmoides*	
Planehead filefish	*Monacanthus hispidus*	
Striped mullet	*Mugil cephalus*	

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White mullet	*Mugil curema*	
Moray eel, larval	*Muraenidea*	
Worm eel	*Myrophis punctatus*	
Emerald parrotfish	*Nicholsina usta*	
Golden shiner	*Notemigonus crysoleucas*	
Taillight shiner	*Notropis maculatus*	
Leatherjacket	*Oligoplites saurus*	
Shrimp eel	*Ophichthus gomesi*	
Striped cusk-eel	*Ophidion marginatum*	
Jawfish	*Opisthognathus* sp.	
Atlantic thread herring	*Opisthonema oglinum*	
Oyster toadfish	*Opsanus tau*	
Pigfish	*Orthopristis chrysopterus*	
Gulf flounder	*Paralichthys albigutta*	
Southern flounder	*Paralichthys lethostigma*	
Sailfin molly	*Poecilia latipinna*	
Black drum	*Pogonias cromis*	
Threadfin	*Polydactylus octonemus*	
Bluefish	*Pomatomus saltatrix*	
Black crappie	*Pomoxis nigromaculatus*	
Atlantic midshipman	*Porichthys porosissimus*	
Leopard searobin	*Prionotus scitulus*	
Searobin	*Prionotus* sp.	
Bighead searobin	*Prionotus tribulus*	
Yellow goatfish	*Pseudupeneus maculatus*	
Clearnose skate	*Raja eglanteria*	
Mangrove rivulus	*Rivulus marmoratus*	SSC
Spanish sardine	*Sardinella anchovia*	
Blackchin tilapia	*Sarotherodon melanotheron*	
Parrotfish	*Scarus* sp.	
Red drum (redfish)	*Sciaenops ocellatus*	
Spanish mackeral	*Scomberomorus maculatus*	
Barbfish	*Scorpaena brasiliensis*	
Plumed scorpionfish	*Scorpaena grandicornis*	
Spotted scorpionfish	*Scorpaena plumieri*	
Scorpionfish	*Scorpaena* sp.	
Lookdown	*Selene vomer*	
Seabass, juvenile	*Serranidae*	
Northern puffer	*Sphoeroides maculatus*	
Southern puffer	*Sphoeroides nephelus*	
Bandtail puffer	*Sphoeroides spengleri*	
Checkered puffer	*Sphoeroides testudineus*	
Great barracuda	*Sphyraena barracuda*	
Northern sennet	*Sphyraena borealis*	
Southern sennet	*Sphyraena picudilla*	
Star drum	*Stellifer lanceolatus*	
Atlantic needlefish	*Strongylura marina*	
Redfin needlefish	*Strongylura notata*	
Needlefishes	*Strongylura* sp.	
Timucu	*Strongylura timucu*	
Blackcheek tonguefish	*Symphurus plagiusa*	
Dusky pipefish	*Syngnathus floridae*	

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Chain pipefish	*Syngnathus louisianae*	
Gulf pipefish	*Syngnathus scovelli*	
Inshore lizardfish	*Synodus foetens*	
Common pompano	*Trachinotus carolinus*	
Florida pompano	*Trachinotus carolinus*	
Permit	*Trachinotus falcatus*	
Atlantic cutlassfish	*Trichiurus lepturus*	
Hogchoker	*Trinectes maculates*	
Houndfish	*Tylosurus* sp.	
Atlantic moonfish	*Vomer setapinnis*	
Phylum Arthropoda (insects, crustaceans)		
Subphylum Crustacea (shrimp and crabs)		
Bigclaw snapping shrimp	*Alpheus heterochaelis*	
Squareback marsh crab	*Armases cinereum*	
Swimming crab	*Callinectes bocourti*	
Ornate crab	*Callinectes ornatus*	
Blue crab	*Callinectes sapidus*	
Great land crab	*Cardisoma guanhumi*	
Thinstripe hermit crab	*Clibanarius vitattus*	
Striped hermit crab	*Clibanarius vittatus*	
Broad-backed mud crab	*Eurytium limosum*	
Pentagon crab	*Heterocrypta granulate*	
Narrow mud crab	*Hexapanopeus angustifrons*	
Spider crab	*Libinia dubia*	
Cinnamon river shrimp	*Macrobrachium acanthurus*	
Long-arm prawn	*Macrobrachium* sp.	
Stone crab	*Menippe mercenaria*	
Say's mud crab	*Neopanope sayi*	
Florida grass shrimp	*Palaemon floridanus*	
Grass shrimp	*Palaemonetes cf. pugio*	
Grass shrimp	*Palaemonetes vulgaris*	
Atlantic mud crab	*Panopeus herbstii*	
Spiny lobster	*Panulirus argus*	
Brown shrimp	*Penaeus aztecus*	
Pink shrimp	*Penaeus duorarum*	
White shrimp	*Penaeus setiferus*	
Green porcelain crab	*Petrolisthes armatus*	
Oyster pea crab	*Pinnotheres ostreum*	
Crayfish	*Procambridae* spp.	
Harris's mud crab	*Rhithropanopeus harrisii*	
Mangrove crab	*Sesarma* sp.	
Common mantis shrimp	*Squilla empusa*	
Atlantic sand fiddler crab	*Uca pugilator*	
Mud fiddler crab	*Uca pugnax rapax*	
Class Maxillopoda (Barnacles, Copepods)		
Purple striped barnacle	*Balanus amphitrite*	
Ivory barnacle	*Balanus eburneus*	
Class Merostomata (Horseshoe crabs, Eurypterids)		
Horseshoe crab	*Limulus polyphemus*	
Phylum Mollusca (Mollusks)		
Class Gastropoda (snails)		
Sooty sea hare	*Aplysia brasiliana*	

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Oyster mosquito	*Boonea impressa*	
Lightening whelk	*Busycon contrarium*	
Pear whelk	*Busycon spiratum*	
Awl miniature cerith	*Cerithiopsis emersoni*	
Green's miniature cerith	*Cerithiopsis greeni*	
Florida cerith	*Cerithium atratum*	
Eastern slipper shell	*Crepidula astrasolea*	
Convex slipper shell	*Crepidula convexa*	
Atlantic slipper shell	*Crepidula fornicata*	
Keyhole limpet	*Diodora cayensis*	
Lemon drop sea slug	*Doriopsilla pharpa*	
Thick-lipped drill	*Eupleura caudata*	
Banded tulip	*Fasciolaria hunteria*	
True tulip	*Fasciolaria mlipa*	
Snail	*Gastropoda* spp.	
Marsh periwinkle	*Littorina irrorata*	
Common marsh snail	*Melampus bidentatus*	
Crown conch	*Melongena corona*	
Common nassa; mottled dog whelk	*Nassarius vibex*	
Nerite snail	*Neritidae* spp.	
Florida horse conch	*Pleuroploca gigantean*	
Atlantic moon snail	*Polinices duplicates*	
Plicate mangelia	*Pyrgocythara plicosa*	
Salle's auger snail	*Terebra salleana*	
Florida rock snail	*Thais haemastoma floridana*	
Atlantic oyster drill	*Urosalpinx cinerea*	
Class Bivalvia (clams, mussels, oysters)		
Blood ark	*Anadara ovalis*	
Tranverse ark	*Anadara transversa*	
Jingle shell	*Anomia simplex*	
Pen shell	*Atrina rigida*	
Scorched mussel	*Brachidonetes exuctus*	
False muscle	*Congeria leucophaeta*	
Eastern oyster	*Crassostrea virginica*	
Coquina shells	*Donax variabilis*	
Flat mud crab	*Eurypanopeus depressus*	
Ribbed mussel	*Geukensia demissa*	
Mahogany date mussel	*Lithophaga bisulcata*	
Striated wood paddock	*Martesia cuneiformis*	
Hard shelled clam	*Mercenaria mercenaria*	
Tulip mussel	*Modiolus americans*	
Charru mussel	*Mytella charruana*	
Florida marsh clam	*Pseudocyena floridiana*	
Rangia clam	*Rangia cuneata*	
Jacknife clam	*Tagelus divisus*	
Quahog clam	*Venus* sp.	
Phylum Annelida (Segmented worms)		
Tube worms	*Hydroides* spp.	
Nereid polychaete worm	*Neanthes spp.*	
Oligochaete worm	*Oligochaeta* sp.	
Oyster mud worm	*Pal vdora websteri*	
Green oyster worm	*Phyllodoce fragilis*	

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Polychaete worm	*Polychaeta* sp.	
Feather duster worm	*Sabella* spp.	
Phylum Bryozoa (Moss animals)		
Common bryozoan	*Bugula neritina*	
Lacy crust bryozoan	*Conopeum* spp.	
Lacy bryozoan	*Hippoporina verrilli*	
	Vittaticella contei	
	Watersipora subovoidea	
Spaghetti bryozoan	*Zoobotryon verticillatum*	
Phylum Cnidaria (jellyfishes)		
Moon jellyfish	*Aurelia aurita*	
Upside-down jelly	*Cassiopeia xamachana*	
Portuguese man o' war	*Physalia physalis*	
Cannonball jellyfish	*Stomolophus meleagris*	
Phylum Ctenophora (Comb jellies)		
Comb jelly	*Mnemiopsis leidyi*	
Phylum Echinodermata (Starfish, Brittle stars, Sea urchin, Sand dollars)		
Brooding brittle star	*Axiognathus squamatus*	
Reticulated brittle star	*Ophionereis reticulata*	
Phylum Porifera (Sponges)		
Boring sponge	*Cliona* spp.	
Black volcano sponge	*Halichondria melandocia*	
Sun sponge	*Hymeniacidon heliophila*	
Kingdom Protista (phytoplankton)		
Phylum Dinoflagellata (dinoflagellates)		
	Akashiwo sanguinea	
	Amphidinium operculatum	
	Ceratium furca	
	Ceratium fusus	
	Ceratium hircus	
	Coolia monotis	
	Dinophysis caudata var. *acutiformis*	
	Gambierdiscus toxicus	
	Gonyaulax polygramma	
	Gonyaulax scrippsae	
	Gonyaulax spinifera	
	Gymnodinium sanguineum	
	Gymnodinium varians	
	Gyrodinium estuariale	
	Gyrodinium instriatum	
	Gyrodinium spirale	
	Heterocapsa niei	
	Heterocapsa rotundata	
	Karenia brevis	
	Karlodinium micrum	
	Katodinium glaucum	
	Katodinium rotundata	
	Oxyphysis oxytoxoides	
	Oxytoxum scolopax	
	Pheopolykrikos hartmannii	

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	Polykrikos schwartzii	
	Prorocentrum balticum	
	Prorocentrum emarginatum	
	Prorocentrum gracile	
	Prorocentrum micans	
	Prorocentrum minimum	
	Protoperidinium depressum	
	Protoperidinium pellucidium	
	Pyrodinium bahamense var. *bahamense*	
	Pyrophacus horologium	
	Pyrophacus steinii	
	Scrippsiella subsalsa	
	Scrippsiella trochoidea	
Phylum Bacillariophyta (diatoms)		
	Asterionellopsis gracilis	
	Bacillaria paxilifera	
	Bellerochea sp.	
	Cerataulina pelagica	
	Chaetoceros aequatorialis	
	Chaetoceros curvisetus	
	Chaetoceros danicus	
	Chaetoceros decipiens	
	Chaetoceros diversus	
	Chaetoceros lorenzianus	
	Chaetoceros minimus	
	Chaetoceros simplex	
	Chaetoceros subtilis	
	Chaetoceros wighamii	
	Corethron spp.	
	Coscinodiscus granii	
	Cyclotella spp.	
	Dactyiisolen fragilissimus	
	Ditylum brightwellii	
	Grammatophora marina	
	Guinardia delicatula	
	Guinardia striata	
	Hermiaulus sinensis	
	Leptocylindrus danicus	
	Leptocylindrus minimus	
	Licmophora gracillis	
	Lithodesmium sp.	
	Navicula sp.	
	Nitzschia closterium	
	Odontella aurita	
	Odontella mobiliensis	
	Odontella regia	
	Paralia sulcata	
	Pleurosigma/Gyrosigma	
	Pseudo-nitzschia	
	Pseudosolenia calcar-avis	
	Rhizosolenia delicatula	

Common Name	Species Name	Status (FDACS, 2010; FWC, 2013)
Legend: FT = Federally- and State-Designated Threatened • **FE** = Federally-and State-Designated Endangered **ST** = State-Designated Threatened • **SE** = State-Designated Endangered • **SSC** = State Species of Special Concern **(S/A)** = listed due to similarity of appearance • **CE**= commercially exploited		
	Rhizosolenia imbricata	
	Rhizosolenia pungens	
	Rhizosolenia setigera	
	Skeletonema costatum	
	Skeletonema menzellii	
	Stictocyclus stictodiscus	
	Synedra sp.	
	Thalassionema nitzschiodes	
	Thalassiosiera spp.	
Phylum Chrysophyta (golden algae)		
	Chromulina sp.	
	Chrysochromulina parva	
	Dinobryon spp.	
	Metramonas simplex	
	Ochromonas nana	
	Ochromonas ovalis	
	Pseudopedinella pyriforme	
Phylum Cryptophyta (cryptomonads)		
	Cryptomonas erosa	
	Hemiselmis spp.	
	Katablepharis ovalis	
	Rhodomonas lens	
	Rhodomonas minuta	
	Rhodomonas sp.	
Phylum Cyanophyta (cyanobacteria)		
	Calothrix sp.	
	Cyanobacterium sp.	
	Digenia sp.	
	Microcystis sp.	
	Oscillatoria spp.	
	Synechococcus elongatus	
	Synechocystis spp.	
Phylum Chlorophyta (green algae)		
	Avrainvillea sp.	
	Batophora sp.	
	Bryopsis sp.	
	Caulerpa sp.	
	Chlamydomonas coccoides	
	Chlamydomonas quadrilobata	
	Cladophora sp.	
	Dunaliella primolecta	
	Halimeda sp.	
	Micromonas pusilla	
	Nannochloris c.f.	
	Oscillatoria sp.	
	Pyraminonas spp.	
	Rhipocephalus sp.	
	Ulva sp.	
Phylum Choanozoa		
	Choanoflagellate spp.	
Phylum Euglenophyta (euglenoids)		
	Euglena sp.	

Common Name	Species Name	Status (FDACS, 2010; FWC, 2013)
Legend: FT = Federally- and State-Designated Threatened • **FE** = Federally-and State-Designated Endangered **ST** = State-Designated Threatened • **SE** = State-Designated Endangered • **SSC** = State Species of Special Concern **(S/A)** = listed due to similarity of appearance • **CE**= commercially exploited		
	Eutreptiella marina	
Phylum Rhodophyta (red algae)		
	Acanthophora sp.	
	Agardiella sp.	
	Chondria sp.	
	Gracilaria sp.	
	Hernesinum adriaticum	
	Laurencia sp.	
Phylum Phaeophyta (brown algae)		
	Aureoumbra lagunesis	
	Dictyota sp.	

*B.3.2 / **Invasive Non-native and/or Problem Species***

Common Name	Species Name	Category
Kingdom Plantae (plants)		
Division Pteridophyta		
Old world climbing fern	*Lygodium microphyllum*	I
Division Magnoliophyta (flowering plants)		
Class Liliopsida (grass-like flowering plants)		
Asparagus fern	*Asparagus denssiflorus*	I
Wild taro	*Colocasia esculenta*	I
Dwarf papyrus	*Cyperus prolifer*	II
Air potato	*Dioscorea bulbifera*	I
Cogon grass	*Imperata cylindrica*	I
Guinea grass	*Panicum maximum*	II
Torpedo grass	*Panicum repens*	I
Water lettuce	*Pistia stratiotes*	I
Arrowhead vine	*Syngonium podophyllum*	I
Green wandering jew	*Tradescantia fluminensis*	I
Oyster plant	*Tradescantia spathacea*	II
Class Magnoliopsida (woody flowering plants)		
Rosary pea	*Abrus precatorius*	I
Earleaf acacia	*Acacia auriculiformis*	I
Women's tongue	*Albizzia lebbeck*	I
Coral vine	*Antigonon leptopus*	I
Coral ardisia	*Ardisia crenata*	I
Shoebutton ardesia	*Ardisia elliptica*	I
Bischofia	*Bischofia javanica*	I
Australian pine	*Casuarina equisetifolia*	I
Australian pine	*Casuarina glauca*	I
Carrotwood	*Cupaniopsis anacardioides*	I
Ear pod tree	*Enterolobium cyclocarpum*	
Surinam cherry	*Eugenia uniflora*	I
Chandelier plant	*Kalanchoe delaqoensis*	II
Lantana	*Lantana camara*	I
Melaleuca	*Melaleuca quinquenervia*	I
Balsam apple	*Momardica charantia*	II
Philodendron	*Philodendron* sp.	
Strawberry guava	*Psidium cattleianum*	I
Guava	*Psidium guajava*	I

Common Name	Species Name	Category
Castor bean	*Ricinus communis*	II
Mexican petunia	*Ruellia brittoniana*	I
Schefflera	*Schefflera actinophylla*	I
Brazilian pepper	*Schinus terebinthifolius*	I
Purple sesban; rattlebox	*Sesbania punica*	II
Sesbania	*Sesbania* sp.	
Twinleaf nightshade	*Solanum diphyllum*	II
Tropical soda apple	*Solanum viarum*	I
Java plum	*Syzygium cumini*	I
Tropical almond	*Terminalia cattapa*	II
Caesar weed	*Urena lobata*	I
Vitex	*Vitex trifolia*	II
Wedilia	*Wedelia trilobata*	II
Kingdom Animalia (animals)		
Subphylum Vertebrata (vertebrates)		
Superclass Osteichthyes (bony fishes)		
Mayan cichlid	*Cichlasoma urophthalmus*	
Walking catfish	*Clarias batrachus*	
Grass carp	*Ctenopharyngodon idella*	
South American brown hoplo	*Hoplosternum littorale*	
Blue tilapia	*Oreochromis* hybrid	
Plecostomus	*Plecostomus* sp.	
Common lionfish	*Pterois miles*	
Red lionfish	*Pterois volitans*	
Sailfin catfish	*Pterygoplichthys disjunctivus*	
Spotted tilapia	*Tilapia mariae*	
Class Amphibia (frogs, toads,salamanders)		
Greenhouse frog	*Eleutherodactylus planirostris*	
Cuban treefrog	*Osteopilus septentrionalis*	
Class Reptilia (reptiles)		
Brown anole	*Anolis sagrei sagrei*	
Basilisk lizard	*Basiliscus basiliscus*	
Green iguana	*Iguana iguana*	
Class Aves (birds)		
African cattle egret	*Bubulcus ibis*	
Scarlet ibis	*Eudocimus ruber*	
House sparrow	*Passer domesticus*	
European starling	*Sturnus vulgaris*	
Class Mammalia (mammals)		
Black rat	*Rattus rattus*	
Feral hog	*Sus scrofa*	
Nine-banded armadillo	*Dasypus novemcinctus*	
Phylum Arthropoda (insects, crustaceans)		
Subpylum Insecta (insects)		
red imported fire ant (RIFA)	*Solenopsis invicta*	
Subphylum Crustacea (shrimp and crabs)		
Indo-Pacific swimming crab	*Charybdis hellerii*	
Serrated swimming crab	*Scylla serrata*	
Phylum Mollusca (Mollusks)		
Class Bivalvia (clams, mussels, oysters)		
Charru mussel	*Mytella charruana*	
Asian green mussel	*Perna viridis*	
Phylum Cnidaria (jellyfishes)		
Australian spotted jellyfish	*Phyllorhiza punctata*	

Appendix C

Public Involvement

C.1 / ***Advisory Committee***

The following appendices contain information about who served on the Advisory Committee, when the meeting was held, copies of the public advertisements for the meeting, and summary of the meeting.

C.1.1 / ***List of Members and Their Affiliations***

(This information will be provided in the final draft of this management plan.)

C.1.2 / ***Florida Administrative Register Posting***

(This information will be provided in the final draft of this management plan.)

C.1.3 / ***Meeting Summary***

(This information will be provided in the final draft of this management plan.)

C.2 / ***Formal Public Meetings***

The following Appendices contain information about the Formal Public Meetings which were held in order to obtain input from the public about the Indian River Lagoon Aquatic Preserves Draft Management Plan. There are copies of the public advertisements for those meetings, a list of attendees, a summary of the meeting(s), and a copy of the written comments received.

C.2.1 / ***Florida Administrative Register Postings***

(This information will be provided in the final draft of this management plan.)

C.2.2 / ***Advertisement Flyers***

(This information will be provided in the final draft of this management plan.)

C.2.3 / ***Newspaper Advertisements***

(This information will be provided in the final draft of this management plan.)

C.2.4 / ***Summary of the Formal Public Meetings***

(This information will be provided in the final draft of this management plan.)

Goals, Objectives, and Strategies Table

D.1 / *Current Goals, Objectives and Strategies Table*

The following table provides a cost estimate for conducting the management activities identified in this plan. The data is organized by year and Management Program with subtotals for each program and year. The following represents the actual budgetary needs for managing the resources of the aquatic preserve. This budget was developed using data from the Florida Coastal Office (FCO) and other cooperating entities, and is based on actual costs for management activities, equipment purchases and maintenance, and for development of fixed capital facilities. The budget below exceeds the funds FCO has been receiving through the state appropriations process, but is consistent with the direction necessary to achieve the goals and objectives identified in the Goals, Objectives and Strategies Table in Appendix D.1. Budget categories identified correlate with the FCO Management Program areas.

Goals, Objectives & Integrated Strategies	Management Program	Implementation Date (Planned)	Length of Initiative	Est. Avg. Yearly Cost	Estimated Yearly Cost									
					13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23
Issue 1: Water Quality														
Goal 1: Maintain and improve water quality within and entering the IRL System to meet the needs of the natural resources.														
Objective 1: Regularly assess water quality conditions within the aquatic preserves and the potential impacts on natural resources.														
Strategy 1: Collaborate with groups collecting water quality data within the aquatic preserves to stay informed about water quality.	Ecosystem Science	Requires Additional Staff	Recurring	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
Strategy 2: Assess compiled data to identify status, trends and information gaps.	Ecosystem Science	2008-2009	Recurring	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
Strategy 3: Use or build on existing monitoring efforts to address information gaps.	Ecosystem Science	2014-2015	Recurring	$5,000		$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000	$5,000
Objective 2: Protect natural resources by restoring altered areas that contribute to reduced water quality within the IRL System.														
Strategy 1: Stabilize eroding shorelines using natural materials and appropriate native plants.	Resource Management	1995-1996	Recurring	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000	$20,000
Strategy 2: Restore and establish oyster reef structure and function using natural, biodegradable materials.	Resource Management	2012-2013	Recurring	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000	$25,000
Strategy 3:Support restoration efforts that will promote reestablishment of submerged grasses.	Resource Management	2002-2003	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Strategy 4: Support efforts to reconnect artificially isolated floodplain habitat (mosquito impoundments).	Resource Management	2002-2003	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000

Goals, Objectives & Integrated Strategies	Management Program	Implementation Date (Planned)	Length of Initiative	Est. Avg. Yearly Cost	Estimated Yearly Cost									
					13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23
Strategy 5: Support muck removal projects within the IRL System where appropriate.	Resource Management	2008-2009	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Strategy 6: Actively support CERP efforts that will benefit the IRL System.	Resource Management	2004-2005	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Strategy 7: Encourage incorporation of restoration strategies into other protective plans for the IRL System.	Resource Management	2006-2007	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Objective 3: Coordinate with regulatory programs, local government and land owners to reduce the impacts from development in the watershed.														
Strategy 1: Review and provide recommendations for local comprehensive plans that address development adjacent to the IRL System.	Resource Management	Requires Additional Staff	Recurring	$800			$800	$800	$800	$800	$800	$800	$800	$800
Strategy 2: Comment on permit applications for construction activities on sovereign submerged lands within the IRL System.	Resource Management	1986-1987	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Strategy 3: Recommend use of soft, living shorelines to decrease erosion and protect the water quality and resources within the IRL System.	Resource Management	2013-2014	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Objective 4: Reduce water quality impacts caused by stormwater and septic system sources within the IRL System watershed.														
Strategy 1: Encourage local governments to convert high priority areas to sewer.	Resource Management	Requires Additional Staff	Recurring	$1,000			$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Strategy 2: Support projects to enhance stormwater and sewage treatment in the IRL System.	Resource Management	2013-2014	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Strategy 3: Support BMAPs including TMDLs and BMPs.	Resource Management	2011-2012	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Objective 5: Protect lands to conserve the water quality and natural resources of the IRL System.														
Strategy 1: Support acquisition of lands that will have a direct benefit on the IRL System's resources.	Resource Management	2008-2009	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000

Goals, Objectives & Integrated Strategies	Management Program	Implementation Date (Planned)	Length of Initiative	Est. Avg. Yearly Cost	Estimated Yearly Cost									
					13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23
Objective 6: Increase public awareness about water quality issues within the IRL System.														
Strategy 1: Prioritize, develop, and implement water quality improvement education programs within the IRL System.	Education/ Outreach	Requires Additional Staff	Recurring	$2,000			$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000
Objective 7: Facilitate knowledge and understanding of how activities in the watershed impact the IRL System.														
Strategy 1: Deliver presentations to promote knowledge and stewardship of the IRL System to adults, children and students.	Education/ Outreach	Requires Additional Staff	Recurring	$800			$800	$800	$800	$800	$800	$800	$800	$800
Issue 2: Loss of Natural Community Function and Species Diversity														
Goal 1: Implement management practices that maintain or improve viable habitats and populations within the IRL System.														
Objective 1: / Collect and compile existing and ongoing research studies, reports and data on the IRL System.														
Strategy 1: Attend and/or participate in IRL conferences and meetings.	Ecosystem Science	1985-1986	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Objective 2: Associate aquatic species with specific habitats located in each aquatic preserve with the IRL System.														
Strategy 1: Develop a GIS database and maps that link aquatic species locations to specific aquatic habitats located within the IRL System.	Ecosystem Science	Requires Additional Staff	2 Years	$3,000			$3,000	$3,000						
Strategy 2: Assist research and conservation groups and agencies with maintenance of species inventories.	Ecosystem Science	2007-2008	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Objective 3: Establish, implement and build upon existing routine biological monitoring programs for essential habitats, and rare and listed species.														
Strategy 1: / Monitor bird rookeries.	Ecosystem Science	2005-2006	Recurring	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
Strategy 2: Monitor shorebird nesting.	Ecosystem Science	2005-2006	Recurring	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
Strategy 3: / Monitor diamondback terrapins.	Ecosystem Science	2012-2013	Recurring	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
Strategy 4: Assist partners with natural resource monitoring efforts (i.e., seagrass).	Ecosystem Science	1994-1995	Recurring	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000	$1,000
Strategy 5: Collaborate with academic institutions to meet research and monitoring needs.	Ecosystem Science	2013-2014	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500

Goals, Objectives & Integrated Strategies	Management Program	Implementation Date (Planned)	Length of Initiative	Est. Avg. Yearly Cost	Estimated Yearly Cost									
					13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23
Strategy 6: Establish a program to collect information from researchers and commercial fisherman within the aquatic preserves.	Ecosystem Science	Requires Additional Staff	Recurring	$1,500			$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500	$1,500
Objective 4: Develop and implement conservation and restoration projects for key natural communities and species based on the best available scientific data and information.														
Strategy 1: Continue and expand SRP.	Resource Management	2007-2008	Recurring	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000	$16,000
Strategy 2: Continue and expand spoil island enhancement through SIP.	Resource Management	2000-2001	Recurring	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500
Strategy 3: Continue and expand oyster restoration projects	Resource Management	2011-2012	Recurring	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000	$35,000
Objective 5: Reduce the abundance and diversity of non-native species within the IRL System														
Strategy 1: Conduct routine exotic plant species removal through regularly scheduled spoil island work days	Resource Management	2008-2009	Recurring	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500	$2,500
Strategy 2: Assist other agencies in controlling non-native species	Resource Management	2014-2015	Recurring	$7,500		$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500
Objective 6: Provide hands-on habitat restoration volunteer opportunities within the IRL System to promote knowledge through personal interactions														
Strategy 1: Coordinate increased volunteer participation in SRP	Education/ Outreach	2013-2014	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Strategy 2: Coordinate volunteer participation in SIP	Education/ Outreach	2008-2009	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Strategy 3: Support the establishment of the Spoil Island Ambassador Citizen Support Organization	Education/ Outreach	2013-2014	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Issue 3: Sustainable Public Use														
Goal 1: Encourage user experiences and public recreation opportunities consistent with natural resources conservation.														
Objective 1: Inform local residents and visitors about actions they can take to conserve and restore resources of the IRL System.														
Strategy 1: Post educational signage at public access points.	Public Use	2014-2015	One Year	$5,000		$5,000								
Strategy 2:Coordinate community-based clean-up events in conjunction with the SIP.	Public Use	2008-2009	Recurring	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000

Goals, Objectives & Integrated Strategies	Management Program	Implementation Date (Planned)	Length of Initiative	Est. Avg. Yearly Cost	Estimated Yearly Cost									
					13 - 14	14 - 15	15 - 16	16 - 17	17 - 18	18 - 19	19 - 20	20 - 21	21 - 22	22 - 23
Objective 2: Examine public use patterns and trends within the IRL System to proactively identify potential resource/public use conflicts and, working with key stakeholders, develop conservation strategies to minimize damage to the natural resources.														
Strategy 1: Develop and conduct spoil island user surveys.	Public Use	2012-2013	Recurring	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500	$500
Strategy 2: Identify potential sites for designation as Critical Wildlife Areas.	Public Use	2014-2015	Recurring	$1,000										
Objective 3: Encourage an increase in the amount and frequency of law enforcement and citizen patrol within the IRL System.														
Strategy 1: Facilitate regular communication with law enforcement for rapid response to illegal activities.	Public Use	2013-2014	Recurring	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000	$2,000
Objective 4: Promote low impact recreational opportunities.														
Strategy 1: Develop facilities on high use recreational spoil islands.	Public Use	2000-2001	Recurring	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500	$7,500

*D.2 / **Budget Summary Table***

The following table provides a summary of cost estimates for conducting the management activities identified in this plan.

2013-2014 Cost Estimate	
Ecosystem Science Subtotal	$13,000
Resource Management Subtotal	$114,000
Education and Outreach Subtotal	$1,500
Public Use Subtotal	$12,000
2013-2014 Total	***$140,500***

2018-2019 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2018-2019 Total	***$159,100***

2014-2015 Cost Estimate	
Ecosystem Science Subtotal	$18,000
Resource Management Subtotal	$121,500
Education and Outreach Subtotal	$1,500
Public Use Subtotal	$1,700
2014-2015 Total	***$142,700***

2019-2020 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2019-2020 Total	***$159,100***

2015-2016 Cost Estimate	
Ecosystem Science Subtotal	$22,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2015-2016 Total	***$162,100***

2020-2021 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2020-2021 Total	***$159,100***

2016-2017 Cost Estimate	
Ecosystem Science Subtotal	$22,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2016-2017 Total	***$162,100***

2021-2022 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2021-2022 Total	***$159,100***

2017-2018 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2017-2018 Total	***$159,100***

2022-2023 Cost Estimate	
Ecosystem Science Subtotal	$19,500
Resource Management Subtotal	$123,300
Education and Outreach Subtotal	$4,300
Public Use Subtotal	$12,000
2022-2023 Total	***$159,100***

D.3 / Major Accomplishments Since the Approval of the Previous Plan

The Indian River Lagoon (IRL) System includes the Banana River, IR–Malabar to Vero Beach, IR–Vero Beach to Ft. Pierce, and Jensen Beach to Jupiter Inlet aquatic preserves. Initial management plans for the Banana River, IR-Vero Beach to Ft. Pierce and Jensen Beach to Jupiter Inlet aquatic preserves were adopted in 1985 as part of IRL Aquatic Preserves management plan. The initial management plan for the IR–Malabar to Vero Beach Aquatic Preserve was adopted in 1986. The management plan for Jensen Beach to Jupiter Inlet Aquatic Preserve part of the 1985 IRL Aquatic Preserves management plan was updated in 1990. For over a decade, management of the IRL System was divided between two regional offices. The IR–Malabar to Vero Beach and Banana River aquatic preserves were managed by the East Central Aquatic Preserve office located in Cocoa while the IR-Vero Beach to Fort Pierce and Jensen Beach to Jupiter Inlet aquatic preserves were managed by the Southeast Aquatic Preserve office originally located in Jensen Beach and relocated to Ft. Pierce in 2003. Budgetary shortfalls forced the merger of the East Central and Southeast aquatic preserves offices in July 2008. The merger resulted in the establishment of the present day IRL Aquatic Preserves (IRLAP) office located at the former Southeast Aquatic Preserves facility in Ft. Pierce.

Although the protection and management of the natural resources within the IRL System has always been a priority, the primary focus of both the East Central and Southeast aquatic preserve offices for ten years following the adoption of the original IRL System management plans was management of the North Fork St. Lucie River and St. Sebastian River state buffer preserves. The highlights of the work associated with the buffer preserves included the drafting of buffer preserve management plans, removal of exotic species, installation of fence lines and posting signage. Management of the North Fork St. Lucie River and St. Sebastian River buffer preserves was transferred from the Office of Coastal and Aquatic Managed Areas (currently the Florida Coastal Office [FCO]) to the Division of Recreation and Parks (state parks) in 2003 and 2004, respectively.

Over the first 10 years (1986-1996), activities in the aquatic preserves involved natural resource protection through the regulatory permit review process and education and outreach. Staff routinely coordinated with the regulatory division when permit applications were submitted for projects within the IRL System. This included site visits of the proposed project areas and completing detailed reports for the regulatory office to review. An informative children's coloring book, Aquatic Preserves are Exceptional, was designed by Southeast Florida Aquatic Preserve staff in the early 1990s and is still produced and distributed state-wide today.

Involvement with the Comprehensive Everglades Restoration Plan (CERP) and, more specifically, the IRL-South Project became a priority for aquatic preserve staff in 2002. Research and monitoring projects designed to document the success of CERP restoration projects through the CERP Research, Coordination, and Verification (RECOVER) teams have been supported by FCO staff as well as other agency staff within and adjacent to the southern portions of the IRL System. These include fish studies and a floodplain vegetation study overseen by the South Florida Water Management District.

Due to the improvement of Geographic Information Systems (GIS) capabilities at the field office, ArcGIS software is routinely used in all aspects of managing the IRL System. GIS gives staff the capability to better document and use the current condition data to help foster local stewardship and protect natural resources within the aquatic preserves. Public access and derelict vessel surveys were performed throughout the length of the IRL System in June 2007. The IRLAP office continues working with the Florida Department of Environmental Protection (DEP) regulatory staff and the Florida Fish and Wildlife Conservation Commission law enforcement to remove derelict vessels located within the IRL System. A GIS-based exotic species database has also been created to document and manage exotic species.

The Spoil Island Project is the result of the Spoil Island Working Group (SIWG), which is hosted by the IRLAP and consists of federal, state, and county government agencies and non-governmental organizations. The SIWG was created in 1998 to implement the IRL Spoil Island Management Plan put forth by the Florida Inland Navigation District (FIND). The IRLAP office manages 91 islands based on their designations of Recreation, Education, and Conservation from the management plan. In 2008 the IRLAP office began a major campaign to address spoil island enhancement throughout the IRL System. IRLAP staff maintain a network of over 500 volunteers for island adoption, cleanups, and enhancement work days. Biannual meetings of the SIWG are held to discuss management, law enforcement, and other various needs of the spoil islands region wide. This includes 17 recreation islands with campsite enhancements including picnic tables, barbeque grills, and metal fire rings.

Since 2006, IRLAP staff coordinated three major spoil island projects. These include spoil islands IR36, SL3 and SL15. Approximately 2.25 acres in size, IR36 receives heavy recreational use from boaters and campers. The enhancement objectives included: a) increase user education, b) impact isolation, c) promotion of stewardship and adoption, d) increase biodiversity and e) island stabilization. Beginning in early 2006, SIWG volunteers removed all exotic plants (e.g. Australian pine and Brazilian pepper) by hand and planted approximately 800 coastal strand/maritime hammock plants to supplement existing native vegetation, reduce erosion, foster wildlife, create buffers, and promote natural resource education. IRLAP staff constructed and installed an educational kiosk, picnic tables, fire rings, benches and a self-guided trail with 15 educational signs. Enhancement activities were primarily funded through a FIND grant.

Restoration of SL15 was conducted as mitigation associated with improvements to the North A1A Causeway in Ft. Pierce. Prior to the project, the 10-acre island consisted of exotic dominated uplands surrounded by mangrove fringe. Nearly all the uplands were excavated in order to create a 3.2 acre seagrass bed, 4.74 acre mangrove/salt marsh and 2.38 acre coastal hammock. Over 15,000 native grasses and forbes along with 24,000 red mangrove were planted as part of the project. The project began in early 2005 and was completed by the end of the year.

Enhancement of SL3, a nearly six acre island, was conducted in cooperation with St. Lucie County and funded by the National Association of Counties' Coastal Restoration Initiative grant program. Enhancement of the island occurred from March 2010 through the end of the year. The goal of the SL3 project was to reconnect a mangrove marsh to the IRL, remove 100 percent of the non-native vegetation on the 5.8 acre island, replant with native species, and ultimately reduce the public health risk associated with an established mosquito breeding site. Using heavy machinery, all exotics plants were removed from the island. Establishment of a regular tidal connection provided nutrient exchange between the wetland and the estuary, fostered mangrove habitat success, created habitat for marine organisms, and rendered the area unsuitable for mosquito reproduction. The establishment of native vegetation now protects the wetlands from degradation due to encroachment by non-native species. With regular maintenance by IRLAP staff, the native plantings have outcompeted non-native plants, improved soil quality, contributed to the biodiversity of the site, and provided habitat for native species.

The IRL Shoreline Restoration Project (SRP) managed by DEP, aims to re-establish fringing mangrove habitat along IRL shorelines while fostering community involvement and stewardship. The project was started in 1995 through the Environmental Learning Center in Vero Beach. In 2008 the program was transferred to the IRLAP Field Office. The project boundary extends from State Road 528 in Brevard County to Jupiter Inlet in Palm Beach County. The project coordinator works closely with land managers across project boundaries to find shorelines in need of restoration. The goal of the SRP is addressed in two parts; the establishment, maintenance and monitoring of new and existing shoreline restoration sites; and promotion of the project and awareness about the lagoon's ecosystem through outreach and service learning. The program relies heavily on volunteer support with all aspects of the project, including assisting with monitoring, planting events, and maintenance at the Coastal Wetland Plant Nursery. The SRP hosts outreach workshops in partnership with various governmental, educational, and non-profit institutions. The purpose of these workshops is to inform the public on the importance of mangroves within the IRL, as well as to provide the opportunity to actively take part in the protection of natural resources for future generations. IRLAP currently manages 51 restoration sites, including 29 previously established sites from the Environmental Learning Center, 11 mangrove experimental grid sites, and 10 saltmarsh restoration sites. Every year, the SRP continues to identify new restoration sites, as well as recruit and engage new volunteers.

The majority of directives have been addressed to some extent in the management program over the past 24 years. While IRLAP staff continue to coordinate with federal, state and local agencies and conduct routine biological monitoring, management of the IRL System has been affected by shortage of staff, undersized annual budgets, and management responsibility of seven aquatic preserves. IRL is receiving national, state, and local attention due to the well-documented need to improve the quality of the water. Additional staff and increased budget would be the most effective way for FCO to support these high priority efforts.

Appendix E

Other Requirements

E.1 / ***Acquisition and Restoration Council Management Plan Compliance Checklist***

(This information will be provided in the final draft of this management plan.)

E.2 / ***Management Procedures for Archaeological and Historical Sites and Properties on State-Owned or Controlled Lands*** (revised March 2013)

These procedures apply to state agencies, local governments, and non-profits that manage state-owned properties.

A. General Discussion

Historic resources are both archaeological sites and historic structures. Per Chapter 267, Florida Statutes, '*Historic property' or 'historic resource' means any prehistoric district, site, building, object, or other real or personal property of historical, architectural, or archaeological value, and folklife resources. These properties or resources may include, but are not limited to, monuments, memorials, Indian habitations, ceremonial sites, abandoned settlements, sunken or abandoned ships, engineering works, treasure trove, artifacts, or other objects with intrinsic historical or archaeological value, or any part thereof, relating to the history, government, and culture of the state."*

B. Agency Responsibilities

Per State Policy relative to historic properties, state agencies of the executive branch must allow the Division of Historical Resources (Division) the opportunity to comment on any undertakings, whether these undertakings directly involve the state agency, i.e., land management responsibilities, or the state agency has indirect jurisdiction, i.e. permitting authority, grants, etc. No state funds should be expended on the undertaking until the Division has the opportunity to review and comment on the project, permit, grant, etc.

State agencies shall preserve the historic resources which are owned or controlled by the agency.

Regarding proposed demolition or substantial alterations of historic properties, consultation with the Division must occur, and alternatives to demolition must be considered.

State agencies must consult with Division to establish a program to location, inventory and evaluate all historic properties under ownership or controlled by the agency.

C. Statutory Authority

Statutory Authority and more in depth information can be found at: www.flheritage.com/preservation/compliance/guidelines.cfm

D. Management Implementation

Even though the Division sits on the Acquisition and Restoration Council and approves land management plans, these plans are conceptual. Specific information regarding individual projects must be submitted to the Division for review and recommendations.

Managers of state lands must coordinate any land clearing or ground disturbing activities with the Division to allow for review and comment on the proposed project. Recommendations may include, but are not limited to: approval of the project as submitted, cultural resource assessment survey by a qualified professional archaeologist, modifications to the proposed project to avoid or mitigate potential adverse effects.

Projects such as additions, exterior alteration, or related new construction regarding historic structures must also be submitted to the Division of Historical Resources for review and comment by the Division's architects. Projects involving structures fifty years of age or older, must be submitted to this agency for a significance determination**.** In rare cases, structures under fifty years of age may be deemed historically significant. These must be evaluated on a case by case basis.

Adverse impacts to significant sites, either archaeological sites or historic buildings, must be avoided. Furthermore, managers of state property should make preparations for locating and evaluating historic resources, both archaeological sites and historic structures.

E. Minimum Review Documentation Requirements

In order to have a proposed project reviewed by the Division, certain information must be submitted for comments and recommendations. The minimum review documentation requirements can be found at: www.flheritage.com/preservation/compliance/docs/minimum_review_documentation_requirements.pdf .

Questions relating to the treatment of archaeological and historic resources on state lands should be directed to:

Deena S. Woodward
Division of Historical Resources, Bureau of Historic Preservation, Compliance and Review Section
R. A. Gray Building, 500 South Bronough Street
Tallahassee, FL 32399-0250
Phone: (850) 245-6425, Toll Free: (800) 847-7278, Fax: (850) 245-6435

E.3 / ***Letters of Compliance with County Comprehensive Plans***

(This information will be provided in the final draft of this management plan.)

Indian River Lagoon System
Management Plan

Including Banana River, Indian River – Malabar to Vero Beach, Indian River – Vero Beach to Ft. Pierce, and Jensen Beach to Jupiter Inlet aquatic preserves

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