Indian River Lagoon
Surface Water Improvement & Management (SWIM) Plan

2002 Update

This update contains status reports and a plan for the next five years

Executive Summary

This 2002 update is the second update of the Indian River Lagoon SWIM Plan which was first adopted by the state in 1989 in compliance with the 1987 SWIM Act (Chapter 373.451-373.4595, F.S.). Considerable progress has been made since the last plan update, which was completed in 1994; but there is still much more work that should be done. This update documents the accomplishments, the current problems, and lays out a plan for future work. This update is also timely; prepared at a time when the Indian River Lagoon (IRL) restoration program, in general, is entering into an unprecedented era of major funding partnerships, both local and federal. These partnership programs are aimed at acquiring environmentally strategic lands for preservation or restoration purposes and implementing large-scale construction projects with specific water quality, seagrass, emergent wetland, or other resource targets in mind.

This 2002 plan update includes a status report on the state of the Lagoon, a summary of progress on projects undertaken since the last update, and recommendations for future projects and other actions over the next 5 years (including the major partnership programs mentioned above). This plan update received reviews by the general public and by state, federal, and local agencies, many of which have been active partners with the St. Johns River and South Florida Water Management Districts in conducting the plan's programs since 1989.

The reader, when casting a comparative glance between this update and previous plan documents, will immediately notice a major change in format. Previous IRL SWIM plans were organized by program; each program serving as a major chapter or section heading: Water and Sediment Quality; Habitat Preservation and Restoration, etc. This document, however, is organized by geographic region, beginning with a chapter offering a *Lagoon-wide Overview* (Chapter 2), followed by chapters on the major sub-lagoon watersheds: *Mosquito Lagoon* (Chapter 3), *Banana River Lagoon* (Chapter 4), *North and Central IRL* (Chapter 5), *South IRL* (Chapter 6), *and St. Lucie River* (Chapter 7). Then, within each chapter, the descriptions of resource status, issues, project objectives and progress, and planned activities are covered under the three major programs: *Seagrass & Water Quality, Coastal Wetlands, and Public Involvement and Education*. The 2002 IRL SWIM Plan update is designed so that a reader with an interest in a specific sub-lagoon area can locate most of its information within a single chapter. Hopefully, by this format change, the reader will find this plan update more informative and interesting.

The three programs, *Seagrass & Water Quality, Coastal Wetlands, and Public Involvement and Education*, address the three IRL SWIM goals, which have remained unchanged since they were first established for the development of the 1989 IRL SWIM Plan. These three goals and their corresponding objectives are presented on the next page (Figure A).

Figure A. Goals and Objectives* of the 2002 SWIM Plan for the Indian River Lagoon

Goal I. To attain and maintain water and sediment of sufficient quality (". . . to Class III or better . . .", Chapter 373.453, F.S.) in order to support a healthy, macrophyte-based, estuarine lagoon ecosystem.

Goal II. To attain and maintain a functioning macrophyte-based ecosystem which supports endangered and threatened species, fisheries and wildlife.

Goal III. To achieve heightened public awareness and coordinated interagency management of the Indian River Lagoon ecosystem that results in the accomplishment of the two afore-mentioned goals.

Seagrass & Water Quality Objectives

- Restore lost seagrass beds and preserve existing seagrass beds (largely by fulfilling the objectives below)
- Manage **excessive** freshwater inflows to minimize their impacts on salinity**
- Decrease inputs of suspended materials from point and non-point sources**
- Decrease inputs of excessive loadings of nutrients from point and non-point sources**
- Eliminate or reduce the releases of toxic substances from point and non-point sources

Coastal Wetland Objectives

- Restore function of impounded and other impacted marshes
- Preserve existing marshes
- Create new marshes

Seagrass & Water Quality, Coastal Wetland, and Interagency Coordination Objectives

- Review rules and revise as necessary to protect water quality and aquatic habitats
- Ensure adequate level of rule enforcement & compliance
- Improve coordination among agencies to implement regulatory, research, monitoring and other mgmt. projects efficiently
- Continue to improve administrative support of programs

Public Involvement and Education Objectives

- Develop a public awareness campaign concerning the IRL and restoration programs that benefit it
- Continue to improve administrative support and seek ways to coordinate with other public information programs

*The set of objectives above are slightly different from those in the 1994 IRL SWIM Plan. Please read Chapter 1, p. 1-3 for an explanation of changes.

** Objective served by development of and compliance with Pollutant Load Reduction Goals (PLRGs), which would be considered in the development of federal and state Total Maximum Daily Loads (TMDLs).

Another program specific to the St. Lucie River generally complies with the three aforementioned goals, but has additional objectives related to the recovery of oyster habitat in the lower and middle reaches of the River and the enhancement of a fisheries nursery habitat in the River's upper reach. The key performance indicators are the re-establishment of viable oyster habitat and submerged aquatic vegetation to their respective target levels.

The Districts' IRL and St. Lucie River programs are closely coordinated with several agency management plans and programs. It's important that these programs coordinate with other agencies to ensure consistency in the management of seagrasses and other important estuarine resources, pollution controls (e.g., pollutant load reduction goals, non-point and point source controls), and coastal wetlands. Increasingly, it's becoming a budgetary necessity for the Districts and other governmental programs to share costs and labor associated with restoration monitoring, applied research, and management. Much of what has been accomplished in the past decade is due to the cooperation and efforts of many agencies -- local, regional, state, and federal.

And, much has been accomplished in addressing the issues, goals and objectives of the IRL SWIM Plan.

Our understanding of the relationship between water quality and seagrass has advanced considerably, and thus, the factors that probably do or do not control seagrass distribution in the IRL system. This understanding is an important pre-requisite for the development of final pollutant load reduction goals (or PLRGs). PLRGs[1] can be viewed as "design criteria" for projects or strategies whose purpose is the improvement of water quality or clarity, the major Lagoon-wide factor influencing seagrass coverage.
Even though final PLRGs are not recommended at this time, provisional water quality or pollutant load reduction targets have been established to enable the design of many non-point source projects to begin pollution abatement now rather than later. There has been significant achievement in the control of point sources with the removal of more than 28 billion gallons of discharge from domestic wastewater treatment plants during the 7-year period from 1993 to 2000. Nearly 56,000 acres of wetlands and uplands have been acquired for the purpose of constructing water quality remediation projects as well as for habitat preservation or rehabilitation. More than a half-million cubic yards of harmful muck sediment deposits were removed from tributary creeks and canals; a precursor of more, larger scale muck removal projects in the future.

So, as a result of all this work, is there any improvement in water quality or seagrass coverage? There has been measurable improvement, but it's difficult to ascertain whether the improvement is primarily a result of restoration efforts or a response to weather patterns or other natural events. There has been a net gain in seagrass coverage of nearly 4,000 acres from 1992 to 1999 (65,700 to 69,700 acres, respectively). The greatest gains in seagrass acreage are in areas that had experienced the greatest losses since1943. It's possible that the long drought in the late1990s may have been largely responsible for this positive trend; nonetheless, the cumulative effect of restoration work now and in the future should help to maintain this trend.

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[1] It is presumed by Florida Department of Environmental Protection that final recommended PLRGs may be heavily relied upon for the development of the EPA-mandated Total Maximum Daily Loads (TMDLs) as stipulated in the Florida Watershed Restoration Act (Chapter 403.067, F.S.).

The most tangible and immediate improvement in the IRL system is the hydrologic reconnection of more than 23,000 acres of impounded wetlands since 1989. Impoundment reconnections restore many of the estuarine functions provided by salt marsh and mangrove wetlands. Once they are reconnected, fisheries utilization of the wetlands increase essentially overnight, a more natural and diverse vegetative community and its associated fauna are given a chance to recover and usually do.

There has certainly been a noticeable increase in the public's awareness of the Lagoon's problems and its ecology, and the public's understanding of the projects -- federal through local -- that benefit the Lagoon's recovery and management. Public concern for maintaining a stable, productive human community with a good quality of life includes a healthy Lagoon system.

Much has been accomplished, but more work remains to be done to reach the targets established for seagrass and coastal wetland restoration. During the past decade, the greatest Lagoon-wide seagrass coverage documented or mapped was 69,700 acres in 1999. The ultimate or maximum target is coverage to 1.7 meters depth for much of the Lagoon, representing more than 118,000 acres of seagrass. With respect to the reconnection of impounded wetlands, the total acreage target is more than 37,000 acres. Currently, the reconnected acreage stands at about 28,000; a major advance toward the target. However, the remaining 9,000 acres is proving to be a much greater challenge to reconnect.

Based on the monitoring and diagnostic work to date, it is clear that future work on water quality and seagrass should be focused on non-point (stormwater) source controls. In particular, most of the effort will be directed at large-scale, watershed projects designed to annually reduce thousands to millions of pounds of key pollutants affecting water clarity and billions of gallons of freshwater discharges where it is determined to be excessive and detrimental to salinity regimes. These proposed watershed projects are located in the Central and South IRL and in the St. Lucie River watershed. Those are the areas in the IRL system where water quality and seagrasses (and oyster habitat in the case of St. Lucie River) have suffered most from such impacts, and the land requirements for these large projects can generally be met.

It is also clear that in order to fully achieve the coastal wetland targets, especially in the North and Central IRL, land ownership and marsh management issues need to be resolved. The remaining privately owned impoundments are strategically important wetland habitats relative to their location in the Lagoon basin and are unique relative to the surrounding landscape. Public acquisition is a prerequisite to their rehabilitation. Furthermore, the proper management of all reconnected impoundments is critical to the diversity and health of the IRL system.

Descriptions and budgets of planned work over the next 5 years (2002/03 – 2006/07) are provided in some detail in the following chapters, and a summary of the same 5-year budgets is provided at the end of this Executive Summary (Tables A and B). Most of the planned work and projected annual budgets reflect the focus on priority needs mentioned above. Other important work is also planned and described. This is work that can accelerate, enhance, or ensure restoration success (e.g., muck removal and the evaluation of alternatives to enhance Lagoon flushing); continue our vigilance on the status of the Lagoon (e.g., water quality and seagrass monitoring); gauge the efficacy of implemented projects (e.g., stormwater treatment and muck removal projects); diagnose other potential problems related to seagrass or wetland resources; and further educate and involve the public in the management of the estuary.

The plan for the next 5 years – the projects, and their schedules and budgets – is dependent on a relatively high level of federal, state, regional, and local cooperation, whether that cooperation is manifest as cost-share or as project collaboration collecting data or building structures. An example of interagency partnership programs that can produce significant improvement in the IRL are those that exist between the U.S. Army Corps of Engineers (USACE) and each of the Districts: the recently initiated IRL-North Feasibility Study (SJRWMD/USACE) and the recently completed IRL-South Feasibility Study (SFWMD/USACE). Both study programs have the potential of drawing down hundreds of millions of federal dollars to implement a variety of solutions (mostly structural) that are determined feasible and cost-effective in helping meet SWIM plan objectives, especially the watershed PLRGs and other restoration targets cited above. Both Districts view these USACE partnership programs as the new *flagships* of the IRL restoration effort over the next 5 years and beyond.

If the USACE/Districts partnerships are considered the *flagships*, then the cooperation and work performed by local governments is the *frontline*. Success of the IRL programs will continue to be highly dependent on local government involvement – by cities, counties, mosquito control districts, and water control districts. Their collective involvement is typically demonstrated in the large amount of labor and equipment expended each year assisting the Districts in water quality and seagrass monitoring, reconnection and management of impounded coastal wetlands, land acquisition and management support, construction and maintenance of drainage treatment and erosion control systems, public education, and in many other activities. Much of this work is in-kind service; that is, work that is taken on by local agencies and supported by their own budgets[2]. Participation by cities, counties, and water control districts will likely grow as they work to meet their responsibilities for achieving PLRGs and related resource targets, and wetland management targets.

[2] It is not possible to accurately represent local government in-kind support in monetary terms for presentation in this updated plan; however, it is safe to assume the each county in the IRL basin (inclusive of city and water control district jurisdictions) contributes several hundreds of thousands of dollars to about a million dollars per any given year toward projects related to IRL management.

Table A. Summary of Projected Budgets by Sub-Lagoon, Program, & Fiscal Year A more detailed budget is found in Chapter 8, Tables 8-1a through f.	**SJRWMD (SJ) and SFWMD (SF) Budget Estimates includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts** ***Fiscal Year***					
	FY 02	***FY 03***	***FY 04***	***FY 05***	***FY 06***	***FY 07***
Lagoon-wide	**Monitoring, Research & PLRG development, Land Acquisition, Planning, Education Projects**					
Seagrass & Water Quality	SJ: $3.627M SF: $972,000	SJ: $3.086M SF: $1.135M	SJ: $1.714M SF: $1.125M	SJ: $3.489M SF: $1.199M	SJ: $1.330M SF: $1.090M	SJ: $2.947M SF: $1.073M
Coastal Wetlands	SJ: $24,000 SF: $5,000	SJ: $29,000 SF: $ 6,000	SJ: $44,000 SF: $ 6,000	SJ: $38,000 SF: $ 6,000	SJ: $44,000 SF: $ 6,000	SJ: $50,000 SF: $ 5,000
Public Involvement & Education	SJ: $320,000 SF: $ 26,000	SJ: $580,000 SF: $ 30,000	SJ: $414,000 SF: $ 42,000	SJ: $414,000 SF: $ 29,000	SJ: $417,000 SF: $ 29,000	SJ: $417,000 SF: $ 42,000
Totals rounded to nearest $1,000	*SJ: $3.611M* *SF: $1.003M*	*SJ: $3.695M* *SF: $1.171M*	*SJ: $2.172M* *SF: $1.173M*	*SJ: $3.941M* *SF: $1.234M*	*SJ: $1.791M* *SF: $1.125M*	*SJ: $3.414M* *SF: $1.120M*
Districts/IRLNEP Planning & Administration	*SJ: $165,000* *SF: $ 92,594*	*SJ: $165,000* *SF: $ 23,216*	*SJ: $165,000* *SF: $50,000*	*SJ: $165,000* *SF: $ 99,750*	*SJ: $165,000* *SF: $ 42,000*	*SJ: $165,000* *SF: $ 32,000*
Mosquito Lagoon	**Model application, PLRG development, Research, Non-Point Source and Wetland Projects**					
Seagrass & Water Quality	SJ: $186,400	SJ: $278,050	SJ: $250,600	SJ: $264,850	SJ: $251,100	SJ: $151,100
Coastal Wetlands*	SJ: $209,350	SJ: $159,350	SJ: $262,100	SJ: $212,100	SJ: $362,100	SJ: $312,100
Totals rounded to nearest $1,000	*$396,000*	*$437,000*	*$513,000*	*$477,000*	*$613,200*	*$463,200*
Banana River Lagoon	**Model application, PLRG development, Research, Non-Point Source and Wetland Projects**					
Seagrass & Water Quality	SJ: $258,800	SJ: $158,800	SJ: $480,250	SJ: $291,251	SJ: $333,000	SJ: $1.791M
Coastal Wetlands	SJ: $ 6,050	SJ: $ 6,050	SJ: $ 36,050	SJ: $106,050	SJ: $ 56,050	SJ: $106,050
Totals rounded to nearest $1,000	$265,000	$165,000	$516,000	$397,000	$389,000	$1.879M
North & Central IRL*	**Model application, PLRG development, Research, Non-Point Source and Wetland Projects**					
Seagrass & Water Quality	SJ: $6.659M	SJ: $4.902M	SJ: $5.878M	SJ: $5.448M	SJ: $7.723M	SJ: $6.209M
Coastal Wetlands	SJ: $124,150	SJ: $473,650	SJ: $235,400	SJ: $110,400	SJ: $221,400	SJ: $110,400
Totals rounded to nearest $1,000	$6.783M	$5.376M	$6.113M	$5.558M	$7.944M	$6.319M
South IRL	**Model application, PLRG development, Research, Non-Point Source and Wetland Projects**					
Seagrass & Water Quality	SF: $737,650	SF: $550,949	SF: $2.605M	SF: $2.605M	SF: $2.965M	SF: $2.640M
Coastal Wetlands	SF: $262,541	SF: $257,700	SF: $257,700	SF: $232,700	SF: $207,700	SF: $182,700
Totals rounded to nearest $1,000	*$1.000M*	*$809,000*	*$2.863M*	*$2.838M*	*$3.173M*	*$2.823M*
St. Lucie River*	**Model application, PLRG development, Research, Non-Point Source and Wetland Projects**					
Water Quality & Biological Resources	SF: $22.18M	SF: $445.07M	SF: $167.47M	SF: $147.20M	SF: $58.87M	SF: $17.62M
Shoreline & Floodplain Restoration	SF: $0	SF: $70,000	SF: $70,000	SF: $70,000	SF: $105,000	SF: $115,000
Totals rounded to nearest $1,000	*$22.18M*	*$445.14M*	*$167.54M*	*$147.27M*	*$58.98M*	*$17.74M*

* Most or all the funding from either the SJRWMD or SFWMD for these projects is counted as cost- share by the USACE in the IRL-North and IRL-South Feasibility Study programs, respectively. USACE's costs are shown in Table B.

Table B. Other Major Programs Benefiting the IRL System A more detailed budget is found in Chapter 8, Table 8-2.	• **U.S. Army Corps of Engineers (USACE): Feasibility Studies & Project Implementation** • ***Blueway* Land Acquisition Program (estimated land purchase costs only)** • **St. Lucie River Issues Team** ***Fiscal Year***					
	FY 02	***FY 03***	***FY 04***	***FY 05***	***FY 06***	***FY 07***
IRL- NORTH Feasibility Study; USACE costs only *IRL-North F.S. Project Management Plan, 6-17-02)***	*$81,300*	*$1.550M*	*$1.354M*	*$430,000*	*$302,000*	*$212,000*
IRL-SOUTH Feasibility Study & Project Implementation **USACE costs only** (based on IRL-South F.S. Report**)***	*$3.300M*	*$6.636M*	*$23.872M*	*$40.867M*	*$89.255M*	*$92.218M*
BLUEWAY Land Acquisition (Phase I) – Approximate Land Purchase Costs* up to 7,705 acres in Mosquito Lagoon, Banana R. Lagoon, N. and Central IRL	*$0*	*$4M*	*$5M*	*$5M*	*$5M*	*$10M*
St. LUCIE RIVER Issues Team Legislative appropriations only	*$4M*	*$5M*	*$5M*	*$5M*	*$5M*	*$5M*

* The IRL-North and IRL-South programs are funded 50/50 by the USACE and the Districts (as the local sponsors). The budgets shown above are the estimated USACE costs only. The Districts' match is represented in the preceding table as indicated by asterisks.

** The total 1998 assessed value of the 8,857 acres of land targeted for Phase I of *Blueway* acquisition is ~$60,000,000. Funds would be derived from individual county land acquisition programs (especially in the case of South IRL – St. Lucie and Martin counties), and from the state's Florida Forever program, FDOT mitigation bank, and the Districts' Save Our Rivers program.

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CHAPTER 1. INTRODUCTION

The SWIM Act

The Florida Legislature enacted the Surface Water Improvement and Management (SWIM) Act (Chapter 373.451-373.4595, F.S.) in 1987 and revised it in 1991. This Act declares that many natural surface water systems in Florida, including the Indian River Lagoon (IRL), have been or are becoming degraded. Factors contributing to this degradation include point and non-point sources of pollution and the destruction of natural habitats. The SWIM Act directed the St. Johns River and South Florida Water Management Districts, with the cooperation of state agencies and local governments, to design and implement a plan for the improvement of surface waters and habitats in the IRL.

The Districts complied with this mandate in the development of the 1989 SWIM Plan for the Indian River Lagoon, which was updated in 1994. This 2002 plan document serves as the second update of the plan. It includes a status report on the state of the Lagoon, a summary of progress on projects undertaken since the last update in 1994, and recommendations for future projects and other actions over the next 5 years. This plan update, like the 1989 and 1994 plan documents, received reviews by the general public (via public workshops) and by appropriate state, federal, and local agencies, many of which have been active partners with the Districts in implementing the plan since 1989. Additional detail on the formal plan review process is provided in the 1994 IRL SWIM Plan (Chapter 1, pp.1 – 8).

The Evolution of the IRL SWIM Plan

<u>What's New About the 2002 IRL SWIM Plan Update</u>

The main purpose of this document is to provide an update of the SWIM Plan and its programs and projects since 1994. As such, the content is devoted primarily to progress and accomplishments since 1994, any programmatic changes since 1994, and what is planned over the next 5 years.

The reader is advised to have a copy of the *1994 SWIM Plan for the Indian River Lagoon* on hand as a reference to obtain background and progress information relevant to the many projects that were started during the 1987 – 1994 period. There is frequent reference made to the 1994 IRL SWIM Plan and its appendices throughout this plan update. Two other documents are also recommended as useful technical references concerning the IRL system and its resources: The IRL Reconnaissance Report (SJRWMD and SFWMD, 1987) and the series of the IRL characterization reports developed by Woodward-Clyde Consultants for the IRL National Estuary Program (1994).

The most obvious change is the layout of this 2002 plan document compared to the 1994 and 1989 IRL SWIM plans. The content of the earlier plan documents are organized by program; each program serving as a major chapter or section heading: Water and Sediment Quality; Habitat Preservation and Restoration; Regulation and Enforcement; Public Awareness; and Administration, Planning, and Coordination. This document, however, is organized by geographic regions, beginning with a chapter offering a *Lagoon-wide Overview* (Chapter 2), followed by chapters on the major sub-lagoon areas: *Mosquito Lagoon* (Chapter 3)*, Banana River Lagoon* (Chapter 4)*, North and Central IRL* (Chapter 5)*, South IRL* (Chapter 6)*, and St. Lucie River* (Chapter 7). This 2002 Plan update is designed so that a reader with an interest in a particular sub-lagoon area can find most of the relevant information within a single chapter. Hopefully, by this format change, the reader will find this update more useful and interesting.

Within each chapter, content is organized by program; but the program titles and content have changed reflecting an evolution of the programs and their functions. The new programs are *Seagrass & Water Quality, Coastal Wetlands, and Public Involvement & Education.*

Seagrass & Water Quality. This program and the 2002 plan update reflect the increasing focus on the relationship between water quality and seagrass productivity and diversity. The recovery and maintenance of healthy seagrass beds is the program's emphasis. The fundamental pre-requisite to seagrass recovery is the improvement in water clarity, allowing more sunlight to penetrate deeper into Lagoon waters, enabling the expansion of seagrass beds. Therefore, water quality monitoring, pollutant load reduction goals (PLRGs), and remediation projects have become more specific to what is required to improve water clarity and light penetration.

In each of the following chapters, 2 – 6, the Seagrass and Water Quality section includes a summary of the Districts' assessment of seagrass and water quality status and trends during the past decade, 1990 through 1999. Provisional PLRGs, expressed as "allowable" loading targets, are presented by SJRWMD for Mosquito and Banana River lagoons, and North and Central IRL. SFWMD presents pollutant concentration targets for the South IRL. At the end of this section, there are discussions on the remediation strategies and projects intended to help achieve the PLRGs or water quality targets.

Coastal Wetlands. This program replaces the Habitat Preservation and Restoration program and its related chapter or sectional narratives in the 1989 and 1994 IRL SWIM plans. Seagrass management was removed from this program and merged with water quality as explained above. Wetland management remains focused on the rehabilitation of salt marsh and mangrove habitats, but new initiatives are also underway. This important and expanding program is integral to the holistic management of the IRL system. Accomplishments have been tremendous, but much remains to be done. This program's significance, its progress, and where it's heading are explained in the chapters that follow.

Public Involvement and Education (PIE). This program was entitled *Public Awareness* in the previous IRL SWIM plans. The PIE program is a Lagoon-wide campaign and, as such, is covered only in Chapter 2 (Lagoon-Wide Overview). The goal of PIE has not changed, but the program's scope has broadened since the mid-1990s when the IRL National Estuary Program assumed responsibility for it.

Other Programmatic Changes. Two other SWIM programs, Regulation & Enforcement (R&E) and Administration, Planning, & Coordination (APC), have been subsumed by the three new programs described above. For example, the objectives served by the R&E Program are now made part of the Seagrass & Water Quality and Coastal Wetlands programs. These changes reflect the evolution of the IRL SWIM Plan and the pursuit of efficiency and improved coordination.

Issues, Goals and Objectives

The management issues have not changed substantively since the 1994 IRL SWIM Plan update. Please refer to Chapter II of the 1994 IRL SWIM Plan, pp. 9 – 16, for a discussion of the issues. Since 1994, many of the issues have been further clarified and made more manageable through investigative and remediation efforts. This should become apparent to the reader upon further review of this 2002 SWIM Plan update.

The three major goals of the IRL SWIM Plan, first stated in the 1989 IRL SWIM Plan and re-stated in the 1994 IRL SWIM Plan (Chapter III, p. 19), have remained intact and relevant. The goals are as follows:

> *Goal I. To attain and maintain water and sediment of sufficient quality (". . . to Class III or better . . .", Chapter 373.453, F.S.) in order to support a healthy, macrophyte-based, estuarine lagoon ecosystem.*
>
> *Goal II. To attain and maintain a functioning macrophyte-based ecosystem which supports endangered and threatened species, fisheries and wildlife.*
>
> *Goal III. To achieve heightened public awareness and coordinated interagency management of the Indian River Lagoon ecosystem that results in the accomplishment of the two aforementioned goals.*

Although the goals have remained unchanged, that is not the case with the original set of general objectives (1994 IRL SWIM Plan, Chapter III, p. 21). The objectives have evolved with the programs since 1994. The objectives of the old R&E and APC programs are now handled under the new *Seagrass & Water Quality* and *Coastal Wetlands* programs. The seagrass management objectives are now addressed under the *Seagrass & Water Quality* program. The objectives dealing with marsh restoration, preservation, and creation are addressed under *Coastal Wetlands*.

The most substantive change is the removal of one of the original water quality objectives: *"Reduce …coliform bacteria in shellfish harvesting areas…"* (see 1994 IRL SWIM Plan, p. 21). That objective, as stated, can be misconstrued as suggesting that the Districts are accountable for monitoring and meeting background coliform or state bacteriological standards in shellfish harvesting areas. The Districts do not have that authority[1]. Nonetheless, the Districts believe that substantial reductions in coliform bacteria loading to the IRL can occur when the other water quality objectives of the Plan are addressed. This "coliform objective" is now viewed as an ancillary benefit to the IRL if Goal I and its current set of water quality objectives are achieved.

In summary, the revised set of objectives is presented in Figure 1-1 along with their corresponding goals.

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[1] Florida Department of Agriculture and Consumer Services (via Shellfish Environmental Assessment Section) is responsible for monitoring the bacteriological condition of shellfish waters. The counties' public health agencies and FDEP play a role in preventing or controlling sources of bacteriological contamination in ambient waters and potable water supplies.

Figure 1-1. Goals and Objectives* of the 2002 SWIM Plan for the Indian River Lagoon

Goal I. To attain and maintain water and sediment of sufficient quality (". . . to Class III or better . . .", Chapter 373.453, F.S.) in order to support a healthy, macrophyte-based, estuarine lagoon ecosystem.

Goal II. To attain and maintain a functioning macrophyte-based ecosystem which supports endangered and threatened species, fisheries and wildlife.

Goal III. To achieve heightened public awareness and coordinated interagency management of the Indian River Lagoon ecosystem that results in the accomplishment of the two afore-mentioned goals.

Seagrass & Water Quality Objectives

- Restore lost seagrass beds and preserve existing seagrass beds (largely by fulfilling the objectives below)
- Manage **excessive** freshwater inflows to minimize their impacts on salinity**
- Decrease inputs of suspended materials from point and non-point sources**
- Decrease inputs of excessive loadings of nutrients from point and non-point sources**
- Eliminate or reduce the releases of toxic substances from point and non-point sources

Coastal Wetland Objectives

- Restore function of impounded and other impacted marshes
- Preserve existing marshes
- Create new marshes

Seagrass & Water Quality, Coastal Wetland, and Interagency Coordination Objectives

- Review rules and revise as necessary to protect water quality and aquatic habitats
- Ensure adequate level of rule enforcement & compliance
- Improve coordination among agencies to implement regulatory, research, monitoring and other management projects efficiently
- Continue to improve administrative support of programs

Public Involvement and Education Objectives

- Develop a public awareness campaign concerning the IRL and restoration programs that benefit it
- Continue to improve administrative support and seek ways to coordinate with other public information programs

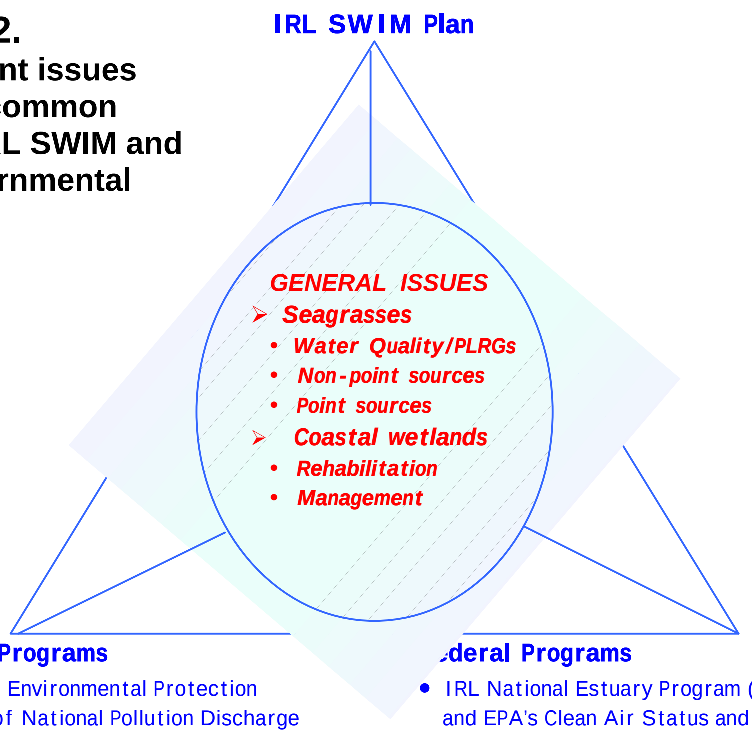
* The set of objectives above are slightly different from those in the 1994 IRL SWIM Plan. Please read Chapter 1, p. 1-3 for an explanation of changes.

** Objective served by development of and compliance with Pollutant Load Reduction Goals (PLRGs), which would be considered in the development of federal and state Total Maximum Daily Loads (TMDLs).

Relationship to Other Programs and Plans

It is both a goal and a necessity that the IRL SWIM Plan and its programmatic activities coordinate with other agency plans or programs. Rather than acting alone, it's more advantageous and prudent for the IRL SWIM programs to engage with other governmental programs to ensure that goals are consistent in the management of seagrasses, pollution controls (PLRGs, non-point and point sources), and coastal wetlands (Figure 1-2). It makes sense to coordinate with other agency programs to achieve mutual aims, prevent or minimize management conflicts, and conduct cost-effective and efficient projects. Also, it's a budgetary necessity for the Districts and other governmental programs to cost-share the expenses associated with restoration monitoring, applied research, and management. For these reasons, the Districts' IRL SWIM programs closely coordinate with several federal, state, and local management plans and programs. Those plans and programs that are described below are currently in the forefront of IRL management (Figure 1-2).

Figure 1-2. Management issues shared in common between IRL SWIM and other governmental programs



Other Florida Programs

- Florida Dept. of Environmental Protection administration of National Pollution Discharge Elimination System and development/implementation of Total Maximum Daily Loads (TMDLs)
- State Aquatic Preserves (FL Dept. of Environmental Protection)
- FL Inland Navigation District, SJRWMD, SFWMD, and water control district plans for dredge, water supply, and local drainage programs, respectively
- Florida Dept. of Community Affairs – State & Local Growth Comprehensive Plans
- Florida Dept. of Agriculture and Consumer Services (aquaculture, shellfish waters, mosquito control districts and management of coastal wetlands)

Federal Programs

- IRL National Estuary Program (EPA & WMDs) and EPA's Clean Air Status and Trends Network
- TMDLs & NPDES – EPA Guidance & Oversight (PLRGs -> TMDLs)
- National Wildlife Refuge and National Park Service Plans (especially the USFWS and NPS management of coastal wetlands)
- NASA's environmental programs
- Comprehensive Everglades Restoration Plan -- South and North IRL Feasibility Studies (U.S. Army Corps of Engineers, SFWMD, and SJRWMD)

Additionally, there are numerous public and private grant programs that can support the implementation of the SWIM Plan. Information on public and private grant programs can be obtained from IRL National Estuary Program office located at the SJRWMD Palm Bay Service Center. That program routinely updates and disseminates current lists and descriptions of grant opportunities.

Federal Plans and Programs

The IRL National Estuary Program. The EPA's National Estuary Program was established in 1987 as Section 320 of the Clean Water Act. In 1990, following resolutions of support by the Governor and the Districts, the Indian River Lagoon was proclaimed an Estuary of National Significance, and the IRL National Estuary Program (IRLNEP) was established. Two organizational aspects of the program were immediately set in motion: 1) an IRLNEP management group or " Management Conference" representing SJRWMD, SFWMD, state, local and federal agencies; and 2) the selection of the SJRWMD as the IRLNEP sponsor whose responsibilities include providing staff support and the local administration of federal funds. A cooperative agreement between the SJRWMD and the EPA was signed on January 4, 1991.

Between 1991 and 1996, the main objective of the IRLNEP, facilitated by both the SJRWMD and SFWMD, was to have the conference agencies[2] agree on goals and related actions for restoration and protection of the Lagoon and document such an agreement in a Comprehensive Conservation and Management Plan (CCMP). The CCMP was completed in 1996 and is now being implemented in concert with the IRL SWIM Plan. In fact, the CCMP adopted the same three goals found in the IRL SWIM Plan (see SWIM goals above); but also proposed a fourth goal (which concerns long-term commitments toward CCMP implementation) as well as other applied research, education, planning, and "action now" activities.

The IRLNEP has built upon the IRL SWIM mission and its accomplishments, furthering the restoration campaign for the IRL system. The IRLNEP fostered active participation by other federal agencies, notably the U.S. Fish and Wildlife Service, NASA, and the U.S. Army Corps of Engineers. It also manages a local government cost-share program that assists counties and municipalities with planning and implementing pollution abatement projects, which are typically small-scale with an emphasis on stormwater treatment. In recent years, the IRLNEP has tackled some of the important and controversial issues in the IRL Basin such as septic tanks and reverse osmosis treatment facilities as potential sources of pollution. Since 1994, the IRLNEP has assumed complete responsibility for the Public Awareness Program initiated under SWIM in 1987 (the program is now called Public Involvement and Education; pp. 238 – 251 in the CCMP). Furthermore, the IRLNEP office provides budget administrative support to all SJRWMD's IRL projects (regardless of funding source) in addition to its administration of EPA IRLNEP funds and IRL license plate revenues for both Districts and the counties of the IRL Basin.

[2] Most of these conference agencies are now represented on the IRLNEP Advisory Committee. Information on Committee representation and function can be obtained from the IRLNEP office at SJRWMD's Palm Bay Service Center.

The EPA's National Pollution Discharge Elimination System (NPDES) Program. The counties and nearly all municipalities in the IRL basin are required to apply to Florida Department of Environmental Protection (FDEP) for a general permit under the U.S. EPA's NPDES Phase 2 municipal separate storm sewer system (or MS4). FDEP administers this program in Florida on behalf of EPA[3]. The NPDES permit application must be completed in 2003; and the permitted program should be implemented by 2008. As part of the application, the counties and cities must develop a stormwater management plan and program that controls surface water (stormwater) pollution to the maximum extent feasible. At a minimum, the program must implement and set measurable goals for each of the following six elements: *1) public education, 2) public participation, 3) illicit discharge detection and elimination, 4) construction site stormwater controls; 5) post-construction controls; and 6) pollution prevention/good housekeeping for municipal operations*

The SJRWMD and SFWMD can assist local governments, at some level, in accomplishing most of the elements listed above. Both Districts, through the IRL SWIM and NEP programs, have assisted the counties and many of the cities and towns in developing surface water management plans and associated source control data (land use coverage, drainage maps, pipe and canal outfall locations, topographic and geotechnical data for best management practice [BMP] design, etc.). The Districts will continue to provide such support insofar as the intended local government actions help to achieve PLRGs or other SWIM/NEP objectives. Public education and participation projects promote public understanding of the relationship between stormwater management and a healthy Lagoon, and enable "grassroots" participation in projects. Both Districts cost-share with local governments in the planning and construction of BMPs designed for runoff storage/treatment. Work of this type that has been accomplished prior to 1994 is described in the 1994 IRL SWIM Plan (specifically pp. 30 – 53, 69 –74, and 78 – 79), and work since 1994 is described in this 2002 SWIM Plan update (in the non-point source strategy sections in each of the subsequent chapters).

As the local governments prepare their permit applications and corresponding plans, the Districts will be prepared to review the draft plans to ensure consistency with the PLRGs established for their respective jurisdictions, and to determine whether their programs and strategies appear to be capable of meeting those targets.

National Park and National Wildlife Refuge Plans. The National Parks (National Park Service) and the National Wildlife Refuges (U.S. Fish and Wildlife Service), both under the U.S. Department of the Interior, manage extensive areas of open waters and uplands, and over half of the wetland acreage, in the IRL Basin[4].

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[3] Congress through the Water Quality Act of 1987 mandated the EPA to develop a tiered implementation strategy for the NPDES Storm Water Program. Phase I was implemented for major urban centers =100,000 people. Phase II handles local government jurisdictions of <100,000 people.

[4] Maps depicting boundaries of the Canaveral National Seashore and the National Wildlife Refuges in the IRL Basin are found in the IRL Joint Reconnaissance Report, Chapter 6 (SJRWMD and SFWMD, 1987).

Canaveral National Seashore (managed by NPS) covers the southern two-thirds of Mosquito Lagoon. *Merritt Island National Wildlife Refuge* (*MINWR*) also has management responsibility over a significant portion of the southern Mosquito Lagoon. Additionally, *MINWR* manages nearly all of North Merritt Island inclusive of northern Banana River Lagoon, extending from the Canaveral Barge Canal (near S.R. 528) to north of Haulover Canal just inside Volusia County. *Pelican Island National Wildlife Refuge* (the first National Refuge established in the country) covers about 14 sq mi of IRL immediately south of Sebastian Inlet. *Hobe Sound National Wildlife Refuge* covers about a 10-mile length of Hobe Sound, including 4 miles of barrier island.

The National Park Service (NPS) and U.S. Fish and Wildlife Service (USFWS) are evaluating their policies and activities as they relate to their long-standing, land management directives while giving serious consideration to current management issues or problems. The evaluations of management aims and activities, and any proposed adjustments to them, will be documented in their respective management plans.

The Canaveral National Seashore is revising its 1982 Water Resources Management Plan. The new plan was completed by the NPS in December 2001. The plan is intended to guide water-related management and public use activities over the next 5 to 10 years. Examples of the management issues that the plan emphasizes are protection of shellfish beds (oysters primarily) and seagrasses by regulating human uses in the southern Mosquito Lagoon, addressing pollution impacts whether originating within or outside the park boundaries, and improving marsh management practices to provide more complete ecological benefits inclusive of protections to federally listed species.

The Refuge Comprehensive Conservation plans for Merritt Island, Pelican Island, and Hobe Sound are in development by USFWS and may be completed by 2003. Each plan will deal with its own issues related to water and land resources and how best to regulate human activities within Refuge boundaries. The Refuge plans have a lifespan of 15 years before they are revised. Considering the expanse of land and water that the three Refuges manage -- well over 150,000 acres in the IRL Basin -- it's important for both the Districts and USFWS to review or assist in the development of their respective plans to ensure consistency among their goals and objectives.

The planning by NPS and USFWS is an excellent opportunity for the Districts to collaborate with those agencies on projects that can improve upon the holistic management of estuarine systems, such as seagrasses and coastal wetlands. Examples of current and potential collaborations are presented in some of the subsequent chapters (e.g., Canaveral National Seashore/ Mosquito Lagoon, Chapter 3; Wetlands Management Research Initiative in MINWR/North IRL, Chapters 2 and 5).

The IRL South and North Feasibility Studies (U.S. Army Corps of Engineers and the Districts). During the late 1940s through early 1970s, extensive drainage works were constructed by the U.S. Army Corps of Engineers (USACE) throughout central and southern Florida -- in the Upper St. Johns River, Kissimmee River, Lake Okeechobee, and Everglades basins -- for purposes of flood control. This major flood control project, known as the Central and Southern Florida Project, created a variety of unanticipated environmental impacts, not only to the aforementioned basins but also to the IRL that receive diverted, augmented drainage from the Project. The USACE and its non-federal sponsors, SFWMD and SJRWMD, have embarked on long-term programs, 15 years or more, to rehabilitate the degraded environmental quality and ecological functions of the affected ecosystems.

These programs are being conducted under Congressional authority through the Water Resources Development Act (WRDA) and the Comprehensive Everglades Restoration Plan (CERP). The first phase of these programs is a *feasibility study* whose purpose is to diagnose the impacts and evaluate the feasibility and costs of remedial alternatives. The IRL system is, of course, a subject of these feasibility studies

The IRL is divided into two study areas: IRL-South (South IRL and St. Lucie River sub-basins in SFWMD) and IRL-North (the SJRWMD portion of the IRL system). The IRL-South Feasibility Study was conducted over the last five years and its final report can accessed via internet: www.evergladesplan.org. The IRL-North Feasibility Study was recently initiated in 2002[5] and is scheduled to conclude by 2008. Under the feasibility studies, the USACE and the Districts evaluate the efficacy of restoration alternatives and recommend those that can achieve the intended purpose, are practical, and are cost-effective. The feasibility study reports are essentially plans that include recommended watershed or regional construction projects, along with their conceptual designs and budgets. For example, the studies can recommend large-scale projects whose purpose would be to attenuate excessive freshwater discharges and/or treat the quality of surface water drainage to the IRL system. Still other types of projects can be proposed to restore Lagoon water quality or enhance wetlands.

The IRL-South F.S. and IRL-North F.S. reports will be submitted to Congress for approval via the re-authorization of WRDA in 2004 and 2008, respectively. WRDA re-authorization could mean a federal appropriation of up to several hundreds of millions of dollars to implement the recommendations of the reports. For successful implementation, the Districts would also need to follow through on their commitments.

This level of federal involvement in an estuarine restoration effort is unprecedented. It is anticipated that this joint USACE/WMD program will ensure the future success of the IRL restoration programs, both SWIM and IRLNEP.

State, Regional, and Local Programs

State Programs. The discussion here should start with the relationship between the Districts and the Florida Department of Environmental Protection (FDEP). The FDEP is the state's lead administrative agency that reviews the policies and actions of the state's five water management districts relative to the State Water Policy and its related plans (e.g., State Comprehensive Plan, Florida Water Plan, District Water Management Plans). The FDEP administers the NPDES program in the state on behalf of U.S. EPA (please refer to p. 1-7 for more information about the NPDES program). In addition, the FDEP is the agency that administers the SWIM Act on behalf of the state, establishing SWIM plan development and implementation guidance policies pursuant to the Act, and serving as the primary state agency that reviews the SWIM plans and their revisions or updates (Chapter 373, F.S.). The FDEP and the water management districts have also established the general guidance and schedules for the development of PLRGs, which the Districts have

[5] According to the USACE, a link to the IRL-North Feasibility Study will be developed in 2003 through the web page at www.evergladesplan.org.

the authority to establish (Chapter 62-40, F.A.C.)[6]. The FDEP, through its Bureau of Watershed Management, is delegated by U.S. EPA to develop and implement Total Maximum Daily Loads (TMDLs) with the intent to adopt or, at minimum, be consistent with the Districts' recommended PLRGs. Similar to a PLRG, a TMDL is the maximum amount of a given pollutant that the estuary can absorb and still maintain its designated use (e.g., suitable for fishing or swimming). For details on the development and implementation of TMDLs in the IRL system and throughout the state, please refer to Appendix A.

A summary description of the programmatic linkages between FDEP and the Districts is covered in the 1994 IRL SWIM Plan (Chapter I, pp. 2 – 6). On a project level, both the SJRWMD and SFWMD frequently coordinate with FDEP's divisions and district offices[7] regarding water quality and biological monitoring, permit reviews, point source inventory updates, watershed and aquatic preserve[8] plans, and a variety of other management issues. For example, the FDEP and Districts coordinate on the review of development permit applications that affect stormwater discharge quality and quantity. The agencies impose a higher level of treatment for development drainage to Outstanding Florida Waters (OFW). The IRL basin is fortunate to have a majority of its open water designated as OFW (see Appendix B.1 for OFW listing).

Other state agencies that periodically work with the Districts on IRL SWIM issues are the Florida Department of Agriculture and Consumer Services (regulation of shellfish harvesting in seagrass areas, aquacultural and agricultural management practices, administrative oversight of the local mosquito control districts); the Florida Fish and Wildlife Conservation Commission, especially the Florida Marine Research Institute regarding seagrass and fisheries information; and the Florida Department of Community Affairs.

The Florida Department of Community Affairs is responsible for shepherding the development of local comprehensive growth plans to ensure consistency of local plans to state growth policies (Rule 9J-5 and Chapter 163, F.S.). Certain elements of the local growth plans are intended to guide growth in order to minimize or prevent local development burdens on water resources. It's imperative that SJRWMD and SFWMD review local plans for consistency with the SWIM Plan goals and objectives, particularly for the following elements: Future Land Use, Infrastructure, Coastal Management, Conservation, Intergovernmental Coordination, and Capital Improvements. Local plans can be important mechanisms for transforming SWIM objectives into action. The Capital Improvement element of local plans should accommodate SWIM Plan construction projects that may affect large-scale land use and zoning and are designed to provide regional or watershed benefits.

Regional Programs – Water Control Districts and Florida Inland Navigation District. The Districts are actively engaged with two regional governmental entities: the water

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[6] Furthermore, PLRGs may also be heavily relied upon for the development of the FDEP/EPA Total Maximum Daily Loads (TMDLs) as stipulated in the Florida Watershed Restoration Act (Chapter 403.067, F.S.).

[7] FDEP's Division of Water Resource Management, Office of Coastal and Aquatic Managed Areas (aquatic preserves), and Division of Recreation and Parks. FDEP has Central District offices in Orlando and Sebastian Buffer Preserve; and Southeast District offices in Port St. Lucie and West Palm Beach.

[8] For names and locations of the state aquatic preserves in the IRL system, refer to the IRL Joint Reconnaissance Report, Chapter 6 (SJRWMD and SFWMD, 1987) or to FDEP's website: www.dep.state.fl.us/coastal/programs/aquatic.htm.

control districts (a.k.a. "Chapter 298" drainage districts[9]) and the Florida Inland Navigation District (FIND).

In addition to the large canal systems directly managed by SJRWMD and SFWMD[10], there are major, regional drainage systems managed by the seven Water Control Districts (WCDs):

- SJRWMD/IRL Basin: Melbourne-Tillman, Sebastian River, Fellsmere, Vero Lakes, and Indian River Farms Water Control Districts
- SFWMD/IRL Basin: Ft. Pierce and North St. Lucie Water Control Districts

The WCDs are working with the two water management districts (SJRWMD and SFWMD), and the USACE on planned projects (via the IRL-North and IRL-South feasibility studies) that should substantively achieve watershed PLRGs and IRL water quality targets by treating the quality and reducing the quantity of discharges to the IRL from WCD canals. These plans are discussed in Chapters 5 through 7 (Central IRL, South IRL, and St. Lucie River, respectively).

The FIND is Florida's non-federal sponsor allied with the USACE, the federal sponsor, in maintaining the Intracoastal Waterway along Florida's east coast. FIND is responsible for developing dredge maintenance plans, acquiring and developing sites for dredged material management, and, in general, supporting projects that enhance the navigational and environmental/aesthetic features of the IRL's waterways. The Districts, FIND, and the USACE have developed mutual objectives and, thus, cost-share arrangements regarding muck sediment projects because the potential outcome is improved navigation and water quality. Also, methods in dredged material management including the beneficial uses of dredged material can be explored. More information on these projects is provided in the following chapters (especially in Chapters 2, and 5 through 7).

Local Programs. Local programs[11] that are key to the achievement of SWIM objectives include:

- the counties' and cities' local growth comprehensive plans (especially the conservation and infrastructure elements) and NPDES compliance programs,
- the counties' environmental programs (monitoring, species protection, etc.),
- the counties' land acquisition programs pursuant to the IRL Blueway program12, and
- the counties' mosquito control district programs for rehabilitation and management of impounded wetlands.

It is important to stress that a significant amount of the on-the-ground effort to implement the various urban and watershed remediation projects is and will be expended by local government agencies. It will ultimately fall to the counties and municipalities to achieve many of the watershed PLRGs through their NPDES programs, to acquire and manage many of the environmentally sensitive lands in the IRL Basin, and to manage several thousands of acres of reconnected or rehabilitated wetlands. The Districts have and will continue to guide, assist, and cooperatively fund local agencies in these endeavors.

[9] There are 7 Water Control Districts in the IRL basin whose general legal authority was originally established under Chapter 298, F.S., General Drainage Law of Florida.

[10] SJRWMD: C-54 canal; SFWMD: C-25, C-24, C-23, and C-44 canals

[11] In the IRL Basin there are more than 30 cities and towns and 6 coastal counties: Volusia, Brevard, Indian River, St. Lucie, Martin, and Palm Beach.

[12] The Districts and counties developed a coordinated approach – the Blueway Program -- to acquire most of the remaining, environmentally critical lands in the IRL Basin (~8,000 acres of wetlands and uplands). More information on this program is found in Chapter 2.

More detail about local government involvement in the SWIM programs is provided in subsequent chapters.

Major Accomplishments and Challenges

Now, after more than a decade of federal-through-local-level attention to the IRL system, significant progress has been made in addressing SWIM issues, goals, and objectives.

We are closer to a more definitive and quantitative understanding of the relationship between water quality and seagrass, and thus, the reasons for seagrass loss or gain. This understanding is an important prerequisite for the development of PLRGs, whose purpose is the improvement of water quality, the major factor influencing seagrass coverage.

Besides the good progress made on the science, there is also good progress taking place "on the ground." Nearly 56,000 acres of wetlands and uplands have been acquired for various purposes – water quality remediation projects, habitat preservation, etc. There is good progress in the removal of large volumes of treated wastewater from the IRL; in the steady, incremental improvements in stormwater management throughout the IRL basin; and in the removal of harmful muck deposits. There has also been a net gain in seagrass coverage of nearly 4,000 acres from 1992 to 1999[13]. The most dramatic gains in seagrass acreage are in areas that have experienced the greatest losses since1943. The long drought in the late 1990s may have been largely responsible for this positive trend, but the cumulative effect of the restoration work now and in the future should help to maintain this trend.

The greatest tangible improvement in the IRL is the hydrologic reconnection of more than 23,000 acres of impounded wetlands since 1989 under SWIM (in addition to the nearly 5,000 acres reconnected through other programs). Impoundment reconnections restore many of the estuarine functions provided by salt marsh and mangrove wetlands.

Equally as rewarding is the positive impact the IRL programs are having on the public. There is a noticeable increase in the awareness of the Lagoon's problems and its ecology, and an understanding of the projects -- federal through local -- that benefit the Lagoon's recovery and management. The public's concern for maintaining a stable, productive community with a good quality of life includes a healthy Lagoon system.

Much has been accomplished, but more work remains to be done to reach targets established for seagrass and coastal wetland restoration. The issues of yesterday -- seagrass/water quality, coastal wetlands, and public awareness -- are still the issues of today. They should also be regarded as the issues of tomorrow, because even in the aftermath of restoration success, preventative safeguards, vigilance, and education are necessary so that the issues do not again emerge as problems for the Indian River Lagoon.

[13] 65,717 acres of seagrass in 1992; 69,692 acres of seagrass in 1999

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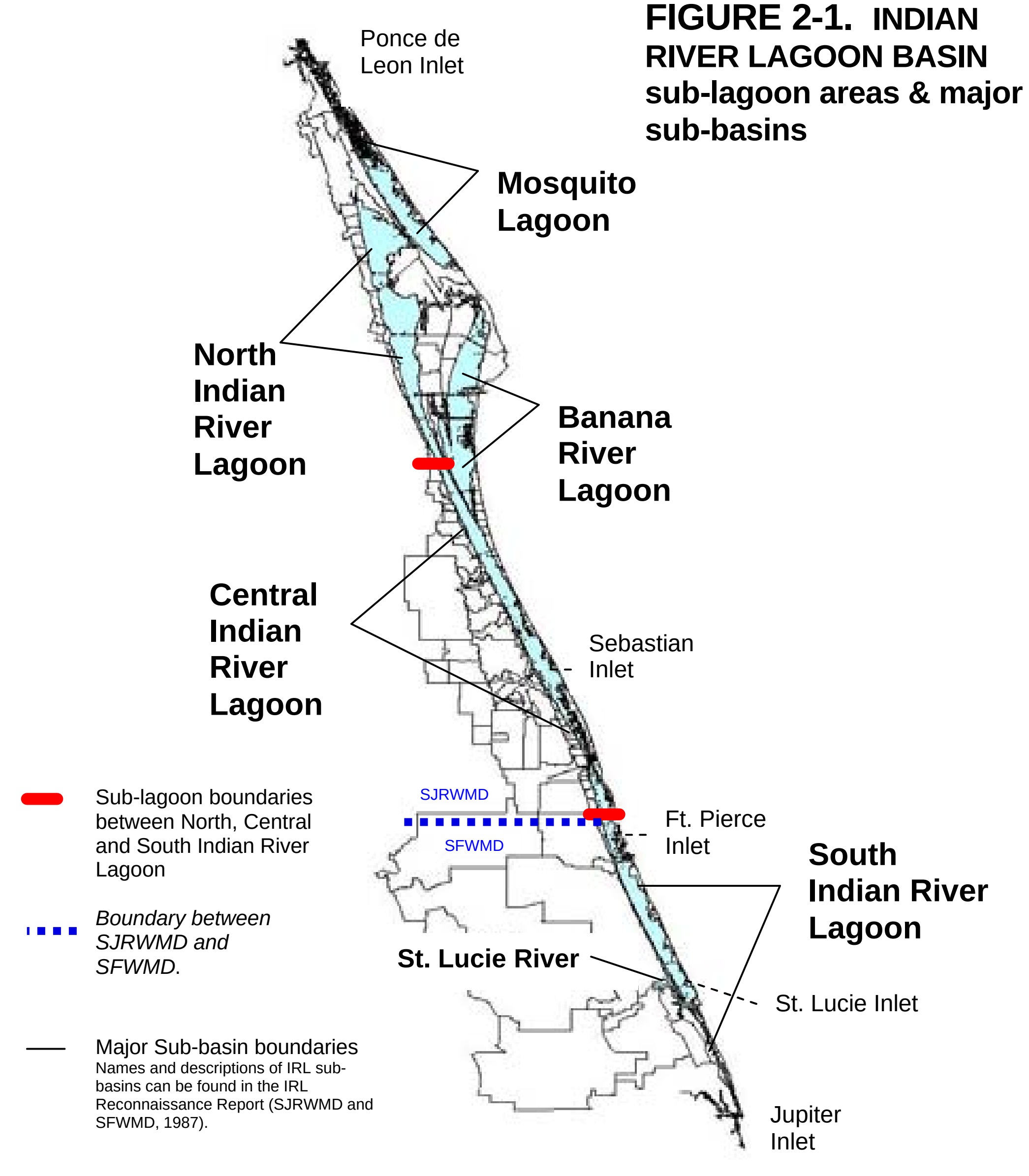
CHAPTER 2. A LAGOON-WIDE OVERVIEW

Introduction

This chapter is devoted to an overview of the IRL system: a summary report on its status with respect to its seagrass, water quality, and coastal wetland resources, and a summary discussion about those strategies and projects which have application throughout the IRL Basin in both the SJRWMD and SFWMD (Figure 2-1).

The first major section in this chapter, *Seagrass and Water Quality*, opens with a brief report on the Lagoon-wide status of seagrass and water quality. This report is based on the general findings of the monitoring and diagnostic projects in the *Seagrass*

FIGURE 2-1. INDIAN RIVER LAGOON BASIN sub-lagoon areas & major sub-basins



and Water Quality program and constitutes an interpretation of the condition and trends of seagrass and water quality in the IRL system during the 1990s. Similar status reports specific to the sub-lagoon regions – Mosquito Lagoon, Banana River Lagoon, North, Central and South IRL, and St. Lucie River – are found in Chapters 3 - 6.

Following the status report are the general descriptions of the projects and basic management approaches that have Lagoon-wide application (e.g., monitoring networks, diagnostic investigations, general approach to non-point and point source management, reconnection of impounded wetlands, etc.). The project descriptions include their progress and what is planned over the next 5 years. The project descriptions are organized by program: *Seagrass and Water Quality*, *Coastal Wetlands*, and *Public Involvement and Education*. These programs were initiated in 1988/89, at the inception of the IRL SWIM Program. For information on project progress prior to 1994, please refer to the 1994 IRL SWIM Plan. Project progress since 1994 is discussed in this plan update within their respective programs.

An Overview of the Programs – Seagrass and Water Quality, Coastal Wetlands, Public Involvement and Education

The *Seagrass and Water Quality* program largely consists of projects that have a diagnostic or feasibility assessment function -- assessing the health of the Lagoon's seagrass resource, defining the impacts to this resource, setting restoration targets or performance measures, and recommending and evaluating strategies to achieve those targets. Since 1994, additional efforts have been placed on implementing management strategies and evaluating pollutant load reduction efficiencies and costs for some representative projects (e.g., stormwater treatment basins and sediment traps).

The *Coastal Wetlands* program is engaged in the rehabilitation of impacted coastal wetlands, particularly impounded wetlands (a.k.a. mosquito control impoundments). In contrast to the *Seagrass and Water Quality* program, the *Coastal Wetlands* program benefited from over a decade's worth of diagnostic and feasibility research[1] in Lagoon wetland management prior to the passage of the 1987 SWIM Act. Such research led to the development of methods for reconnecting and managing impounded wetlands that allow a large degree of ecological recovery and sustainability but still provide for mosquito control. Consequently, the Districts immediately launched a Lagoon-wide campaign at the inception of the SWIM program to reconnect and rehabilitate tens of thousands of acres of impounded wetlands. Progress toward that goal and what is planned over the coming years to complete that goal -- and even go beyond -- are the main subjects of the *Coastal Wetlands* section.

The *Public Awareness* program, renamed *Public Involvement and Education* (PIE), has been fully managed by the IRL National Estuary Program (IRLNEP) since 1994. Through the IRLNEP's exceptional efforts, public awareness, and support have grown steadily. Maintaining a high level of awareness and eliciting support for restoration projects is a constant challenge. When one considers the fact that nearly 400 people move into the IRL basin every week, the on-going process of public awareness should

[1] Much of that research was jointly conducted by Florida Medical Entomology Laboratory (Vero Beach), Harbor Branch Oceanographic Institution, and the local Mosquito Control Districts.

be a mainstay of any large restoration program. For details on the PIE program's strategies and projects, please refer to pages 238 – 251 of the IRLNEP's Comprehensive Conservation and Management Plan. This SWIM Plan update briefly covers progress and accomplishments, and what milestones are established for the future.

Seagrass and Water Quality

Lagoon-wide Status of Seagrass and Water Quality

Seagrass Resource Assessment. The Districts' assessment of the IRL seagrass resource is based on three measurement indices:

- ❖ Acres of seagrass coverage gain or loss
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of total surface sunlight that reaches the targeted depth of 1.7 m

Seagrass coverage is evaluated against multiple targets. Both Districts considered the potential coverage, based on a target depth of 1.7 m, and 1940 - 1943 mapped coverages, which are the earliest documented coverage years known for the IRL. Based on "healthy" areas of the Lagoon, the Districts set a target depth of 1.7 m (5 ft 7 in)[2] to which seagrass can grow if given optimal conditions (Morris et al., 2002). Therefore, gauging the maximum depth of the edge of seagrass beds is as important a measure of health as is areal coverage. Finally, the extent to which sunlight reaches the target depth of 1.7 m is a measure of the water clarity condition: the clearer the water, the more light reaches the bottom, and the greater potential there is for seagrass growth and expansion.

Seagrass coverage distributions vary widely throughout the IRL system (Figure 2-2; IRL seagrass coverages in the 5 sub-Lagoons and the St. Lucie River). Major findings about seagrass coverage distribution in the IRL are summarized below (refer to Figure 2-2 for additional detail).

- Lagoon areas containing the largest seagrass coverages are around N. Merritt Island in the federally protected bottomlands of NASA/Kennedy Space Center (North IRL and northern Banana River) and the Canaveral National Seashore (southern Mosquito Lagoon). These areas experienced little change between 1943 and 1999.
- The largest area with the least seagrass coverage, and with the greatest loss since 1943 (70% loss), extends from Cocoa to just south of Turkey Creek
- Within the SJRWMD portion of the IRL (Mosquito Lagoon, Banana River, North and Central IRL), the current (1999) 61,884 acres of seagrass is 63% of the potential 98,274 acres of coverage (based on 1.7 m depth). The 1943 seagrass coverage was 63,238 acres; 64% of the potential acreage.
- Within the SFWMD portion (South IRL), the current (1999) seagrass cover is 7,808 acres or 39% of the potential 19,799 acres. The early 1940s seagrass coverage was nearly the same – 7,668 acres or 39% of the potential acreage.
- For the entire IRL, the potential coverage area for seagrass is 118,000 acres; but only 59% of that is currently covered in seagrass (69,692 acres in 1999).

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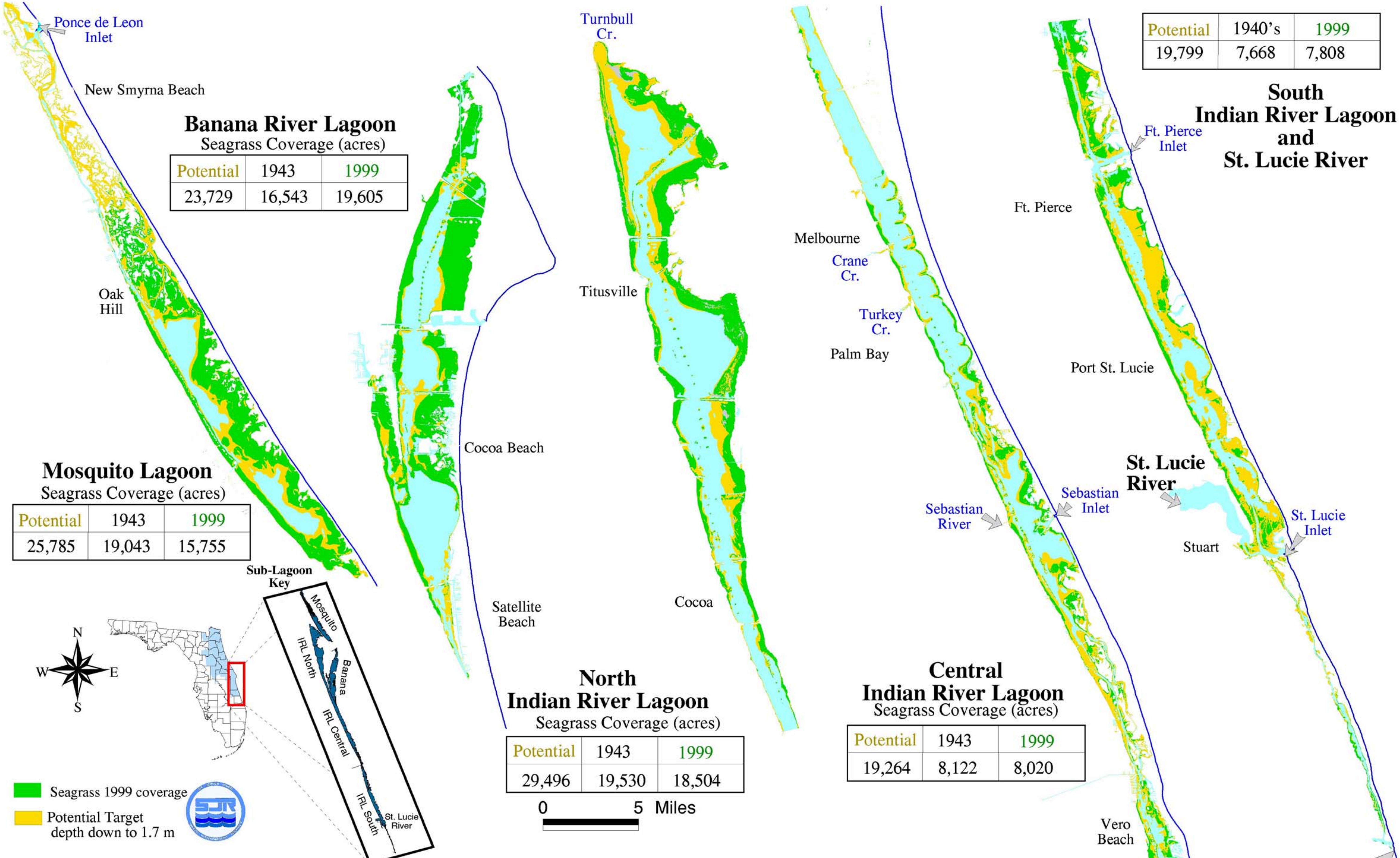
[2] Depth is referenced to NAVD88 by SJRWMD and to NGVD29 by SFWMD.



Mosquito Lagoon
Seagrass Coverage (acres)

Potential	1943	1999
25,785	19,043	15,755

Banana River Lagoon
Seagrass Coverage (acres)

Potential	1943	1999
23,729	16,543	19,605

North Indian River Lagoon
Seagrass Coverage (acres)

Potential	1943	1999
29,496	19,530	18,504

Central Indian River Lagoon
Seagrass Coverage (acres)

Potential	1943	1999
19,264	8,122	8,020

South Indian River Lagoon and St. Lucie River

Potential	1940's	1999
19,799	7,668	7,808

Figure 2-2 Seagrass Coverages in the Indian River Lagoon System

Maps show potential* and current (1999) seagrass coverage. The estimated coverage in 1943 is provided in the tables for comparison

*Potential area coverage is based on 1.7 m depth referenced to the NAVD88 vertical datum, except in South IRL where depths were referenced to NGVD29

- In general, "healthy" seagrass areas are adjacent to relatively undeveloped watersheds or in proximity to inlets, whereas areas of extensive losses are adjacent to highly developed watersheds and shorelines.

The Relationship of Light to Seagrass. It is believed that light limitation is the primary reason for restricting seagrass from growing into deeper water (Morris and Tomasko, 1993; Woodward-Clyde, 1994a). Preliminary analysis of IRL data[3] indicates that nearly 50% of the variability in the depth of seagrass coverage can be explained by the amount of light that can penetrate Lagoon waters[4]. This means that if we can sufficiently increase light penetration, then seagrass should measurably expand.

What is regarded as a *sufficient* amount of light? One way to determine whether there is enough light is to measure the percent of surface light that reaches the target depth of 1.7 m and compare that to some light requirement level. The preliminary minimum light requirement for IRL seagrass is about 25% of the surface light based on the annual median of the percent surface light at the deep edges of seagrass beds. This finding is in good agreement with the scientific literature, which suggests that seagrass light requirements may range from 15% to 37% of surface light (Kenworthy, 1993; Morris and Tomasko, 1993; Kenworthy and Fonseca, 1996).

It appears that throughout the IRL, the percent of surface light reaching 1.7 m falls short of the minimum "25% requirement" (SJRWMD and SFWMD monitoring data; Figure 2-3a and b). The North IRL (near Titusville) and the Jupiter Inlet segment come closest to meeting this incipient standard, receiving nearly 25% or more of surface light. The areas that exhibit good to fair light penetration, 15% of surface light or more, typically have the best seagrass coverage: southern Mosquito Lagoon, northern Banana River, North IRL (near Titusville), and near Sebastian and Jupiter inlets.

Unexpectedly, Mosquito Lagoon exhibits poor light penetration to 1.7 m (Figure 2-3b) although seagrass coverage in its central and southern segments has been very stable since 1943. This may be explained by Mosquito Lagoon's shallowness; less than 1.3 m average; whereas the other Lagoons average 2 to 2.4 m in depth. This shallow depth may lend itself to more wind-induced turbid conditions, limiting light; however, an adequate amount of light is still available at its shallow bottom to maintain expansive beds of seagrass. (There is more about Mosquito Lagoon in the water quality discussions below and in Chapter 3.)

The fact that the preliminary light requirement is not met throughout the IRL may explain why the deep edge of seagrass is generally less than the target depth of 1.7 m (Figure 2-3c; the seagrass depth index = measured depth of seagrass edge in meters as a percent of the 1.7 m target depth). A notable exception is the Jupiter Inlet area where the deep edge of seagrass exceeds 1.7 m (Figure 2-3c). But elsewhere in the IRL, the deep edge of seagrass reaches 0.9 -1.5 m, or 58% - 87% of its potential depth of 1.7 m. The better seagrass coverage segments – northern Banana River Lagoon, North IRL, and around inlets – achieve over 80% of the 1.7 m potential seagrass coverage depth.

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[3] Data collected via Districts' water quality and seagrass monitoring networks, 1990 – 1999.

[4] Other factors that may limit the depth to which seagrass may grow are instability of sediments induced by hydrodynamics or other forces, sediment quality (e.g., hypoxia, grain size), competition by other plants like attached macroalgae, and shading by drift macroalgae. Some of these factors that can be managed may need to be addressed to further seagrass restoration.

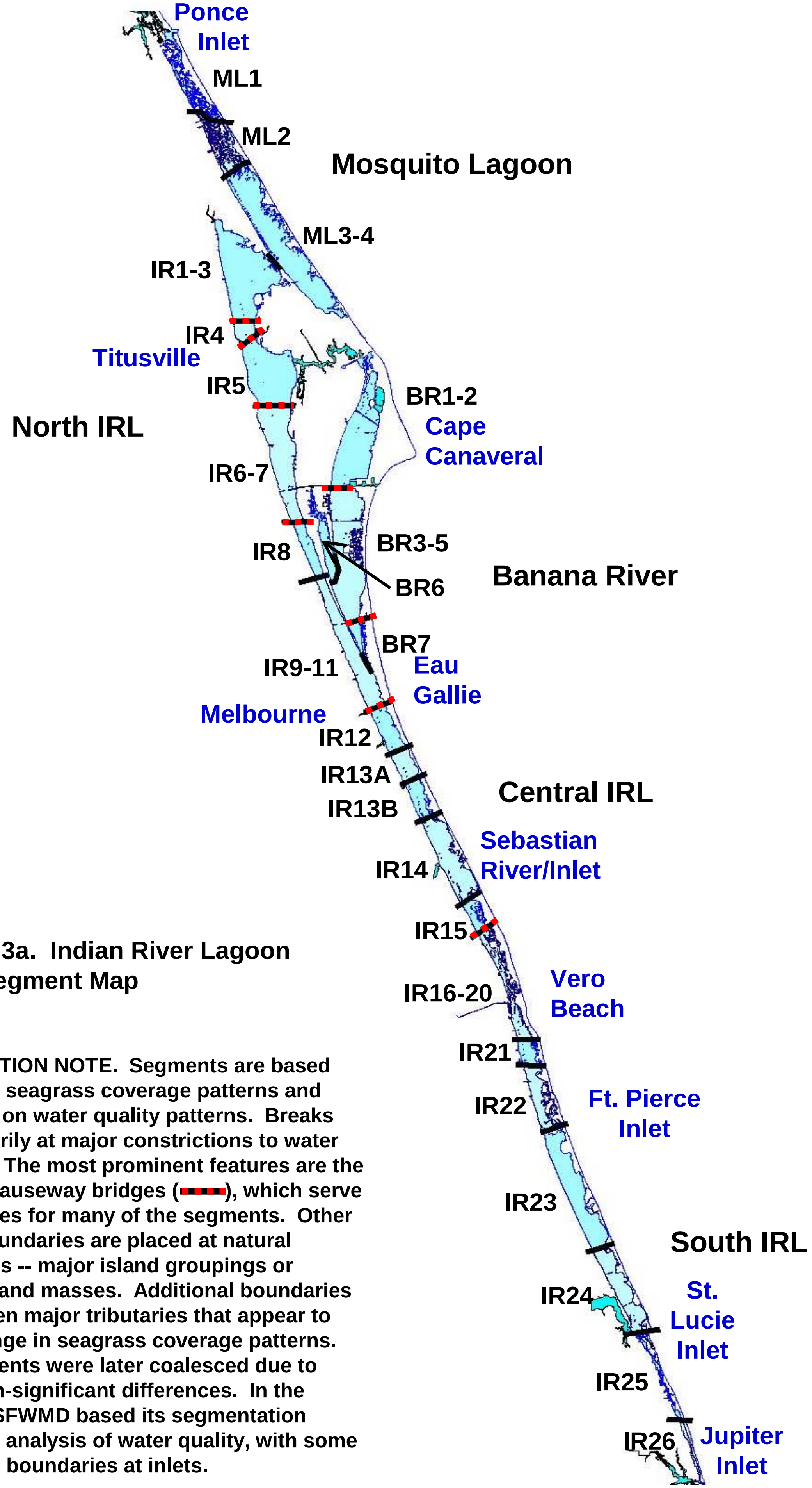


Figure 2-3a. Indian River Lagoon System Segment Map

SEGMENTATION NOTE. Segments are based primarily on seagrass coverage patterns and secondarily on water quality patterns. Breaks occur primarily at major constrictions to water circulation. The most prominent features are the numerous causeway bridges (▬▬), which serve as boundaries for many of the segments. Other segment boundaries are placed at natural constrictions -- major island groupings or peninsular land masses. Additional boundaries were between major tributaries that appear to induce change in seagrass coverage patterns. Some segments were later coalesced due to small or non-significant differences. In the South IRL, SFWMD based its segmentation primarily on analysis of water quality, with some of the major boundaries at inlets.

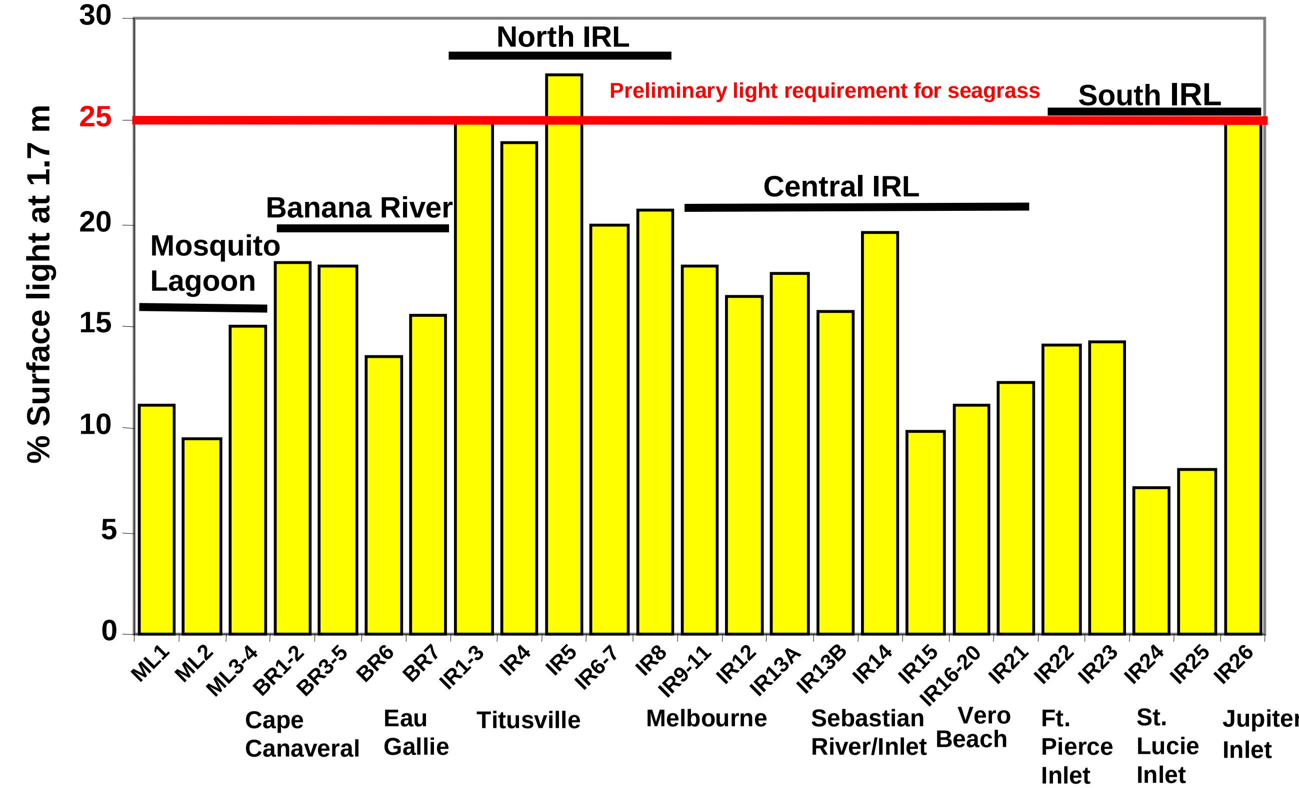


Figure 2-3b. Median percent surface light at the 1.7 m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

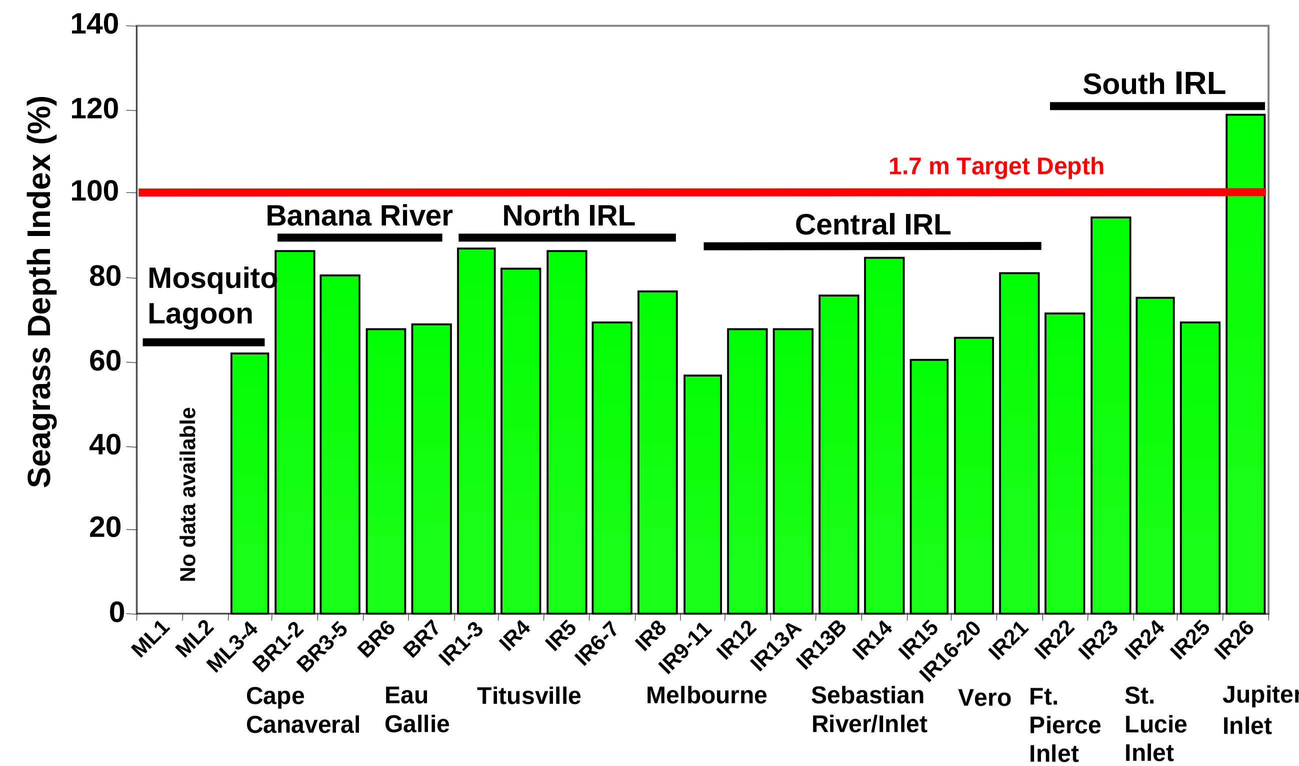


Figure 2-3c. Average Seagrass Depth Index -- depth of edge of bed as a percent of 1.7 m target depth*. Based on seagrass deep edges mapped in 1992, 1994, and 1996. (See map at left for location of segments.)

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum, except in South IRL where depths were referenced to NGVD29. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

Poor vs. Good and Fair Seagrass Areas. IRL segments are identified as "poor" (considered as critical seagrass restoration areas), "good", or "fair" based on the three measurement indices: percent loss of seagrass since the 1940s, the percent of surface light reaching the 1.7 m target depth, and the depth of seagrass edge as a percent of the 1.7 m depth (a.k.a. seagrass depth index). The results are shown in Figure 2-4. For an explanation on how the indices are used to classify segment, refer to either Tables 3-1, 4-1, 5-1 or 6-2 in the following chapters.

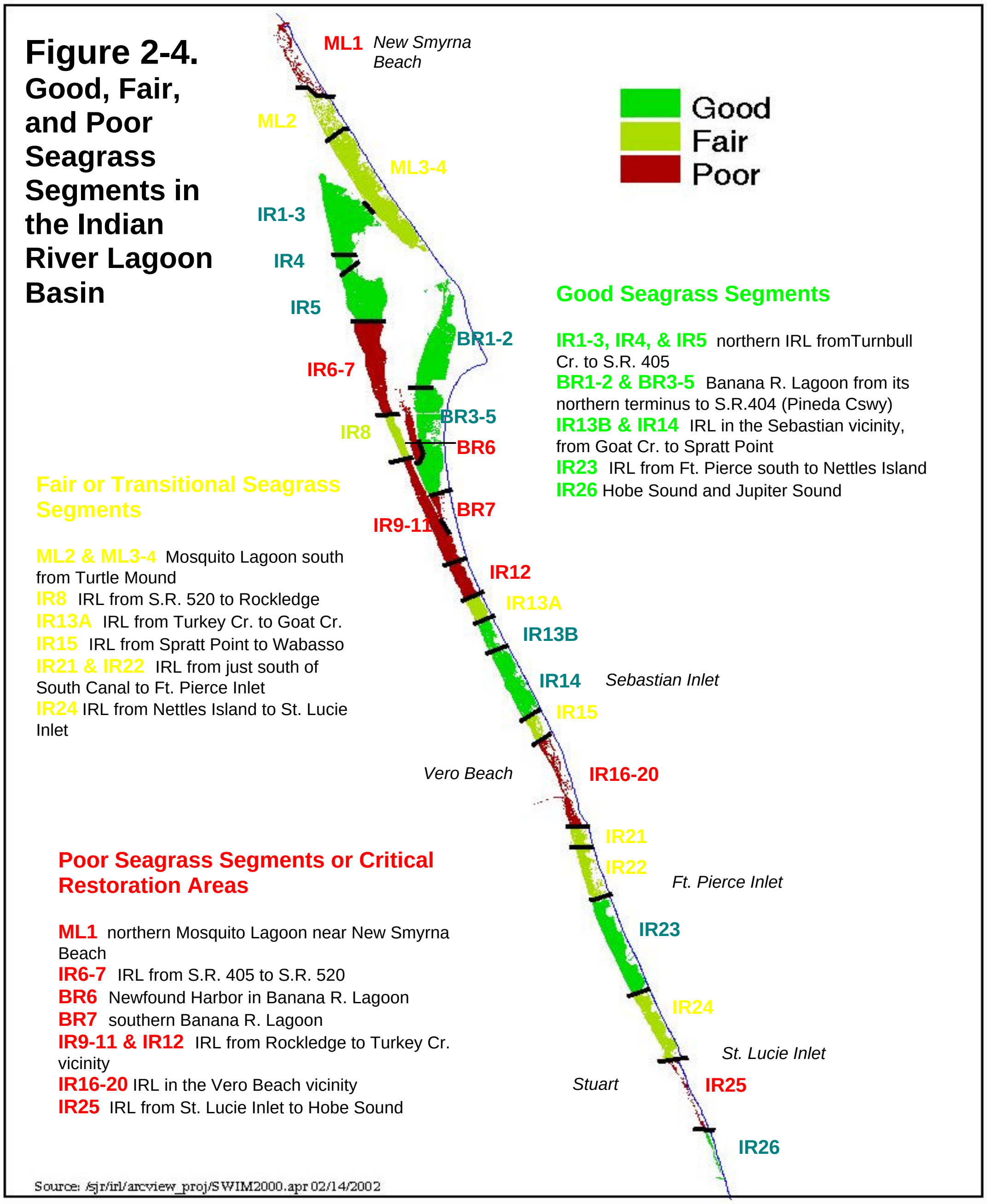


Figure 2-4. Good, Fair, and Poor Seagrass Segments in the Indian River Lagoon Basin

Water Quality Assessment. This assessment is focused on the water quality conditions germane to the seagrass resource with special emphasis on the major water quality factors that may limit light penetration to the Lagoon bottom. The major factors are:

- **Salinity**

An indication of the degree of mixing between marine and fresh waters; the optimum salinity for seagrass growth is above 20 parts per thousand (Reid, 1954; Voss & Voss, 1954; and Humm, 1956); ocean salinity averages 35 parts per thousand. Salinity does not affect light penetration but does affect seagrass species presence/absence and, potentially, overall seagrass coverage.

- **Color**

A relative measure of dissolved substances in the water column that can absorb light

- **Turbidity**

A measure of the degree to which light traveling through the water column is scattered by suspended material.

- **Total Suspended Solids**

Organic and inorganic particles suspended in the water column, which are probably responsible for most the light scatter and turbidity

- **Nitrogen and Phosphorus**

These macro-nutrients are indirect factors affecting light penetration; however, they are important because they 'fuel' phytoplankton and epiphyte growth (read chlorophyll *a* below)

- **Chlorophyll *a***

A component of phytoplankton that absorbs light; can effectively compete with seagrasses for available light if phytoplankton are abundant

This water quality assessment, based on the major factors above, is presented in two parts: (1) a general spatial overview of IRL water quality during 1990 - 1999, and (2) a preliminary identification and discussion of those water quality factors that predominantly affect light penetration in the critical restoration areas (as shown in Figure 2-4). Please refer to Chapters 3 - 7 for additional sub-lagoon detail about water quality, which includes a discussion on temporal trends during the past decade.

General Overview of IRL Water Quality (1990 – 1999). The following discussion is based on the results provided in Figures 2-5 and 2-6.

During the 1990s, throughout the length of the IRL system (tributaries excluded), the10-year average salinities were above 20 ppt and generally well within the optimum salinity range for seagrass growth. The highest average salinities, 29 – 33 ppt, were typically found in Mosquito Lagoon and South IRL, followed closely by North IRL (north of Titusville) and the areas near Sebastian Inlet and Ft. Pierce Inlet.

The lowest average salinities, hovering just above 20 ppt, were found in the southernmost reach of Banana River Lagoon (south of S.R. 404, Pineda Causeway) and in the Melbourne area of the Central IRL. Those areas are distant from oceanic influence, located 15 to 25 miles from Sebastian Inlet, and receive large volumes of urban drainage and tributary creek discharges (Horse, Eau Gallie, Crane, and Turkey Creeks). Salinities have dropped below 20 ppt for extended periods (months).

The 20 ppt level could be the critical minimum growth threshold for all the IRL seagrass species except *Ruppia maritima*, which can grow at lower salinities. If the average annual or seasonal salinity is below 20 ppt, especially during the growing season, the

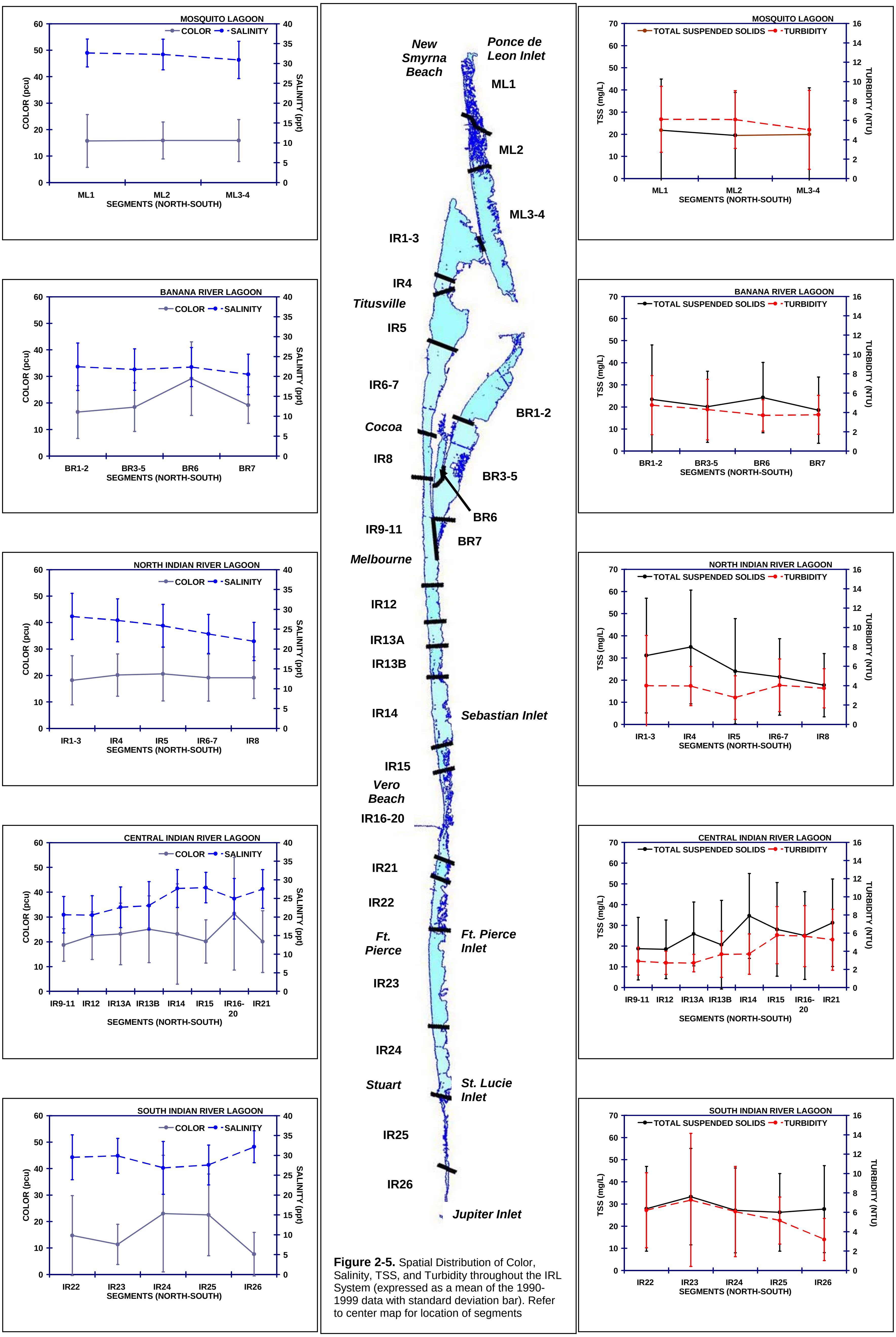
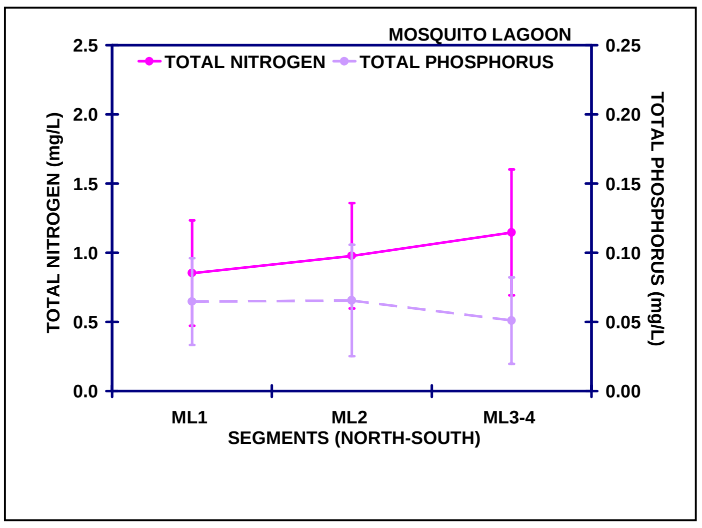
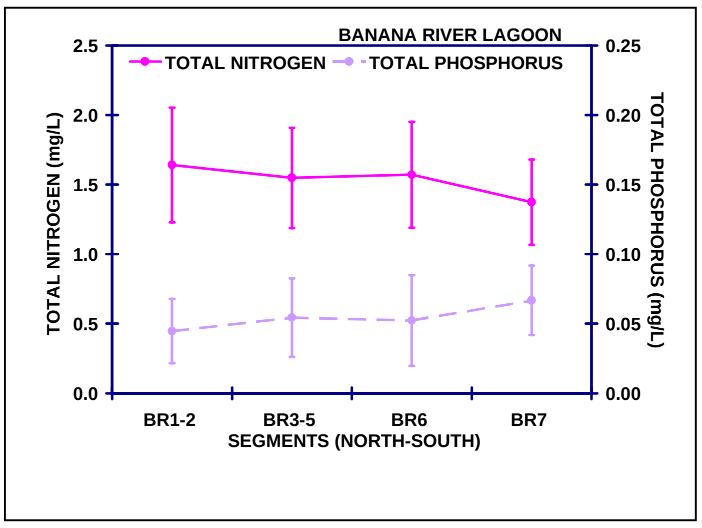
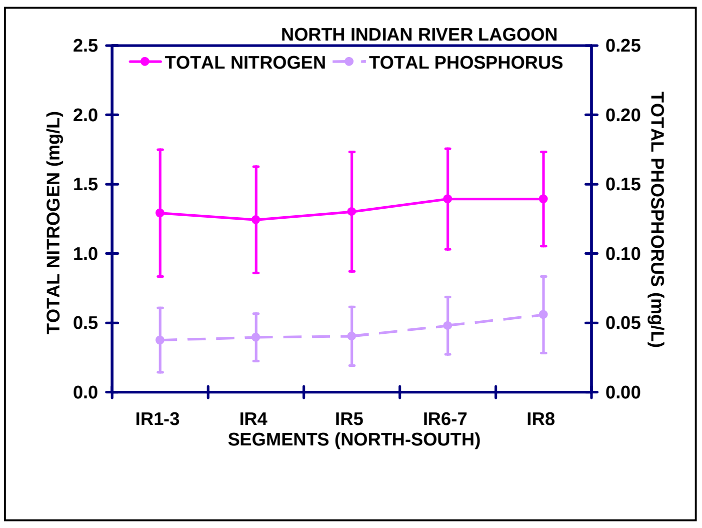
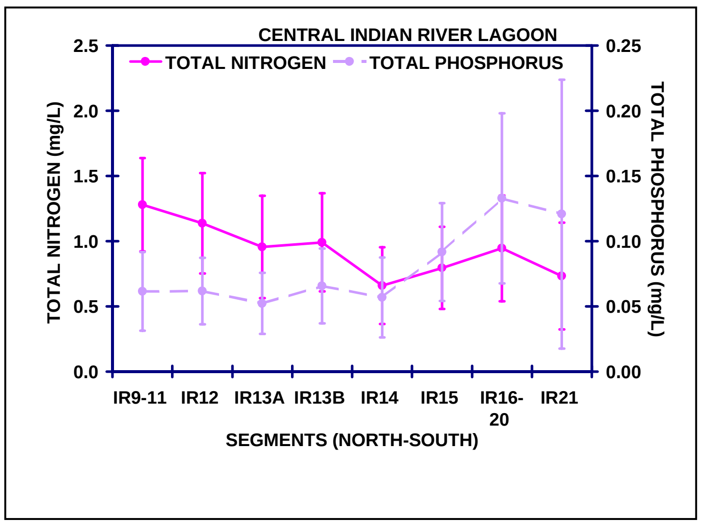


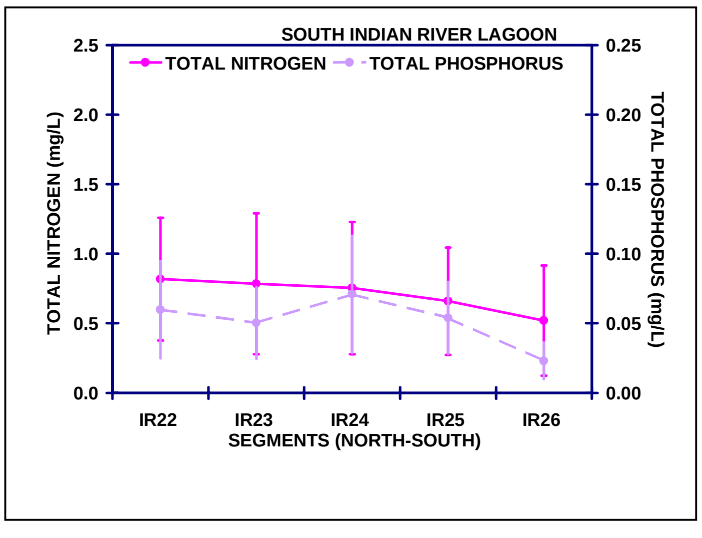
Figure 2-5. Spatial Distribution of Color, Salinity, TSS, and Turbidity throughout the IRL System (expressed as a mean of the 1990-1999 data with standard deviation bar). Refer to center map for location of segments

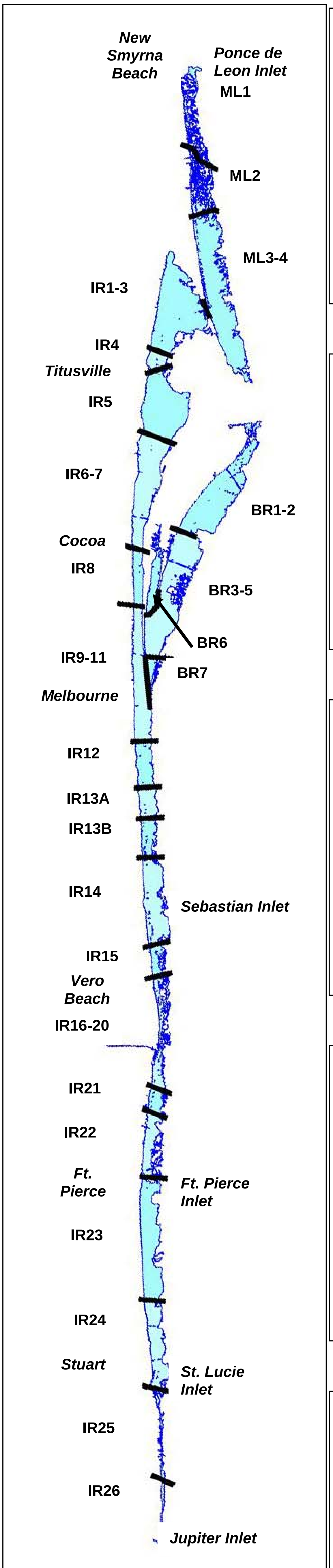


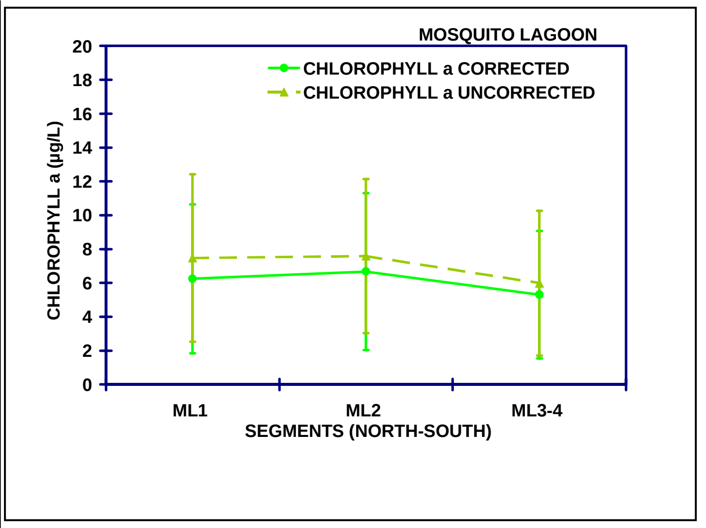


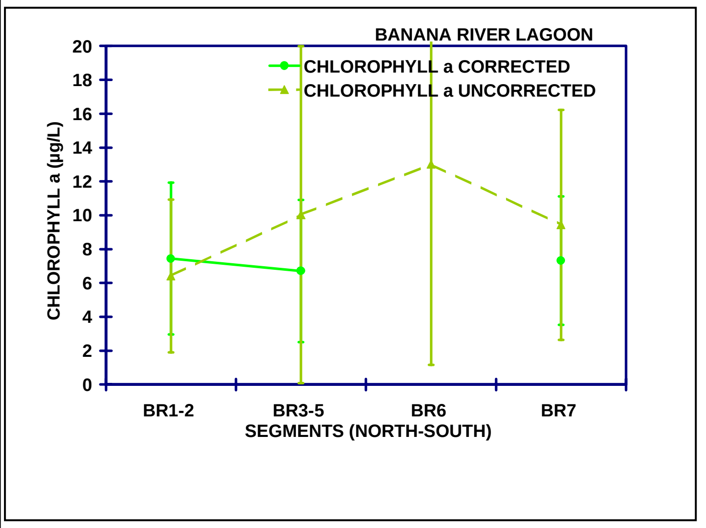


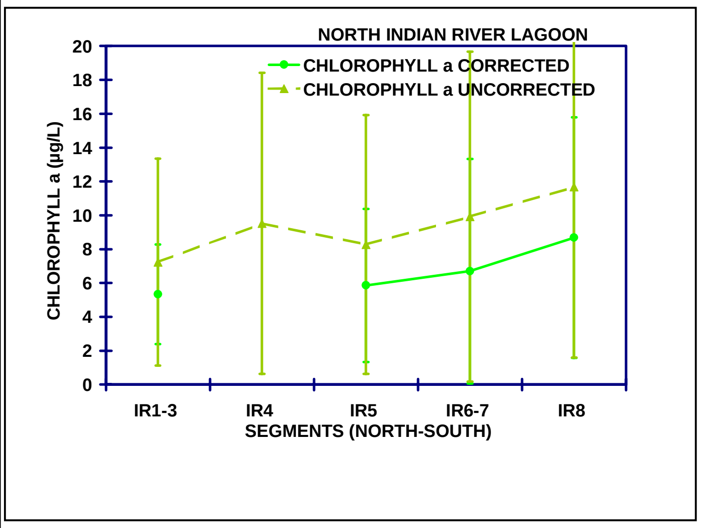


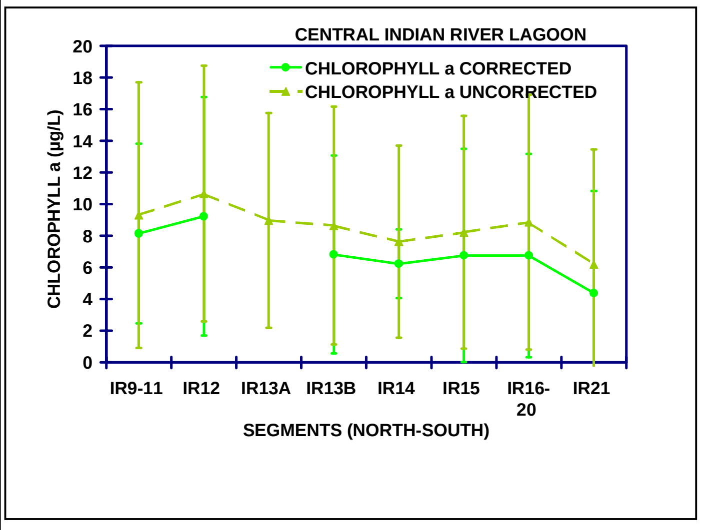












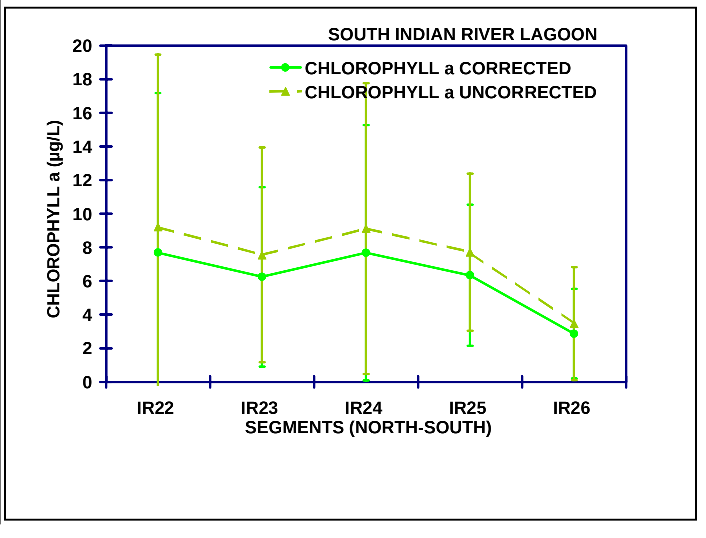


Figure 2-6. Spatial distribution of total nitrogen, total phosphorus, & chlorophyll *a* throughout the IRL System (expressed as a mean of the 1990-1999 data with standard deviation bar). Refer to center map for location of segments.

growth (not necessarily survivability) of most seagrass species may be hampered even if other environmental conditions are good.

Color inversely tracks salinity trends in the Banana River Lagoon, Central and South IRL, where tributaries or canals discharge relatively high colored waters and, concomitantly, salinities can be substantially reduced. For most of the IRL, the 10-year average for color ranged between 15 and 20 platinum-cobalt units (pcu). The highest 10-year average color, 28 to 31 pcu, was found in Newfound Harbor (BR6, Banana R. Lagoon) and in the Vero Beach vicinity (IR16–20). Woodward-Clyde (1994b) found that the average wet season color in the Vero Beach area was 2 to 3 times the dry season levels, <10 to 15 pcu. Some of the lowest color levels were found in the South IRL, with Hobe Sound near Jupiter Inlet standing out with the lowest 10-year average, <10 pcu.

Average turbidity levels in Banana River Lagoon, North and Central IRL generally do not exceed 6 nephelometric turbidity units (ntu), and are typically half that level. In contrast, Mosquito Lagoon and South IRL frequently average above 6 ntu. In the South IRL, the segment immediately south of Ft. Pierce Inlet (IR23) experienced both the highest 10-year average and the highest variability in turbidity levels: approximately 7 ± 7 ntu.

These turbidity trends may be explained by contributions from total suspended solids (TSS). This relationship may be a reasonable explanation since the spatial pattern for TSS roughly mirrors the pattern for turbidity, although disparities are apparent in some segments. Further analysis indicates that TSS concentrations do contribute significantly to turbidities in certain segments, especially in the Mosquito, Banana, and North Indian River Lagoons.

Average TSS levels throughout the IRL system range from 18 to 34 mg/l. It is interesting to note that the Cocoa-Melbourne segments of the IRL (IR9-12) exhibited the lowest average TSS level in the Lagoon system (10-year average is about 18 mg/l). Given the extent of development, the augmented drainage discharges, and relatively small open water area in that reach, one would expect average TSS levels that are higher, if not comparable, to the North IRL and Mosquito Lagoon with TSS levels typically >20 mg/l[5].

From North Banana and Indian River Lagoons through the South IRL, there is a general north-to-south decrease in total nitrogen (TN) concentrations (Figure 2-7). The 10-year average concentrations of TN range from >1.4 mg/l just south of Titusville to ~0.5 mg/l in Hobe Sound. Upward spikes of TN concentrations are also apparent in the Palm Bay and Vero Beach areas. The large concentrations of TN in the northern reaches of Banana and Indian River Lagoons (Figure 2-7) may reflect the large standing pool of organic nitrogen (up to 95% of TN is organic) and plant biomass that can take months to more than a year to flush (based on preliminary hydrodynamic model results, SJRWMD).

Total phosphorus (TP) concentrations exhibit more numerous spikes in areas adjacent to intensively developed sub-basins and large discharge tributaries and canals in the Central and South IRL (Figure 2-7).

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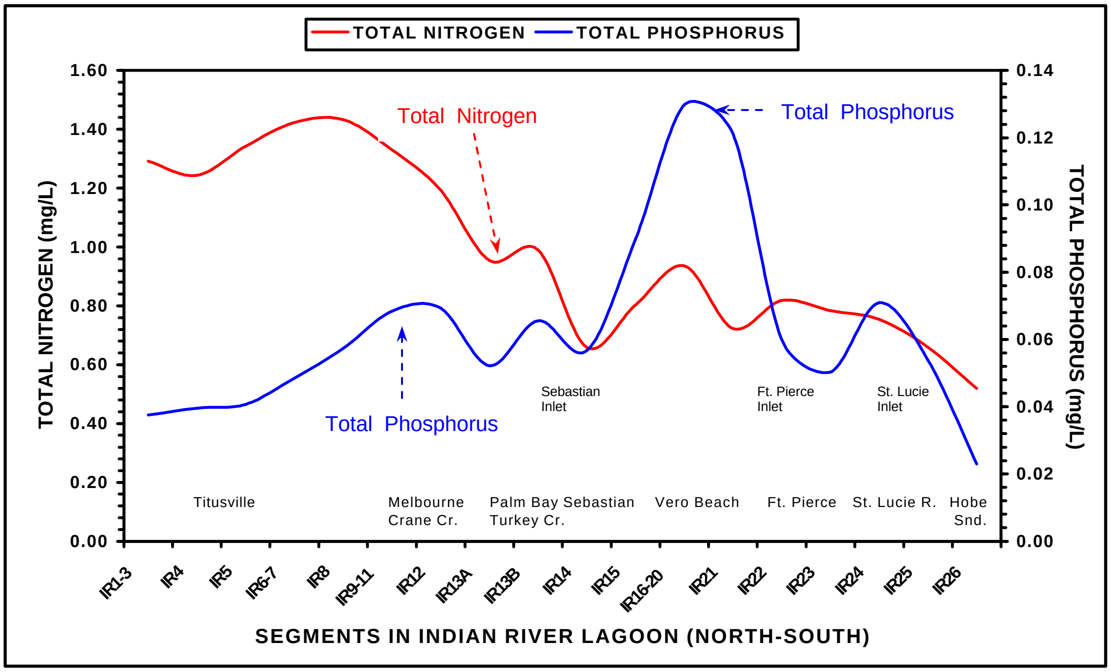
[5] It is believed that the lower-than-expected TSS concentration results in the Cocoa-Melbourne area is an artificial anomaly created by sampling design. It may be due to sampling locations – several sites are in the “wind shadow” of causeways -- or due to sampling times, which are generally in the morning when the sea state is typically calmer than in the afternoon. Modifications to the sampling network will be evaluated to minimize this possible bias.

Figure 2-7. North-to-South Spatial Trend in Total Nitrogen & Phosphorus Concentrations in the IRL
(10-year averages: 1990 – 1999)



One such TP spike peaks dramatically in the Vero Beach segment (IR 16 –20), with 0.13 mg/l as the 10-year average. The Vero Beach segment receives discharges from three large canals: North, Main, and South Canals. These canal discharges, combined, constitute the largest TP loading in the IRL system (~35 metric tons of TP per year; SJRWMD data). Hobe Sound, again, is where the lowest TP concentrations are generally found; the10-year average was about 0.02 mg/l (Figure 2-7)

Phytoplankton response to these spikes in nutrient levels is apparent in the Cocoa/Melbourne area (segments IR8 through IR12), where chlorophyll *a* levels are above 8 µg/l (10-year average, Figure 2-6). However, such an algal response is not seen the Vero Beach area (segment 16 – 20), which may be due to the much shorter residence time or higher flushing rates (2 to 3 weeks) as compared to the Cocoa/Melbourne area (3 to 6 months; based on preliminary hydrodynamic model results, SJRWMD). The Vero Beach area also has higher average color (limiting light for phytoplankton growth) than the Cocoa/Melbourne area – 31 pcu and 21 pcu, respectively. A similar, albeit slight algal response is seen in the Ft. Pierce and St. Lucie River areas (IR 22 and 24 segments), where chlorophyll *a* levels approach 8 µg/l. Moreover, chlorophyll *a* levels in segments IR 8 – 12, IR 22, and IR24 can vary widely as compared to other segments, sometimes reaching 'bloom' levels of 30 to 50 µg/l.

In summary, the Lagoon areas with the worst water quality conditions are the Cocoa to Melbourne/Palm Bay (segments IR9-13A), Vero Beach (segment IR16 – 20), Ft. Pierce (segments IR21 & IR22), and St. Lucie reaches (segments IR24 & IR25). Most of these reaches are also listed as critical seagrass restoration areas (see Figure 2-4).

Relatively low salinities, and high color, nutrients, and chlorophyll *a* may be the compounding factors that are contributing to the poor conditions in the Cocoa/Palm Bay reach. The Vero Beach area may owe its poor condition to color, turbidity, and possibly nutrients. The South IRL segments near Ft. Pierce and St. Lucie appear to be aggravated by high turbidities, TSS, and nutrients, along with the associated algal response as indicated by spikes in chlorophyll *a* levels. Areas near the larger tributaries and canals – Crane Creek, Turkey Creek, Sebastian River, the North, Main, and South Canals in Vero Beach, and St. Lucie River – also experience higher than typical levels in TSS, color, and nutrients (TP being the most obvious).

Other areas of the Lagoon system, southern Mosquito Lagoon, northern Banana River Lagoon and North IRL, exhibit appreciable levels of turbidity, even though their seagrass coverages are fairly robust. Perhaps it is fortunate that the other, possible compounding factors (color, nutrients and chlorophyll) are present at fairly low levels; otherwise the good seagrass status of these areas could be jeopardized.

Preliminary Identification of Factors that Affect Light. Preliminary results, based on analyses[6] to date, indicate that turbidity, color, and chlorophyll *a* are the primary factors that affect the amount of light reaching the Lagoon bottom (Table 2-1). Analysis of Lagoon segments individually shows some differences, particularly in the order of dominance among the factors, but the results are basically consistent throughout the IRL system. A separate investigation by Harbor Branch Oceanographic Institution (Hanisak, 2001) confirmed turbidity and color as the dominant factors in the Banana River Lagoon and the Central IRL. In combination, these water quality factors may account for 30-50% of the attenuation of light through the water column.

Turbidity is a result of the combination of several constituents in the water column – organic suspended solids (living and detrital, both algal and non-algal) and inorganic or mineral suspended solids. In much of the Lagoon system, an overwhelming majority of the suspended solids is mineral in nature (=70%). Much of this mineral fraction can probably be traced to the runoff and re-suspension of sediment material that has upland soil characteristics, which is also a major fraction of "muck" sediment.

Table 2-1. Preliminary Identification of the Principal Water Quality Factors Affecting Light in the IRL System

Sub-Lagoon Area	Principal Factors (Preliminary)
Mosquito Lagoon	Turbidity
Banana R. Lagoon	Turbidity, Chlorophyll *a*
North, Central, South IRL	Turbidity, Color (particularly in S. IRL)
Lagoon-wide	Turbidity, Color, Chlorophyll *a*

Another factor that can restrict the availability of light to seagrass is epiphyte (attached algae) growth on seagrass blades. A study specifically investigating this possibility in

[6] Principal component analysis and step-wise regression analysis used to identify and quantify the degree of contribution from each water quality factor to its attenuation of light (SJRWMD analysis; Hanisak, 2001)

the IRL found that the abundances of epiphytes were not significantly different throughout the Lagoon system (Miller-Myers, 1997). Therefore, epiphytes are probably not contributing to the spatial heterogeneity in seagrass coverage; however, epiphytes are probably contributing to light limitation generally throughout the system. Other studies indicate that epiphytes may 'shade' as much as 50% of available light to seagrass blades (Harden, 1994; Dixon, 2000). Since these studies show that epiphytes are an important light limitation factor, possibly as important as phytoplankton chlorophyll *a*, then the reduction of nutrient loads, as well as suspended solids, should be seriously considered.

The next section, *Projects and Progress to Date*, develops the rationale for the major strategies to improve water quality (specific to the "optical pollutants") and seagrass coverage; and briefly describes the projects required to accomplish the strategies. The major strategies, or more accurately, the long-term campaigns, are (1) the management of surface water runoff and tributary discharges, and (2) the control of muck sources in concert with the removal of major muck deposits. Resources to wage these campaigns will be focused more in the Central and South IRL and the sub-basins therein.

Projects and Progress to Date

Lagoon-wide Monitoring and Diagnostics. Monitoring and diagnostic research are needed to evaluate the condition of the system and determine the (potential) causes of impact. This chapter's opening section, *The Lagoon-wide Status of Seagrass and Water Quality*, would not have been possible without long-term monitoring and diagnosis. Additionally, in order to manage seagrass areas, it is necessary to first map and quantify the spatial distribution and temporal status of seagrass coverage relative to established coverage target(s). Then, the areas of coverage loss or gain are diagnosed to determine the causes. It is assumed that successful diagnosis requires a better, quantitative understanding of the water quality/light relationship – as water quality changes so does the depth extent of light and the corresponding coverage of seagrass. Therefore, as a means to collect assessment and diagnostic data, seagrass, water quality, and hydrological monitoring programs were established within months following passage of the SWIM Act in 1987, and have continued since then. Descriptions of these Lagoon-wide monitoring projects are provided below.

At least two levels of seagrass monitoring are utilized: (1) Lagoon-wide mapping of seagrasses (based on aerial photography) and (2) site-specific monitoring of seagrass density, diversity, and other indicators of health (Virnstein and Morris, 1996).

Lagoon-wide maps of seagrass coverage, produced by SJRWMD and SFWMD, have been completed for the following years: 1986 and1989 (except Mosquito Lagoon), 1992, 1994, 1996, and 1999. Maps are generally developed every 2 to 3 years. In the intervening years, aerial photography of seagrass coverage is processed, archived, and can be used to detect any short-term changes. Areas of seagrass loss or gain are determined from previous years' coverages. For example, 1943 is considered the baseline year for most areas of the IRL from which loss/gain determinations can be made. Trends can also be determined by comparing any mapped coverage to the potential coverage, based on the 1.7 m target depth, which is the ultimate seagrass restoration target (Virnstein et al., 2000).

The site-specific monitoring of seagrass at 74+ locations throughout the IRL started in 1994. This large, semi-annual monitoring project is managed by SJRWMD with substantial fieldwork support by a number of agencies[7] and individuals. Information on seagrass coverage density, species distribution, and general health status is generated from this level of monitoring.

Water quality data relevant to the seagrass condition are collected through various monitoring projects supported or undertaken directly by the two Districts. In 1988/89, each District established a water quality monitoring network[8] in their respective segments of the IRL. The monitoring is designed to detect general spatial conditions and year-to-year trends in water quality at key locations in the IRL. These key locations are representative of water quality conditions throughout relatively large areas of the Lagoon, which can affect (both actual and potential) seagrass coverage. The Districts have continually improved their respective portions of the network over the years to generate better, more specific information, on the seagrass-water quality environment (Sigua et al., 1996).

Monitoring data are also being used to help diagnose changes in seagrass coverage. As stated above, this diagnosis is based on the premise that a certain level of sunlight is required by seagrass, which is restricted by interfering substances in the water (such as suspended solids, color or dissolved substances, algae concentrations). A concerted effort is underway, through this monitoring network and other data-intensive investigations and modeling, to determine which substances are the primary "optical pollutants."

Since 1993/94, several intensive, short-term investigations[9] have been conducted in an attempt to answer questions concerning light level requirements for seagrasses, and the effects of epiphyte[10] abundance and various water quality constituents on light levels. These studies indicate that the IRL is not homogeneous; there is spatial variability among IRL segments with respect to the water quality constituents that are suspected to affect light and seagrass distribution. Preliminary findings of these studies, complemented by data from the Lagoon-wide monitoring networks, are presented in the previous section, *Lagoon-wide Status of Seagrass and Water Quality.*

The Lagoon system's physical processes – meteorological, hydrological, hydrodynamic – do affect the system's water quality and seagrass status. Consequently, a network of instrumented sites collecting data on these physical processes was established and has expanded since 1988/89. The instrumented sites, distributed throughout the major sub-basins and sub-Lagoons, provide physical data on rainfall, wind, atmospheric deposition of nutrients, stream discharges, water elevations, estuary current velocities, salinity, temperature, etc. These data are just as crucial to the calibration of estuary models as the data on water quality and macrophyte productivity. Additionally, detailed bathymetric measurements of the Lagoons and major tributaries were completed in the last 5 years. These measurements are essential to a variety of efforts including the calibration of models, the setting of seagrass depth targets, and muck dredging projects.

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[7] Agencies that participate in the seagrass monitoring project are the Canaveral National Seashore, NASA-Dynamac, FDEP Aquatic Preserve offices, USFWS (Vero Beach office), SFWMD, and the Loxahatchee River District.

[8] In the SJRWMD segments of the IRL, Volusia and Indian River counties and NASA-Dynamac performs much of the fieldwork, which was coordinated and funded by SJRWMD. Brevard County was also a participant up until 2001. SFWMD performs the fieldwork in the south IRL.

[9] These investigations were conducted by Harbor Branch Oceanographic Institution, National Marine Fisheries Service, Florida Institute of Technology, and Smithsonian Institution; all funded by SJRWMD, SFWMD, Sea Grant, and NEP.

[10] Algae attached onto other plants, for example, onto seagrass blades.

Pollutant Load Reduction Goals & Related Modeling Efforts. The data and information generated from the studies and monitoring activities described above are also being applied toward the calibration and verification of numerical models, which are intended to assist the Districts in the development of pollutant load reduction goals (PLRGs). PLRGs are numerical targets for the reduction of pollutants believed to contribute to the loss of seagrass coverage in the IRL. These pollutants include the major nutrients, (nitrogen and phosphorus), suspended matter; and dissolved organic matter (typically measured as 'color'). PLRGs will be established for discrete segments of the IRL and their associated drainage sub-basins.

Additionally, reduction targets for freshwater discharges are being considered for specific drainage sub-basins: St. Lucie River, C-25, Sebastian River, Turkey Creek, and possibly Crane Creek and Indian River Farms Water Control District. In those sub-basins, extensive drainage systems have been constructed, designed to deliver tremendous volumes of drainage (particularly storm water) rapidly to the IRL. The IRL, being an estuary, can absorb occasional excessive discharges with minimal impact. However, over the last several decades, those drainage systems have increased the frequency of excessive discharges. It is believed that these recurring discharges have resulted in frequent, precipitous, and/or prolonged drops in salinity as well as increased loading of pollutants in affected IRL segments. Over the long term, these impacts have worked in concert to diminish seagrass resources, clam and oyster fisheries, and other valuable resources. (Further discussion about these impacts can be found in the 1994 IRL SWIM Plan; pp. 33 – 44, and p. 59).

To restore the impacted resources, it is important to establish and pursue targeted reductions in pollutants and excessive discharges. But, to what level do we set the reductions? And, which pollutants are significant and should be targeted? To help answer these and other management questions, each District is engaged in the development of models intended to predict and quantify specific responses of the IRL system (like salinity, other aspects of water quality, and potential seagrass coverage) to changes in pollutant loadings and discharge levels. The SJRWMD and SFWMD began work on their estuary models in the mid-1990s. Presently, efforts are directed at the calibration and verification of these models using Lagoon-specific data to improve accuracy in the models' predictive results.

The SJRWMD, through its University of Florida[11] contractor, has nearly completed the calibration of the Pollutant Load Reduction (PLR) Model. The PLR Model is a 3-D representation of the estuary from Ponce de Leon Inlet to St. Lucie Inlet, which incorporates a number of essential, interactive processes: hydrology, hydrodynamics, salinity, water quality, and light (Steward et al., 1996). The SFWMD and U.S. Army Corps of Engineers are also developing a multi-dimensional model for the South IRL with special emphasis on the St. Lucie River estuary.

Additionally, both Districts employ sub-basin hydrologic models as a means to generate watershed data for input to the estuarine models and to serve as analytical tools in the evaluation of proposed PLRGs and sub-basin management strategies (e.g., surface water reservoirs or treatment areas). The sub-basin models are being applied where necessary and in prioritized fashion. This prioritization, as presented below (Table 2-2), also serves as the general schedule for the development of final PLRGs.

[11] Dr. Y. P. Sheng , Principal Investigator; Sub-Principal Investigators: Drs. Reddy, Phlips, and Montague.

Table 2-2. Prioritization of sub-basins in the IRL System (1994 – 2007)

SJRWMD sub-basins – PLRGs recommended by end of 2004

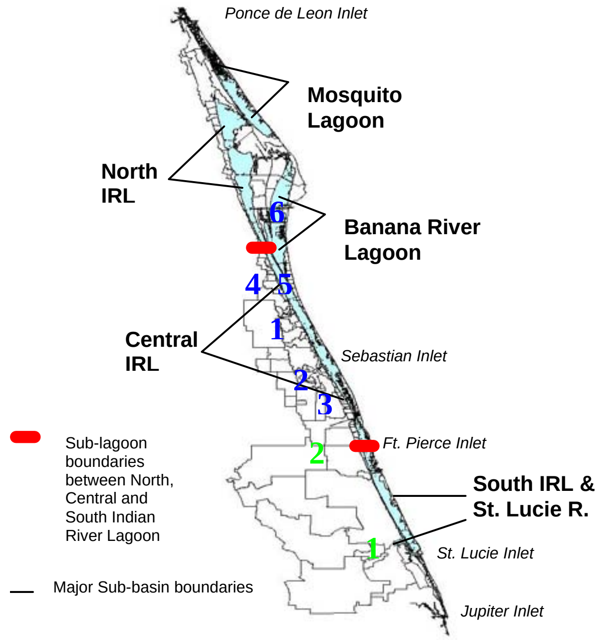
1. Turkey Creek/C-1 canal
2. Sebastian River (includes Sebastian & Fellsmere WCDs)
3. Indian R. Farms WCD/Vero Beach
4. Crane Creek
5. Eau Gallie River
6. S. Merritt Island

Other sub-basins as needed

SFWMD sub-basins – PLRGs recommended by end of 2006

1. St. Lucie River (includes C-23, C-24, C-44)
2. Ft.Pierce/C-25 (includes Virginia Ave.)

Other sub-basins as needed



Until final PLRGs are established, provisional PLRGs for the SJRWMD portion of the IRL system are provided to address the immediate need for reduction target/design criteria for regional or watershed projects that are currently being planned. Provisional PLRGs are fairly conservative approximations of desired pollutant reductions, and for some sub-basins, may be more stringent than final PLRGs. Provisional PLRGs are calculated via inference; utilizing data on rainfall, land use, and soil hydrology of c.1943 – the best-documented year for maximum seagrass coverage (Virnstein and Morris, 2000) -- to numerically *infer* runoff pollutant loading rates. The result is considered an "allowable" loading rate, which is subtracted from current loading or build-out loading (preferable) to obtain a load reduction target (Steward, 2002). Provisional PLRGs for major segments or sub-basins in the SJRWMD portion of the IRL system are listed in Chapters 3, 4, and 5[12].

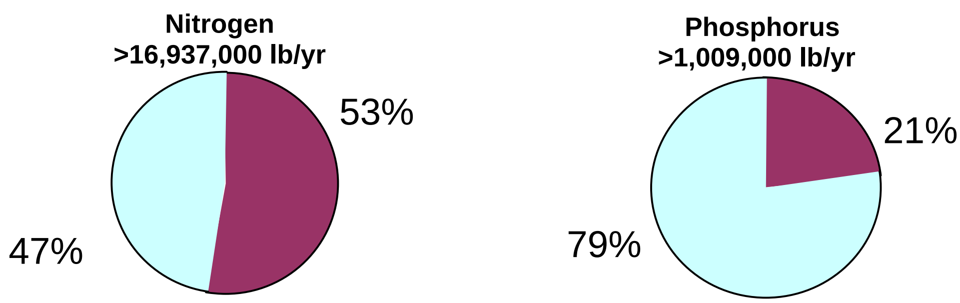
General Management Strategies for Pollutant Load Reduction. Monitoring and diagnosis are critical steps that will continue to improve our understanding of cause-effect phenomena and the magnitude of impacts related to discharges and pollutant loadings. These same steps are also critical to the development of efficient, cost-effective management strategies for achieving PLRGs. Since 1994, both Districts have increasingly emphasized the reduction of major, non-point sources of pollution. Although non-point source control is the key toward truly significant reductions in pollutant loads, reductions in point source loadings are also important. The general, Lagoon-wide approach to the management of non-point and point sources is briefly discussed below. Strategies specific to sub-lagoons and their associated sub-basins are discussed in the chapters that follow.

[12] Tables 3-2, 4-3, 5-4 and 5-5, respectively; and discussed as part of the planning for Central IRL sub-basins on pp. 5-20 through 5-28).

General Non-Point Source Strategies. The SWIM strategy is to concentrate efforts and financial resources on controlling the *major* non-point sources of pollution. Early in the SWIM program, quantification of inputs from various sources was a primary effort; and this effort continues to further improve accuracy and confidence in the results. Preliminary estimates indicate that the sedimentary diffusive loading and external loading[13] of nitrogen (N) may be nearly equal (Figure 2-8). For phosphorus (P), the external watershed loading is much greater than that from sediment diffusion (Figure 2-8). The partitioning of N and P loading between internal and external sources may change as additional data are generated. For example, the nutrient loading via advective flux[14] from the sediments is currently unknown, but could be a significant internal loading source.

At this time, these estimates confirm that surface water drainage is, by far, the major external source of N and P. Muck sediment is the major internal source of N and P in the IRL, based solely on the diffusive process. Additionally, surface water drainage accounts for nearly all (~99%) of the annual suspended solids loading of 121,292,000 lb/yr to the IRL. Therefore, significant reduction in non-point source loadings can be achieved by pursuing two basic strategies: (1) treatment and/or volume reduction of surface water discharges to the extent feasible, and (2) muck removal where it is most effective and practical to do so.

Figure 2-8. Preliminary Nutrient Loading Estimates
Sediment Diffusion vs. External Sources



Sediment Sources **(based on diffusion only)**
79% of N and 65% of diffusive P loading is from mucky as opposed to sandy sediments; and most of the mucky sediment is in the Central IRL.

External Sources **(runoff, stream, WWTP, atmospheric, and groundwater)**
70% of N and 90% of external P loading is from surface runoff and stream/canal discharge; and most of those sources are in the Central and South IRL.

While these strategies are generally applicable Lagoon-wide, more attention is being paid to the Central IRL, South IRL (including St. Lucie River sub-basins), and the southern

[13] External loading estimates are derived from SJRWMD (1986 – 1999) and Woodward-Clyde (1994) sub-basin discharge and loading estimates, FDEP personal communications and file records on WWTPs, and precipitation loading estimates from National Acid Deposition Program, EPA (1997 and 1998)

[14] Advective flux is the movement of material solely by the mass movement of water as opposed to diffusive flux (or loading), which is the movement of material driven primarily by differences in concentration. To date, the diffusive flux of nutrients in the IRL is generally quantified, but not the advective flux.

Banana River Lagoon. These regions constitute the vast majority of surface water drainages – several large sub-basins extensively drained by a network of inter- and intra-basin canals[15]. Stemming the rate of stormwater discharges and implementing base flow treatment measures are key components in these sub-basin plans. The plans for the few major sub-basins that receive interbasin drainage diversions must also address freshwater/ salinity impacts by setting and implementing salinity-based discharge criteria, not only to protect seagrasses, but for the hard clam resource in the Central IRL (specifically related to Turkey Creek, and Sebastian River) and for oysters in the St. Lucie River estuary[16].

As part of plan development, sub-basin or watershed modeling is essential; not only to evaluate measures intended to meet environmental criteria, but also to ensure that flood protection, water supply, and other water resources are not jeopardized. Planning activities and modeling work are focused on high priority sub-basins (as listed in the 1994 IRL SWIM Plan and above in Table 2-2) and involve many local jurisdictions[17]. In fact, most activities could not be done without approval or cooperation by the local jurisdictions. Implementation of sub-basin plans is underway in the priority sub-basins: St. Lucie River, C-25, Turkey Creek, and Sebastian River. These sub-basin activities are discussed in more detail in the following chapters.

Of course, successful implementation of the sub-basin plans would mean PLRGs should be met for nutrients, suspended solids and/or other pollutant loads. Controls on upland sources of nutrients and suspended solids, in particular, should also mean a decrease in the rate of muck sediment deposition in the IRL. Once upland source controls are in place, the removal of major muck deposits can proceed as a means of diminishing another large source of nutrients and suspended material. Projects addressing muck removal and source control are underway in the priority sub-basins and associated Lagoon segments with major support from several local governments, the Florida Inland Navigation District (FIND), and U.S. Army Corps of Engineers (USACE). For example, the SJRWMD, FIND, and partner cities[18] have or are in the process of removing huge volumes of muck from major Lagoon tributaries (details of these projects are provided in the chapters on North and Central IRL, South IRL, and St. Lucie River). The USACE is now planning the 'environmental' muck dredging of the Intracoastal Waterway over the next 10 years, commencing with the North and Central IRL segments in Brevard County.

General Point Source Strategy[19]. Prior to 1995, 15 to 20% of the annual external loading of nitrogen and phosphorus to the IRL was contributed by domestic wastewater treatment plants (WWTPs). Compared to non-point source loadings Lagoon-wide, this point source contribution seemed relatively minor. Nevertheless, point source loadings still represented a fairly large input, especially when one reviews individual segments where

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[15] Descriptions of the sub-basin drainage systems – inter-basin and intra-basin – can be found in the IRL Reconnaissance Report (SJRWMD and SFWMD, 1987), 1994 IRL SWIM Plan, Woodward-Clyde Report to IRLNEP (1994), and the IRLNEP Comprehensive Conservation & Management Plan (1996).

[16] Refer to chapter 5: Sub-basin Water Management Plans; and to Chapter 7: Oysters, SAV, and Water Quality for further information on utilizing shellfish resources as a basis for setting salinity targets.

[17] Primarily cities, water control districts, and counties affected by surface water management plans.

[18] New Smyrna Beach – Canal St. Cove; City of Melbourne – Crane Cr.; City of Palm Bay – Turkey Cr.

[19] This SWIM strategy primarily addresses domestic WWTPs. FDEP is the agency responsible for permitting and monitoring all point source facilities, both domestic and industrial. An FDEP list of permitted industrial facility dischargers is found in Appendix B.2. FDEP finds that permitted industrial facilities present no apparent threat to the IRL (M. Paulic, personal communication, 10/17/02, based on statement from FDEP Central District office).

point source loadings had comprised up to 70% of the total nutrient input (Woodward-Clyde, 1994c). As a result of these findings and at the urging of interest groups, the state legislature determined that it would be prudent to place additional restrictions on loadings from domestic WWTPs. Therefore, the IRL Act was passed in 1990 (formerly named the IRL "No Discharge" Act in the 1994 SWIM Plan; Chapter 90-262, Laws of Florida). With certain limited exceptions, the IRL Act required the major domestic WWTPs to eliminate discharges to the IRL by 1995. By 1996, most of the WWTPs re-directed effluent discharges away from surface waters of the IRL system. Today, all WWTPs are legally in compliance with the Act according to FDEP's Central and Southeast district offices.

In terms of annual load reductions, what progress has been achieved to reduce this point source contribution? To answer this question, let's review the IRL WWTP inventory, which has been updated twice since its initial development in 1985. According to the 1985 WWTP inventory, there were 45 domestic facilities discharging slightly over 39 million gallons per day or 14.2 billion gallons per year of effluent to the IRL system (SJRWMD and SFWMD, 1987). In 1993, when the inventory was updated (1994 IRL SWIM Plan), the number of facilities that surface-water discharged dropped to 22 and the cumulative volume of effluent dropped to 8.4 billion gallons per year.

Now, after years of compliance with the Act, only three WWTPs – the New Smyrna Beach, Edgewater, and City of Cape Canaveral WWTPs -- are currently allowed by the state to discharge continuously, although at much reduced rates. Those three WWTPs are undergoing facility upgrades, including expansion of their reclaimed water systems, to significantly reduce effluent discharges (more details are provided in Chapter 3 for the New Smyrna Beach and Edgewater WWTPs, and in Chapter 4 for the Canaveral WWTP). All other major WWTPs in the IRL Basin that did continuously discharge prior to the Act are not doing so now, albeit "intermittent" or "wet weather" discharges as allowed under permit (up to 91 days/year or 2184 hours/year). The allowance for intermittent discharge means that up to 3.4 billion gallons of domestic WWTP effluent are *potentially* discharged to the IRL system each year. The actual discharge volume may be less. Commensurate with the step-wise reductions in effluent volumes since 1985, there have been significant reductions in the annual nutrient loading from WWTPs (Table 2-3). By 2000, the major domestic WWTPs contributed less than 2% of the annual external nutrient loading to the IRL.

Table 2-3. Estimated Lagoon-wide Loads of Nitrogen, Phosphorus, & Suspended Solids from Domestic WWTPs

	Total Nitrogen lb/yr	Total Phosphorus lb/yr	Total Suspended Solids lb/yr
1985	1,763,700	418,400	1,521,200
1993	1,064,800	244,700	897,300
2000	137,314*	16,267*	43,320*

*In 2000, most of the domestic WWTP loading to the IRL system was contributed by the New Smyrna and Edgewater WWTPs (64% of TN, 59% of TP, and 68% of TSS loadings). These WWTPs are planning further effluent reductions.

Land Acquisition and Management. Acquiring lands is an important strategy to protect or restore wetlands, but it can also be effective in mitigating pollutant loads – present and future. This strategy is largely pursued through the IRL *Blueway* program. The *Blueway* program, its scope and progress, is described in the sections on Coastal Wetlands found in this and the following chapters.

In addition, other lands are sought for the purpose of constructing and operating surface water storage/treatment systems (mostly in the Central and South IRL). For example, the Districts can assist local governments in acquiring lands that would be a necessary prerequisite to constructing municipal or regional stormwater treatment systems. And, of course, upland parcels purchased as a means of acquiring wetlands can be preserved or managed in ways that will preclude or minimize development and future pollutant load increases.

Land acquisition today, however, is a far greater financial challenge than during the 1990s. State funds dedicated to land acquisition are dwindling. The Districts will not be able to acquire as much land on their own, thus making funding partnerships a practical necessity. In fact, *joint* land purchases for the purpose of water management projects are preferred. Typically, the acquisition partner is a local jurisdiction that would be responsible for operation and maintenance following facility construction.

Details on specific purchases are found in the following chapters, particularly in chapters dealing with the North and Central IRL, South IRL, and St. Lucie River watershed (Chapters 5 - 7), where most of the acquisitions are located.

The Next 5 Years – Lagoon-wide Projects

Taking stock of the program's progress and what we know about the current status of seagrass and water quality, project work over the next 5 years can be planned to further the monitoring, diagnostics, and development of restoration targets and strategies.

Lagoon-wide Monitoring and Diagnostics. Lagoon-wide assessments and resource target development (e.g., seagrass targets, PLRGs) would be well served by continuing the various, long-term monitoring activities described at the beginning of this chapter. Both Districts will continue to periodically review the effectiveness and efficiencies of their monitoring projects. Further enhancements of the water quality and seagrass monitoring networks will always be considered to achieve stronger statistical relationships among the field data collected from both networks. Another potential enhancement that will be evaluated is the use of hyperspectral digital imagery as a rapid and cost-effective means to map seagrasses Lagoon-wide, and to differentiate drift macroalgae from seagrasses. This technology may also prove to be an effective monitoring tool with respect to quantifying the Lagoon's turbidity/light attenuation characteristics. In summary, the monitoring networks listed below (Table 2-4) should continue indefinitely, not just over the next 5 years.

Pollutant Load Reduction Goals & Related Modeling Efforts. The SJRWMD and SFWMD estuarine models are presently undergoing final validation using measurement data from the IRL and its tributaries. In 2003, the SJRWMD will begin to apply its estuarine model (a.k.a. Pollutant Load Reduction or PLR Model) in the evaluation of provisional PLRGs, and revising them as necessary to develop recommended final

PLRGs in the Central IRL followed by Banana River Lagoon (with emphasis on its southern end), and other sub-Lagoons (Table 2-2).

Table 2-4. Lagoon-wide Monitoring Activities to be Continued Over the Next 5 Years

- **Water Quality Monitoring Network**
  SJRWMD and partner agencies – Mosquito & Banana R. Lagoons, and N. & Central IRL
  SFWMD – South IRL and St. Lucie River
- **Seagrass Monitoring Network**
  SJRWMD, SFWMD, other agencies, and volunteers conduct various measurements of seagrass abundance, diversity, and ancillary environmental conditions throughout the IRL
- **Seagrass Mapping and Aerial Photography**
  SJRWMD and SFWMD annual contracts for Lagoon-wide aerial photography and biennial mapping of seagrass coverages; evaluation of a hyperspectral map method
- **Hydrological and Meteorological Monitoring of Major Sub-basins**
  SJRWMD, USGS, contractors – Mosquito & Banana R. Lagoons, North & Central IRL
  SFWMD, USGS, FDEP, contractors – South IRL and St. Lucie River
- **Hydrodynamic Monitoring**
  SJRWMD, SFWMD, FDEP conduct measurements (e.g., current velocity, conductivity, water elevation, temperature) at several, strategic locations in the IRL system
- **Atmospheric Nutrient Deposition**
  SJRWMD collects data at a Volusia County site and at Sebastian Inlet (partially supported by funds from the EPA CASTnet and NEP).

SFWMD has developed hydrologic, water quality and hydrodynamic (estuarine) models for the South IRL and St. Lucie River Estuary (SLE). Enhancements of these models are underway with an emphasis on linking the watershed and estuarine water quality models in order to predict estuarine water quality conditions as a function of external inputs and internal hydrodynamics and other processes. Full development of these models and their interconnections are due by the end of 2003[20].

As stated before, both Districts in collaboration with the U.S. Army Corps of Engineers (USACE), and as part of the IRL-North and IRL-South Feasibility Studies, will also utilize sub-basin watershed models where necessary to enhance the calibration of the estuary models, to evaluate and determine the allocation of pollutant load reduction levels among the sub-basins, and to test the feasibility of water storage and treatment alternatives. The 5-year schedule for development and application of sub-basin models is consistent with the PLRG development schedule for the priority sub-basins (see Table 2-2). The Districts will forward their respective, final recommended PLRGs to FDEP for consideration in the development of TMDLs (see Appendix A, TMDL process)

General Management Strategies for Pollutant Load Reduction.

General Non-Point Source Strategies. With respect to a 5-year plan for the reduction of *non-point* source pollution, both Districts will generally "stay the course" on implementing their *surface water storage/treatment projects* as they were generally described in the 1994 IRL SWIM Plan. More focus and detail in strategic planning has occurred since 1994, which is summarized in this SWIM plan update, the IRL-South Feasibility Study Report (USACE and SFWMD, 2001), and the IRL-North Feasibility Study Project Management

[20] Refer to www.sfwmd.gov/org/wrp/wrp_ce/projects/2_wrp_ce_projects.html and www.evergladesplan.org/pm/studies/irl/irl_impact_statements.html (Appendix B) for more information on these South IRL and SLE models.

Plan (USACE and SJRWMD, 2002). The overarching management strategy emphasizes continuation of cooperative, cost-share programs with local governments and with the USACE for construction and operation of surface water treatment projects, particularly on a regional scale in the high priority sub-basins (Figure 2-9).

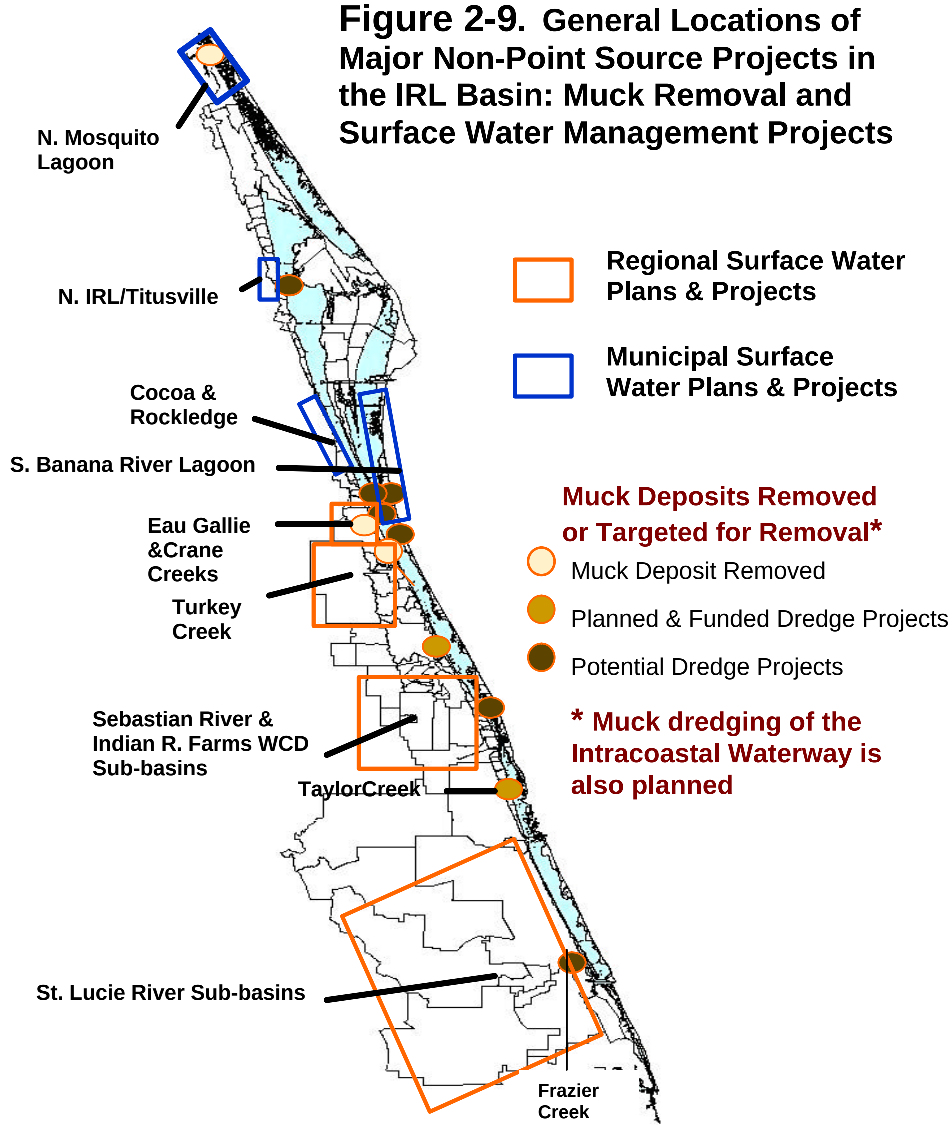

Figure 2-9. General Locations of Major Non-Point Source Projects in the IRL Basin: Muck Removal and Surface Water Management Projects

These high priority sub-basins and associated Lagoon segments merit additional surface water and pollutant load reduction controls for the following reasons: (1) the status assessment of seagrasses and water quality generally indicates greater environmental stress, especially in the Central IRL (including the southernmost segment of Banana River Lagoon), and the St. Lucie River and adjacent segments of the South IRL, (2) a majority of the effort and funding on behalf of the Districts and partner agencies have already been invested in these areas (since 1989), and (3) the potential for further environmental harm in those areas is still great based on rates of population growth, and related development and drainage impacts.

Muck removal[21] coupled with the control of upland muck sources is an important two-fold strategy toward reducing significant sources of nutrients and turbidity in the IRL. Again, the Central and South IRL are the two major target areas simply because they contain most of the major deposits of muck. The Districts have identified specific muck deposits slated for removal between the 1995 and 2010: Eau Gallie River, Sebastian River, Taylor Creek (C-25 sub-basin), and in Wiloughby and Poppleton Creeks (tributaries to the St. Lucie River). In addition, the USACE and FIND are co-sponsors of a 10-year 'environmental' maintenance dredging of the Intracoastal Waterway channel, which contains about 60 to 70% of the muck in the Indian River Lagoon proper.

General Point Source Strategy. The Florida Department of Environmental Protection (FDEP) will continue to monitor the *major domestic WWTPs* for compliance with the Indian River Lagoon Protection Act and conditions associated with permits issued under the requirements of the Act. Both the FDEP and SJRWMD will continue to assess the facility upgrades and corresponding effluent reductions in progress at the New Smyrna Beach, Edgewater, and City of Canaveral WWTPs. They are the only major domestic WWTPs that continuously discharge and, thus, constitute major point-source nutrient loadings to the Mosquito and Banana River Lagoons. The Districts will also continue to update the Lagoon-wide WWTP point source inventory every 5 years.

Presently, the Districts and the IRLNEP are paying closer attention to reverse osmosis (RO) water treatment facilities and the quality of the effluents they discharge to the IRL. The impacts of RO discharges (e.g., salinity and nutrient levels) are reviewed by FDEP but will also be considered by the Districts when these facilities apply for consumptive use permits. It is the intent of the Districts to have RO facilities utilize the best technology available to minimize loading of N, P, and other constituents that could create localized impacts in the Lagoon. Toward that end, cooperation by facility owners and FDEP during these assessments will be encouraged to engender consensus on the best methods or course of action to be taken by RO facilities.

Land Acquisition and Management. SJRWMD and its *Blueway* partners will strive toward an annual acquisition rate of 20% of the 450 parcels identified. Therefore, all available *Blueway* parcels (with willing sellers) may be acquired by 2006. Acquiring such properties will help lessen development impact on the coastal wetlands shorelines and nearby seagrass beds (and allow rehabilitation of impounded wetlands; see Coastal Wetlands section).

Upland parcels will be identified in the priority sub-basins (Sebastian, Indian River Farms WCD, C-25 and St. Lucie sub-basins, etc.) for sites suitable for constructing either municipal-scale or regional-scale surface water storage and/or treatment facilities. Such uplands are deemed generally suitable if they are strategically located within the watershed and do not contain land, ownership, or permitting characteristics that may require enormous up-front costs before construction even begins.

The SFWMD and the USACE, through the IRL-South Feasibility Study, have selected specific land areas that will be required for construction and operation of large surface water treatment and storage systems in the South IRL and St. Lucie River watersheds.

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[21] The muck proposed for removal is basically displaced topsoil (good to excellent soil amendment properties) and free of contamination; therefore, beneficial uses of this sediment should be explored.

The projected cost for the acquiring these lands is between $400 million and $500 million. The SJRWMD and the USACE have recently partnered to undertake the IRL-North Feasibility Study and may also identify lands, primarily in the Central IRL, over the next 3 years for the same purpose. Further description of the IRL-South and IRL-North Feasibility Studies is provided below.

USACE and the Districts (IRL-South and IRL-North Feasibility Studies). The USACE has partnered with SFWMD and SJRWMD to conduct the IRL-South Feasibility Study (F.S.) in South IRL/St. Lucie River sub-basins[22] and the IRL-North F.S. in the SJRWMD portion of the IRL system. These joint programs, managed under the Comprehensive Everglades Restoration Plan, have the potential of drawing down hundreds of millions of dollars from the federal government under the re-authorization of the Water Resources Development Act (WRDA). The IRL-South F.S. is completed, and its proposed projects are scheduled for funding consideration under WRDA re-authorization in 2004. The IRL-North F.S. started in mid-2002 and is scheduled for completion by 2008. Under the feasibility studies, the USACE and the Districts will propose restoration strategies that are considered effective in meeting restoration targets and are technologically feasible at a reasonable cost. More information on the background and purpose of these feasibility studies is found in Chapter 1, pp. 8 - 9.

Water storage reservoirs and treatment areas intended to attenuate canal discharges and reduce pollutant loadings are options being seriously considered in the IRL-South project area. In both the IRL-South and -North project areas muck removal and source control projects are viewed as excellent opportunities for direct USACE involvement, particularly in the application of erosion controls along the miles of canal side-banks found in the water control districts, and in the removal of muck sediments from canals, the Intracoastal Waterway, and other navigational channels. The IRL-North F.S. will evaluate drainage infrastructure improvements, particularly in the water control districts, to both treat and attenuate discharges to the IRL. Additionally, the creation of more or larger openings through causeway bridges and the deepening of Sebastian Inlet as means toward increasing IRL flushing rates are alternatives that will be explored under the IRL-North F.S.

Summary of Lagoon-wide Seagrass and Water Quality Projects Planned for the Next 5 Years. Table 2-5 below provides a summary list of the projects or general strategies that have Lagoon-wide application and are planned for the next 5 years (2002 – 2007). The continuation of these projects is imperative in order to conduct periodic resource status assessments, complete or refine PLRGs, preserve environmentally critical wetlands and uplands, and design and construct surface water storage and treatment projects. For additional information about how many of these projects are being conducted or planned in the specific sub-Lagoons and sub-basins, please refer to the chapters that follow.

[22] Please access www.evergladesplan.org for more information about the IRL-South and IRL-North Feasibility Studies.

Table 2-5. The 5-Year Plan List of Seagrass and Water Quality Strategies and Projects that have Lagoon-wide Application

- **Continuation of Lagoon-wide Monitoring Projects***
  - **Water Quality Monitoring Network**
  - **Seagrass Mapping and Field Monitoring**
  - **Hydrological and Meteorological Monitoring of Major Sub-basins**
  - **Hydrodynamic Monitoring Network**
  - **Atmospheric Nutrient Deposition Monitoring**
- **Development of final recommended PLRGs**
- **Application of estuary and watershed models in evaluating restoration options**
- **Design and construction of surface water storage and/or treatment areas (regional/watershed and local non-point source control)**
- **Muck source control (via watershed erosion control programs)**
- **Continuation of muck removal projects**
- **Periodic inventory of domestic WWTP effluents**
- **Continuation of the *Blueway* land acquisition program**
- **South IRL & North IRL Feasibility Studies & recommended implementation under the Comprehensive Everglades Conservation Plan (CERP)**
- **Districts' review of local comprehensive growth plans and amendments to ensure consistency with SWIM water quality and seagrass resource objectives**

***see descriptions of monitoring projects in Table 2-4 above**

Coastal Wetlands

Coastal wetlands – salt marshes and mangrove swamps -- provide a vast array of ecosystem functions. They serve as links and buffers between land and open water where eroded soils and nutrients from uplands are trapped and assimilated. They provide habitat for large numbers of animals (especially fish and birds), and, as such, are crucial for sustaining Lagoon biodiversity. Wetlands are a source of particulate and dissolved organic materials for adjacent Lagoon waters, supporting estuarine fisheries production. Coastal wetlands also moderate storm/flood damage to upland areas. Many of these functions are dependent on local hydrology and hydrologic links to the estuary.

The Districts address coastal wetland management in four areas:

- Rehabilitation of impacted wetlands, primarily the reconnection of impounded wetlands
- Promotion of holistic or ecologically balanced management of reconnected wetlands
- Preservation of existing, undisturbed wetlands
- Creation of shoreline vegetative habitats

Projects and Progress to Date

Rehabilitation or Restoration[23] of Impounded Wetlands. Between the 1950s and 1970s, nearly 75% of the coastal wetlands in the IRL basin (about 40,420 of the total 53,890 acres) were impounded for mosquito control and, consequently, were isolated from the IRL system. The majority of this acreage, about 28,000 acres, is found within a Federal park and refuge covering expansive areas of northern Merritt Island, southern Mosquito Lagoon, and northern Banana River and Indian River Lagoons (Figure 2-10).

Research conducted in the 1970s and 1980s demonstrated the ecological benefits of reconnecting wetlands to the estuary (Brockmeyer et al., 1997). This *a priori* research prompted an aggressive District campaign to reconnect impounded wetlands (Virnstein and Steward, 1993). This campaign began in 1990 and has been a top SWIM priority ever since. Impoundment reconnections quickly accelerated in the early 1990s. Details on this early progress can be reviewed in the 1994 IRL SWIM Plan.

Since 1994, more than 13,000 acres of impounded wetlands Lagoon-wide have been reconnected. Adding the pre-1994 acreage to that total provides a Lagoon-wide tally of slightly more than 27,500 impoundment acres that are reconnected, breached, or restored (accomplished via non-SWIM and SWIM efforts, Figure 2-10).

Within the SFWMD portion of the IRL basin, approximately 4,695 acres are now reconnected (pre-SWIM and SWIM). The SFWMD reconnection target is 4,943 acres in the South IRL. Only three impoundments, totaling 248 acres, remain isolated; and those are targeted for reconnection contingent upon their acquisition or other favorable negotiations with the private owners.

Within SJRWMD, reconnections have rehabilitated over 23,000 acres of IRL wetlands (non-SWIM: 4,500 acres, and SWIM: 18,555 acres). The goal is 33,000 acres within SJRWMD. However, reconnecting most of the remaining 10,000 acres will not be a simple matter.

Most of the remaining isolated wetlands are located in northern Merritt Island[24]; the rest are privately owned impoundments in Brevard and Indian River counties. In northern Merritt Island, there has been a recent slow-down in reconnection progress attributable to the on-going development of a wetland mitigation plan by NASA (the land owner) and unresolved management issues with U.S. Fish and Wildlife Service (the land manager). The first issue will be rectified when the mitigation plan is completed and accepted by the SJRWMD. The latter issue is being addressed through increased interagency communication and applied research (i.e., Wetlands Management Research Initiative) based on a mutual agreement between SJRWMD, U.S. Fish and Wildlife Service, and NASA.

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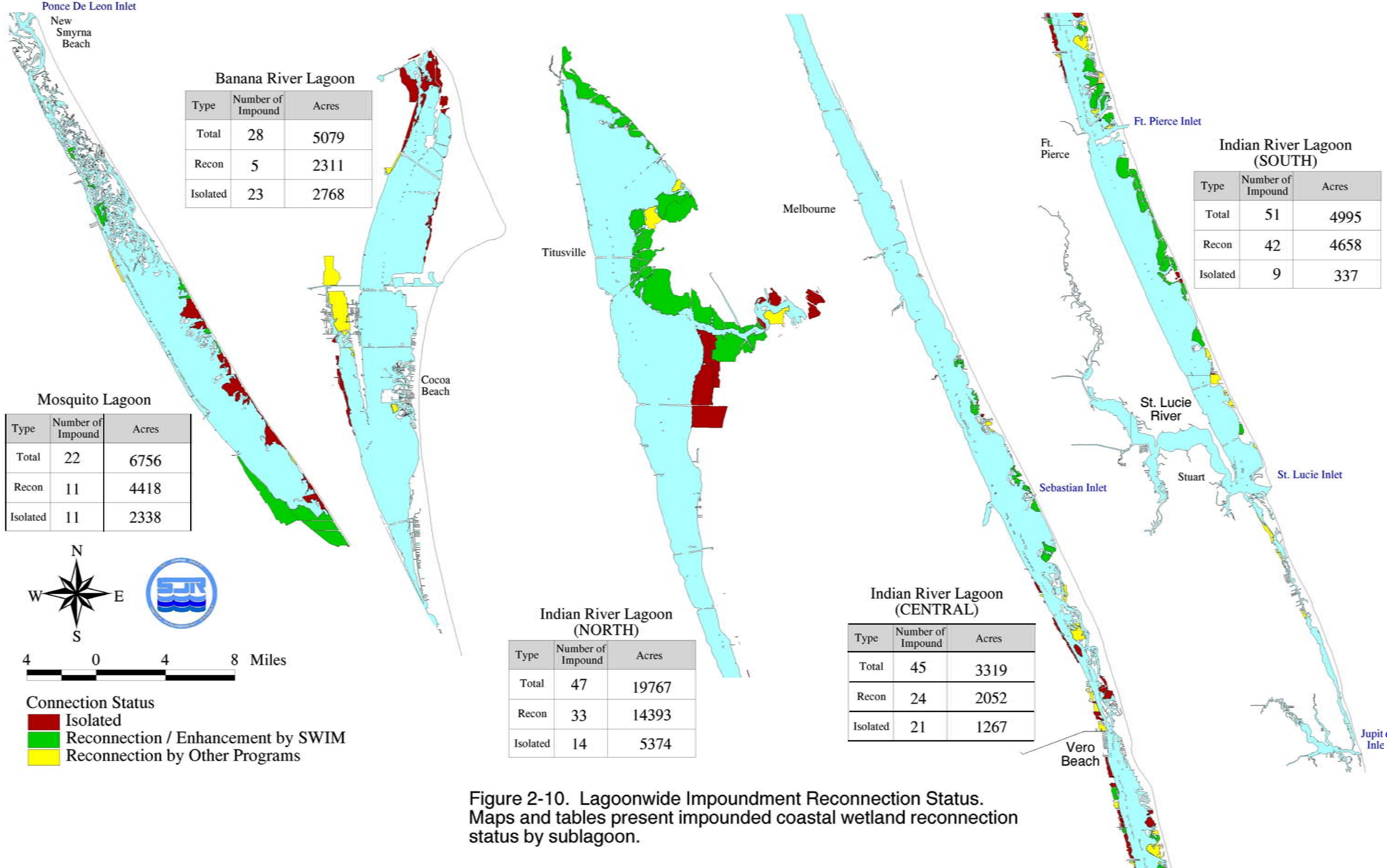
[23] Where feasible, efforts to restore wetlands may consist of complete removal of impoundment dikes, filling in ditches, and grading the surface to natural marsh elevations. This may be feasible where hydrologic manipulation of the wetland is not required for mosquito control or bird management. Otherwise, partial hydrologic restoration or rehabilitation of the wetland, via controlled openings through impoundment dikes, is the next best option.

[24] These impoundments are managed by the U.S. Fish and Wildlife Service; most are in the Merritt Island National Wildlife Refuge.



Mosquito Lagoon

Type	Number of Impound	Acres
Total	22	6756
Recon	11	4418
Isolated	11	2338

Banana River Lagoon

Type	Number of Impound	Acres
Total	28	5079
Recon	5	2311
Isolated	23	2768

Indian River Lagoon (NORTH)

Type	Number of Impound	Acres
Total	47	19767
Recon	33	14393
Isolated	14	5374

Indian River Lagoon (CENTRAL)

Type	Number of Impound	Acres
Total	45	3319
Recon	24	2052
Isolated	21	1267

Indian River Lagoon (SOUTH)

Type	Number of Impound	Acres
Total	51	4995
Recon	42	4658
Isolated	9	337

Figure 2-10. Lagoonwide Impoundment Reconnection Status. Maps and tables present impounded coastal wetland reconnection status by sublagoon.

The problem with private ownership of wetland impoundments is being addressed by a multi-agency land acquisition effort spearheaded by SJRWMD. This effort is known as the Indian River Lagoon *Blueway* Project. The *Blueway* Project targets wetlands in need of restoration as well as relatively undisturbed wetlands that need preservation. FDEP, both Districts, all counties in the IRL basin, and The Nature Conservancy are engaged in the *Blueway* Project.

Wetlands Management Research Initiative. The Wetlands Management Research Initiative, conducted in the Merritt Island National Wildlife Refuge (MINWR), is a logical response to an inter-agency debate about what constitutes appropriate management of reconnected impoundments. For example, a large percentage of reconnected impoundments in the MINWR are closed off from the Lagoon system for longer than 8 months for waterfowl and wading bird management (a.k.a. Wildlife/Aquatic Management or WAM). WAM impacts marsh vegetation and invertebrates and prevents estuarine fish from recruiting to these wetlands during the long closure period. An alternative management technique, popular with the mosquito control agencies, allows the impoundment to be open for 8 to 9 months, but must be closed and flooded during the summer months. This technique known as Rotational Impoundment Management or RIM is effective in controlling the salt marsh mosquito and does allow a longer period of exchange with the Lagoon than does WAM, but also has its drawbacks. RIM may also impact marsh invertebrates and restrict access for some species of fish that recruit to wetlands during RIM's shorter closure period. Where mosquito control is not imperative, then the merits of WAM vs. open management are also debatable.

Therefore, the Wetlands Management Research Initiative was conceived as the primary means to address, if not wholly quell, the debate. The objectives of the Initiative are:

(1) to investigate the effects of the three management techniques – WAM, RIM, and open management – on several functions and features of impoundments and the adjacent Lagoon[25], and
(2) to determine the best management alternative or mix of management techniques that best serve both the natural wetland functions of impoundments and the management mandates of USFWS and the mosquito control districts.

The 3-year Initiative is underway; the first year of research will be completed by the time this plan update is published. It is being generously funded by EPA (~$550,000), and is cost-shared by SJRWMD, FDEP Bureau of Survey and Mapping, USGS, USFWS, and a host of other entities engaged in the research.

Rehabilitation of Other Impacted Wetlands. Most of the wetlands in the IRL that were spared from impounding are, unfortunately, still impacted in another way. These wetlands were crisscrossed with about 200 miles of mosquito control ditches. Large excavation equipment called draglines were used to ditch through 2,000+ acres of wetlands, most of it during the 1960s. (Draglines were used to construct many of the impoundments as well.) By 1970, these wetlands were altered almost beyond recognition, scarred with deep wide ditches and spoil piles. Most of these ditched wetlands are in northern and central Mosquito Lagoon, Volusia County.

[25] Wetland and IRL components investigated include: marsh sediment elevation, plant distributions, nutrient cycling, fish and invertebrate populations, seagrass, and populations of wading birds, waterfowl, and shorebirds.

Rehabilitation of these impacted wetlands was initiated as a pilot project with the cooperation of E. Volusia Mosquito Control District. The project is evaluating several equipment and technique options on a 56-acre ditched wetland. Successful techniques developed in the pilot project will be applied throughout the SJRWMD portion of the IRL. A plan for full-scale operations will be developed following the outcome of the pilot project.

Creation of Shoreline Vegetative Habitats. Under SWIM, wetland planting projects began in 1991. Nearly all plantings targeted the shorelines to protect them and the adjacent uplands from erosion and to reduce the loading of eroded material to the Lagoon. Alterations to the natural landscape (e.g., causeways, spoil islands) may make certain sites potential candidate sites for plantings. These sites may need to be made suitable by slope grading, installing wave barriers, or other site modifications that could increase the margin of success for plantings.

Conventional Plantings. From 1991 to 1995, planting material was typically a mix of red and black mangroves (*Rhizophora mangle* and *Avicennia germinans*) dominated by smooth cordgrass (*Spartina alterniflora*). These plants were placed directly in the ground around the mean high water mark. The major sites were spoil islands in Indian River and Brevard counties, the delta at the end of the South Relief Canal in Indian River County, and an area near the boat ramp in the Sebastian Inlet Park south of the Inlet. Other minor plantings were Watershed Action Committee (WAC) project sites dotting the IRL from central Brevard County south to St. Lucie County.

Routine monitoring of the plantings was conducted. In general, these plantings were not very successful. By the end of the monitoring (2 to 3 years), most sites had less than 5% survival of the planted material, some sites much less. Only those plants most protected from wind and waves survived, which was probably the case at one site that has been exceptionally successful -- the delta site at South Relief Canal in Indian River County.

At the South Relief Canal delta site, over 10,000 cordgrass plugs and 500 mangrove seedlings were planted in 80-ft wide bands. After 3 years, the cordgrass plugs had grown into a continuous bed of vegetation. The mangroves that were planted among the plugs were protected and are maturing. A low berm of sand had formed around the planting site, likely from strong wave action. Both the vegetation and berm appear to have stabilized the previously unconsolidated sediments of the delta. As a result, a new marsh, nearly 2.5 acres in size, is now established and appears to be fully functional habitat.

The conclusion drawn from these conventional shoreline planting experiences (i.e., plants placed directly in the sediments at the high water mark) is that the best chance for success may be achieved with broad rows of plantings where a major portion of the plantings are buffered from wave action. However, there are few sites in the IRL with the suitable characteristics for such plantings. Presently, the conventional mangrove plantings of the early years have been replaced by a new experimental technique: the encased mangrove planting method.

*Encased Mangrove Planting***.** The latest development in an IRL shoreline/wetland planting technique is the PVC-encased mangrove planting method. The method is the innovation of Robert Riley and is called the Riley Encased Methodology or REM. Red mangrove propagules are planted within 2 to 3 ft lengths of thin-walled PVC pipe, which are inserted into the sediment. The pipe protects the young plant from wind and wave action along the shoreline, enabling the mature mangrove to grow beyond its protective enclosure. Details on REM are available on Riley's web page: www.mangrove.org.

This innovative method was the catalyst that re-forged the IRL shoreline planting project as a multi-agency endeavor with volunteer participation. To date, a partnership of agencies and the Indian River County Environmental Learning Center (ELC) have planted more than 10,000 red mangroves utilizing REM and 1,700 hours of volunteer labor at 28 sites, which affects several thousand feet of shoreline throughout Central and South IRL. The project is supported by SJRWMD, SFWMD, IRLNEP, U.S. Fish & Wildlife Service (South Florida Coastal Ecosystem Program), Florida Inland Navigation District, and FDEP (Aquatic Preserve Program). The project is coordinated by the ELC and is largely dependent upon volunteer participation for its implementation. To learn more about this mangrove planting project, please access the ELC web page: www.elcweb.org/shoreline/.

Preservation of Existing Wetlands – Land Acquisition. Land acquisition is a highly popular and successful means of preserving or protecting coastal wetlands. Early in the SWIM program, a SJRWMD acquisition plan, developed upon the data generated by Gurr & Associates (1990), identified critical lands that could help meet SWIM objectives, both for wetland and seagrass protection. In addition, the SJRWMD, FDEP, and local advocates were successful in dedicating state funds to support the Sebastian River and North Indian River CARL projects. Additional details on these projects are found in the 1994 IRL SWIM Plan (pp. 66-67).

From 1995 to 1996, the SJRWMD land acquisition plan for the IRL was used in the preparation and planning for a major proposal known as the IRL *Blueway* acquisition plan (capitalizing on the "greenway" concept, but emphasizing the connectivity of the parcels via waters of the Lagoon). This ambitious planning effort eventually included other agencies: SFWMD; Volusia, Brevard, Indian River, St. Lucie and Martin Counties; and The Nature Conservancy (TNC).

The plan goal is simple and direct -- to acquire all of the IRL wetlands identified as critical by the participating agencies. The agencies identified over 8,000 acres (~600 parcels) in the *Blueway* plan (Figure 2-11). The *Blueway* Project will achieve the SWIM objectives of "preservation of existing wetlands" and allow major advances toward the "restoration / rehabilitation of impacted wetlands."
By 1998, *Blueway* acquisitions were being actively pursued. In SJRWMD, some land parcels in the Sebastian River CARL project area were purchased (part of the Sebastian Buffer Preserve lands whose acquisition pre-dates the *Blueway* program). Also, a few parcels in and adjacent to impoundments were acquired (e.g., Church property near John Smith impoundment and the Pine Island property, both in Brevard County and shown in parcel blocks 5 and 10 in Figure 2-11).

The SFWMD, St. Lucie County, and Martin County have collectively acquired several parcels: Bear Point Sanctuary, Vitolo Family Park, Blind Creek Park (Ocean to IRL), Ocean Bay, Queens Island, and Kings Island. Imminent closures on land include Pepper Park Addition, Avalon Addition III, and Bear Point Addition. SFWMD and FDEP jointly purchased lands as part of the North Fork St. Lucie River Buffer Preserve. A wetland mitigation bank concerning Bear Point is in the permit review stage. And, St. Lucie County Mosquito Control District directs a land acquisition and preservation program, which has succeeded in placing over 55% of the County's coastal barrier island under public ownership.

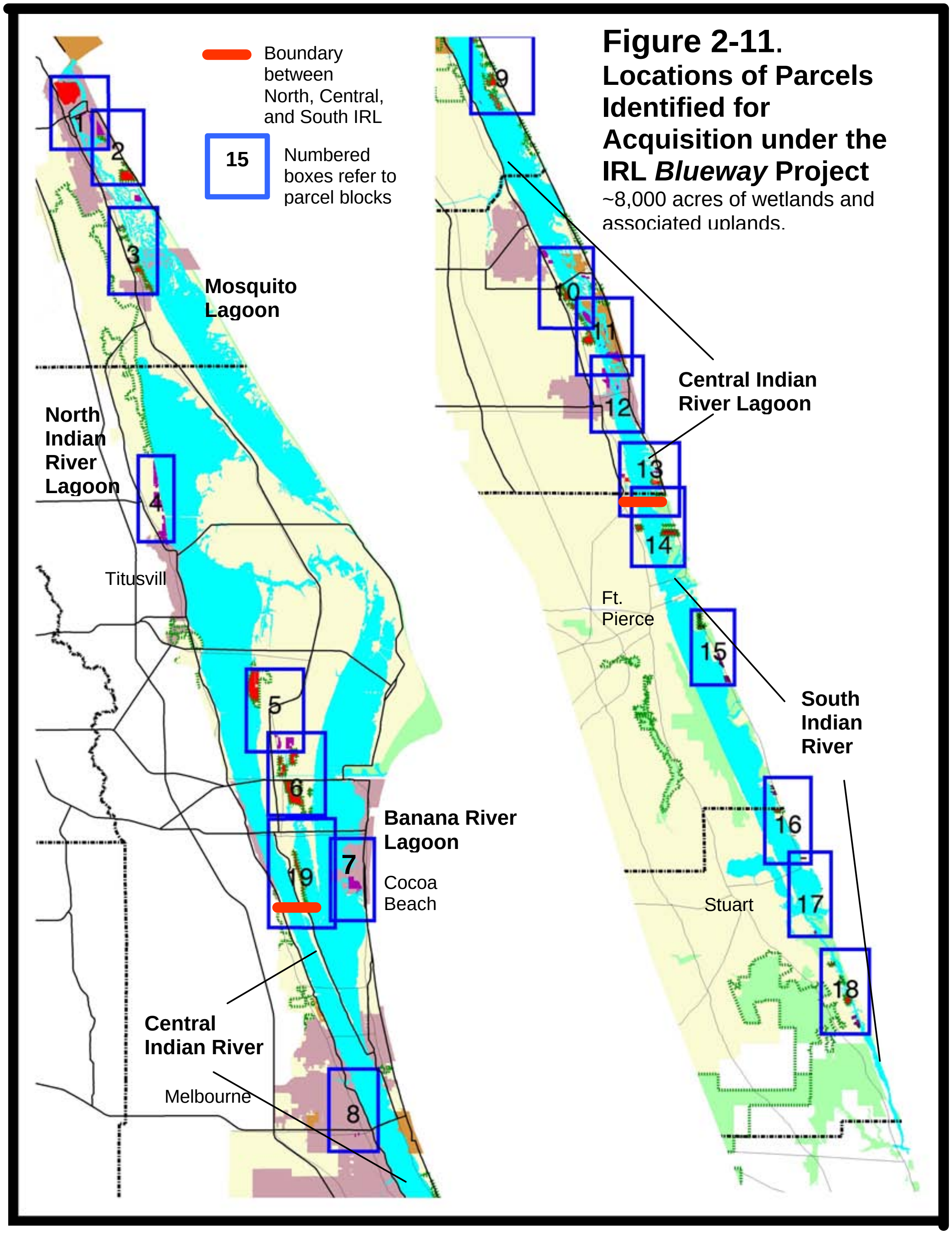


Figure 2-11. Locations of Parcels Identified for Acquisition under the IRL *Blueway* Project
~8,000 acres of wetlands and associated uplands.

Next 5 Years – Lagoon-wide Perspective

Rehabilitation or Restoration of Impounded Wetlands. The ultimate goal is to restore or rehabilitate 33,000 acres within the SJRWMD portion of the IRL basin. To date, slightly over 23,000 acres have been rehabilitated under the SWIM inititative. Over the next 5 years, the SJRWMD plans on reconnecting another 3,000 acres of impounded coastal wetlands. It is anticipated that the regulatory directed mitigation plan affecting NASA-owned impoundments (Merritt Island) and the acquisition of privately owned impoundments will make it possible to reconnect those wetlands, and by 2010 the remaining 7,000 acres.

In the South IRL, the majority of impoundments have either been breached or reconnected. Approximately 300 acres of impounded wetlands remain isolated (contained within 3 impoundments in St. Lucie County), comprising only 6% of the total impounded acreage in the South IRL. Those isolated impoundments will be reconnected or breached when they are either publicly acquired or the owners grant permission (note: ~53 acres may never be reconnected because of their location and use within the St. Lucie nuclear power facility).

Wetlands Management Research Initiative. This research initiative will take a minimum of three years to complete. Data collection should be completed by 2003. The analysis and report recommendations will take another year because of the comprehensive scope of the project. By 2003/04, the agencies involved will be engaged in a consensus process, probably a series of workshops and informal discussions intended to develop a "master" set of recommendations for best management of reconnected impoundments that can be applied throughout the IRL system. Achieving a consensus on these recommendations will require much interagency consultation and cooperation. It will be a difficult process given the large number of agencies involved and the importance of the issues at stake, so setting a date for final agreement on a set of recommendations is not practical nor necessary at this time.

Rehabilitation of Other Impacted Wetlands. The SJRWMD is targeting 2,000 acres of dragline-ditched wetlands for rehabilitation work. The first step is to complete the pilot project work evaluating equipment needs and techniques that can best do the restoration work. The second step is to incorporate the conclusions of the evaluation into a plan that spells out the overall rehabilitation strategy. The plan will include the chosen technique(s) and related cost/benefit information, mapped details of the identified wetlands (most are in Volusia County), the schedule of work, and the approximate annual costs. The rehabilitation plan should be completed in fiscal year 2003. Then, full-scale work can begin, which may take 5 to 10 years to complete.

Creation of Shoreline Vegetative Habitats. Work to expand mangrove-planted shorelines will continue using the Riley Encase Mangrove method. Potential planting sites are identified and evaluated every year with a goal of conducting at least six plantings per year. To date, nearly 10,000 mangroves have been planted along several thousand feet of shoreline. All plantings will be monitored to determine success, and alternative planting methods can be assessed at any time. The long-term goal of this project is to establish mangroves along unvegetated shorelines (from Central through South IRL) determined to be severely eroding[26].

Preservation of Existing Wetlands – Land Acquisition. The main goal over the next five years is to acquire as many of the *Blueway*--designated wetlands as possible (8,000 acres and 600 parcels total). To achieve good progress toward this goal, adequate support services to the land acquisition process must be maintained. This support can

[26] Some spoil islands, in addition to mainland shorelines, have been chosen as sites for vegetative planting to improve habitat and shoreline protection. Consequently, the Districts have become involved with the Spoil Island Workgroup, organized by FDEP, and comprised of various public and private organizations to coordinate enhancement activities for any of the 137 spoil islands in the IRL. Activities include rehabilitation of wetland/upland functions and recreational enhancements.

be accomplished by budgeting sufficient funds to continue a support service contract to handle appraisals (such as the one that the SJRWMD had with The Nature Conservancy). Continued support by the counties and the Districts for *Blueway* acquisitions must be sustained.

Summary of Lagoon-wide Coastal Wetland Projects Planned for the Next 5 Years. Please refer to Table 2-6 below for a summary list of the general strategies and projects that have Lagoon-wide application and are planned for the next 5 years (2002 – 2007).

Table 2-6. The 5-Year Plan List of Coastal Wetland Strategies and Projects that have Lagoon-wide Application

- **Continuation of the reconnection of impounded wetlands**
- **Completion of the Wetlands Management Research Initiative and application of findings toward management of impounded wetlands**
- **Rehabilitation of dragline-impacted wetlands**
- **Continuation of REM mangrove plantings and the application of other innovative shoreline planting methods**
- **Continuation of the *Blueway* land acquisition program**
- **Districts' review of local comprehensive growth plans and amendments (especially as they relate to the coastal resources element) to ensure consistency with SWIM coastal wetland objectives**

Public Involvement and Education

Successful implementation of the IRL SWIM Plan is dependent on public support. Considering the fact that nearly 400 people move into the IRL basin every week, public support must be constantly cultivated through education. A public that is aware of the value of the IRL system and the threats to its ecological integrity and economic viability is more likely to understand and support efforts to restore and protect it.

The *Public Involvement and Education* (PIE) program has been fully managed by the IRLNEP since 1994. Through the IRLNEP's exceptional efforts, public awareness, support, and involvement have grown steadily. The IRLNEP carries out the program's mission in a number of ways. IRLNEP provides informational material, guidance, and financial assistance to several public and private organizations for educational outreach programs. These organizations, along with IRLNEP, also offer opportunities for the public to be directly involved in some small-scale, resource enhancement projects. Major examples of PIE projects and activities are highlighted below.

Progress on Projects

Seminars and Workshops. A series of seminars and workshops, held twice a year in each of the Lagoon's counties, provide a forum for the public to learn and discuss current issues affecting the IRL. The Marine Resources Council (MRC) is currently contracted to organize and host these events.

In addition, the IRLNEP supports the *Indian River Lagoon Symposium*, a conference that was held in 1997 and in 2000. This publicly attended conference includes presentations and posters by many of the entities and individuals involved in monitoring and restoring the health of the IRL system.

Citizens' Water Quality Monitoring Network. Through a renewable contract with the MRC, a citizen's water quality monitoring network has been in operation for many years. Staffed by citizen-volunteers, this network monitors approximately 100 sites throughout the IRL on a weekly basis. This project is an opportunity for residents to participate in the collection of data, and to gain first-hand knowledge about the IRL. Both the IRLNEP and the Districts assist the MRC and volunteers in the interpretation of the data.

Shoreline Mangrove Plantings. The multi-agency, mangrove-planting project, coordinated by the Indian River County Environmental Learning Center, invites citizen-volunteers to provide needed manpower. Using a planting method developed by an IRL resident (Robert Riley; www.mangrove.org), the volunteers have planted red mangroves at dozens of sites throughout the Central and South IRL. Please refer to the previous section, Coastal Wetlands, *Creation of Shoreline Vegetative Habitats*, for more information about planting methods and project progress.

Informational Materials. Several K - 8th grade materials and other informational items were revised and updated in recent years. These include the *Indian River Lagoon Coloring Book*, targeted at grade school children, and the *Indian River Lagoon Activity Book*, a curriculum for middle school students. In addition, a brochure promoting the IRL license plate was recently completed, and the *Fragile Balance* informational brochure is being revised.

The IRLNEP's *Indian River Lagoon Update* newsletter is published quarterly, providing current information about the IRL and projects undertaken to protect and restore the Lagoon. The newsletter has a distribution list of more than 4,000 names with additional copies available at government offices, libraries, and through a variety of groups and organizations.

Indian River Lagoon License Plate. A brief history on the process for state adoption of the IRL "snook" license plate is found in the1994 IRL SWIM Plan, p. 87. The IRL license plate was first issued to the public in February 1995. The plate has proven to be quite popular, with more than 40,000 sold and generating more than $2 million in revenue since 1995. The revenue from all plates, regardless of where they are sold, returns to the IRL region where it is distributed among the Lagoon's counties based on the proportion of IRL tags sold among those counties. The revenue supports IRL restoration and education projects.

The IRL "snook" plate has proven to be a significant public awareness icon, creating a great deal of public interest in the IRL, particularly among residents of the region. An important outreach activity is promoting the IRL license plate by informing the public about how the plate revenue is used.

The Next 5 Years

All projects described above are planned to continue over the next 5 years (Table 2-7).

Table 2-7. The 5-Year Plan List of Public Involvement and Education Projects

- **Continue the regular public seminar forums to inform and elicit feedback on IRL issues and projects**
- **Promotion of volunteerism in monitoring and restoration activities (e.g., shoreline mangrove planting and Citizens' water quality monitoring projects)**
- **Continue development of new informational materials and the updating of existing publications**
- **Continue participation in fairs, festivals, and other public events to increase awareness of the IRL's resources and efforts to protect and restore them**
- **Continue promotion of the IRL "snook" license plate**
- **Continue participation with the IRL Spoil Island Workgroup as one means to elicit public involvement in various IRL management and monitoring activities**

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CHAPTER 3. MOSQUITO LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The assessment of Mosquito Lagoon's seagrass resource is based on the same three measurement indices used in the Lagoon-wide assessment:

- ❖ Acres of seagrass coverage over time (net gain or loss)
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight at the target depth of 1.7 m.

For more information on why and how these indices are used to assess seagrass resource status, refer to Chapter 2, p. 2-3.

Seagrass coverage distributions vary widely throughout the Mosquito Lagoon (Figure 3-1a and b). Major findings about seagrass coverage distribution in Mosquito Lagoon are summarized below (refer to Figure 3-1 for additional detail).

- Mosquito Lagoon, overall, has experienced little loss in seagrass coverage since 1943 (~20% loss). This favorable result is largely due to the consistently good coverage maintained in the southern reach, which is the largest reach in Mosquito Lagoon.
- The southern reach of Mosquito Lagoon (segment ML3-4) contains one of the more extensive seagrass coverages in the IRL system – approximately 732 acres per linear mile of lagoon. This reach has also experienced little change since 1943 (only 13% loss since 1943). It is located within minimally developed watersheds and comprises the federally protected bottomlands managed by the Canaveral National Seashore and U.S. Fish and Wildlife Service. However, despite its apparently stable coverage over time, the seagrass resource status in southern Mosquito Lagoon received only a fair rating based on results of the measurement indices (Table 3-1).
- The area with the least seagrass coverage in Mosquito Lagoon and with the greatest loss since 1943 is the northern reach near New Smyrna Beach (segment ML1, south of Ponce de Leon Inlet). The 1999 seagrass coverage was only 51 acres, which represents a 94% loss since 1943. Not surprisingly, the seagrass status of this reach is considered poor. Segment ML1 may have poor seagrass coverage due to physical factors such as strong current velocities and unstable sediments, in addition to light limitation, because of its proximity to Ponce de Leon Inlet and the multitude of channels and navigational cuts that characterize this segment. Whether these physical factors truly affect seagrass distribution or not in this segment is unknown and subject to investigation.

Southern Mosquito Lagoon (ML3-4) is classified as a fair or transitional area (Table 3-1); an area that is believed to be "pristine". At depths greater than1 m, light levels in Mosquito Lagoon drop significantly below the preliminary minimum light requirement for the IRL of 25% of the surface light (an annual median). Light levels at the restoration target depth of 1.7 m in Mosquito Lagoon's northern and central segments (New Smyrna to Oak Hill) generally fall well below that requirement -- 11% and 9.6% of surface light, respectively (Figure 3-1c). Southern Mosquito Lagoon is only slightly better – 15% of surface light at 1.7 m.

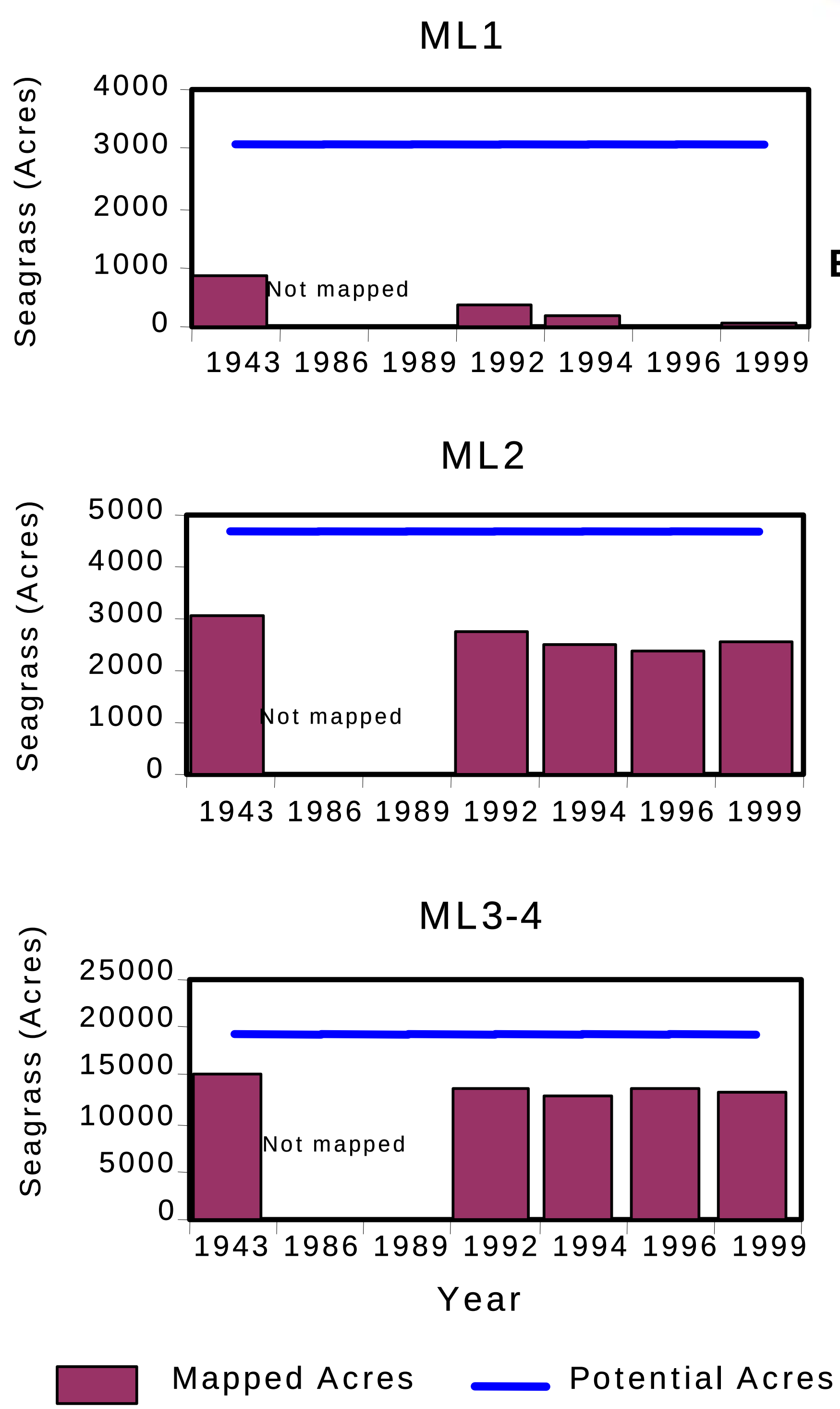


Figure 3-1b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note loss in segment ML1 and long-term stability in ML2 and especially ML3-4.

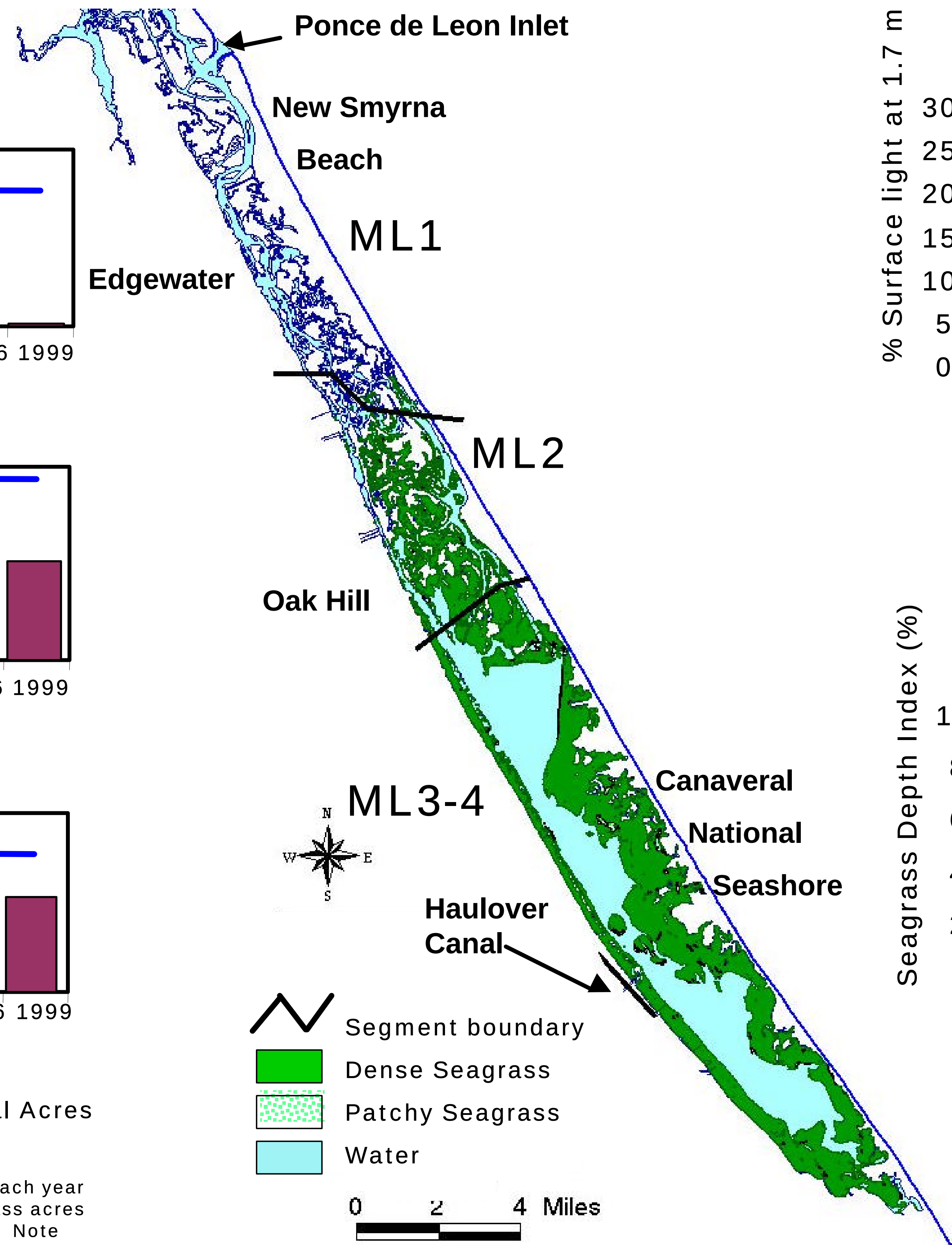


Figure 3-1a. Mosquito Lagoon 1999 seagrass coverage and segment boundaries

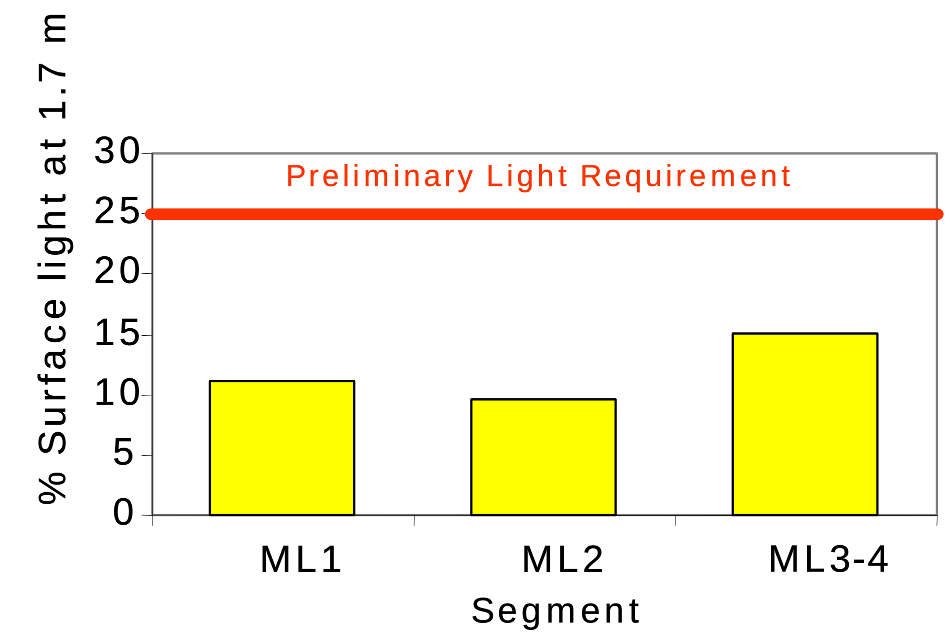


Figure 3-1c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999. Note that even segment ML3-4 is far below the target.

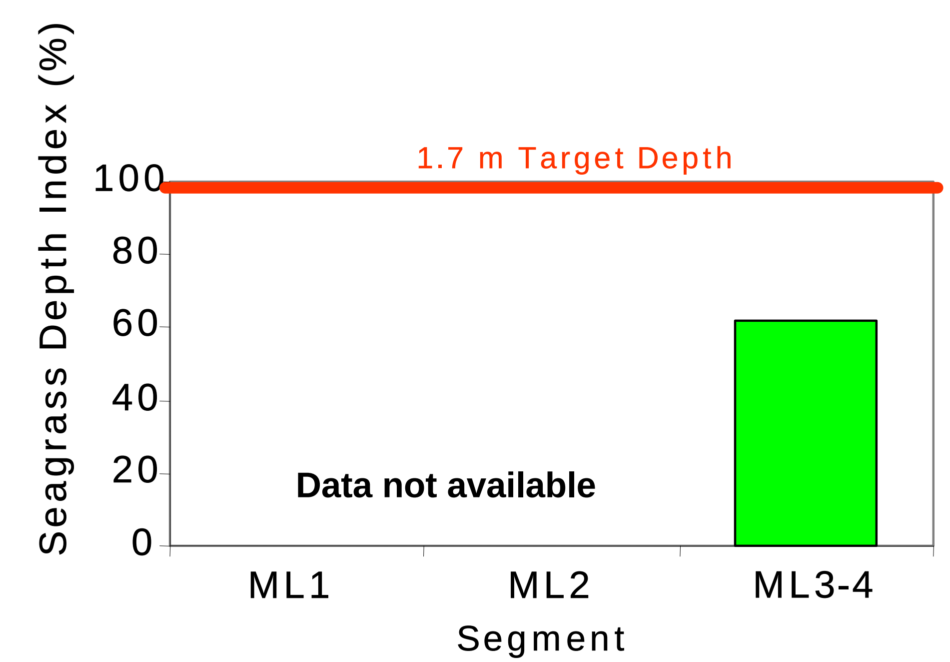


Figure 3-1d. Average Seagrass Depth Index = depth of edge of bed as a percent of 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

Table 3-1. General classification of Mosquito Lagoon segments – Good, Fair, or Poor

Classification is based on the following indices or criteria: % surface light @ 1.7 m, seagrass depth index or SDI (a measure of the depth extent of seagrass relative to the target depth of 1.7 m; see Figure 3-1d), and percent loss of seagrass since 1943 (= 50% and = 75%). Any segment receiving 3 or more marks is classified as Poor, 2 marks indicate Fair, and 1 mark or less is Good.

Mosquito Lagoon Segments	= 20% of surface light @ 1.7 m	SDI = 75%	loss since '43 = 50%	loss since '43 = 75%	Classification
ML1	X	Insufficient Data	X	X	Poor
ML 2	X	Insufficient Data			Fair, possibly Good
ML 3-4	X	X			Fair

So, why does seagrass coverage in southern Mosquito Lagoon remain so extensive and stable? The answer is probably related to its shallowness. Mosquito Lagoon is less than 1.3 m or 4 ft average depth; whereas the other lagoons average 2 to 2.4 m in depth. Mosquito Lagoon's broad shallow flats allow extensive seagrass coverage. Nearly all the seagrass coverage is ≤1.2 m in the southern reach (ML3-4; see Figure 3-1d) and ≤0.3 m in the central reach (ML2). But, this shallow depth, combined with a broad fetch, may lend itself to frequent wind-induced re-suspension of sediment, exacerbating turbid conditions and the attenuation of light. Nonetheless, the amount of light available throughout the expansive shallows is still enough to maintain a large coverage of seagrass.

Water Quality Assessment

Mosquito Lagoon, along with the South IRL, exhibited the highest 10-year average salinities – 31 to 33 ppt -- of any area in the IRL system (Figure 3-2a). There was also fairly strong temporal stability in salinity in Mosquito Lagoon. The slight decline in salinity that did occur from 1994 to 1996 was probably a response to the more protracted higher rainfall levels during that time (Figure 3-2e). In general, salinity remains consistently high and is not a problem relative to seagrass growth.

Color also increased during 1994 – 1996 (Figure 3-2a); a good indication that the higher rainfall levels induced higher land runoff input to Mosquito lagoon. Furthermore, color has been gradually increasing over the years. That may be a natural response to the general increase in annual rainfall (runoff) since the late 1980s (Figure 3-2e). This trend is noticeable in the southern Mosquito Lagoon (ML3-4), where, since 1996, color levels have been above 20 pcu nearly as often as they have been below that level (Figure 3-2b). The implications of this trend with respect to light limitation may be as important as for other optical pollutants, like turbidity and TSS.

As stated above, turbidity is an important factor limiting light in Mosquito Lagoon. Mosquito Lagoon's 10-year average turbidity is >6 ntu, higher than most other IRL areas. Turbidity appears to be strongly influenced by TSS.

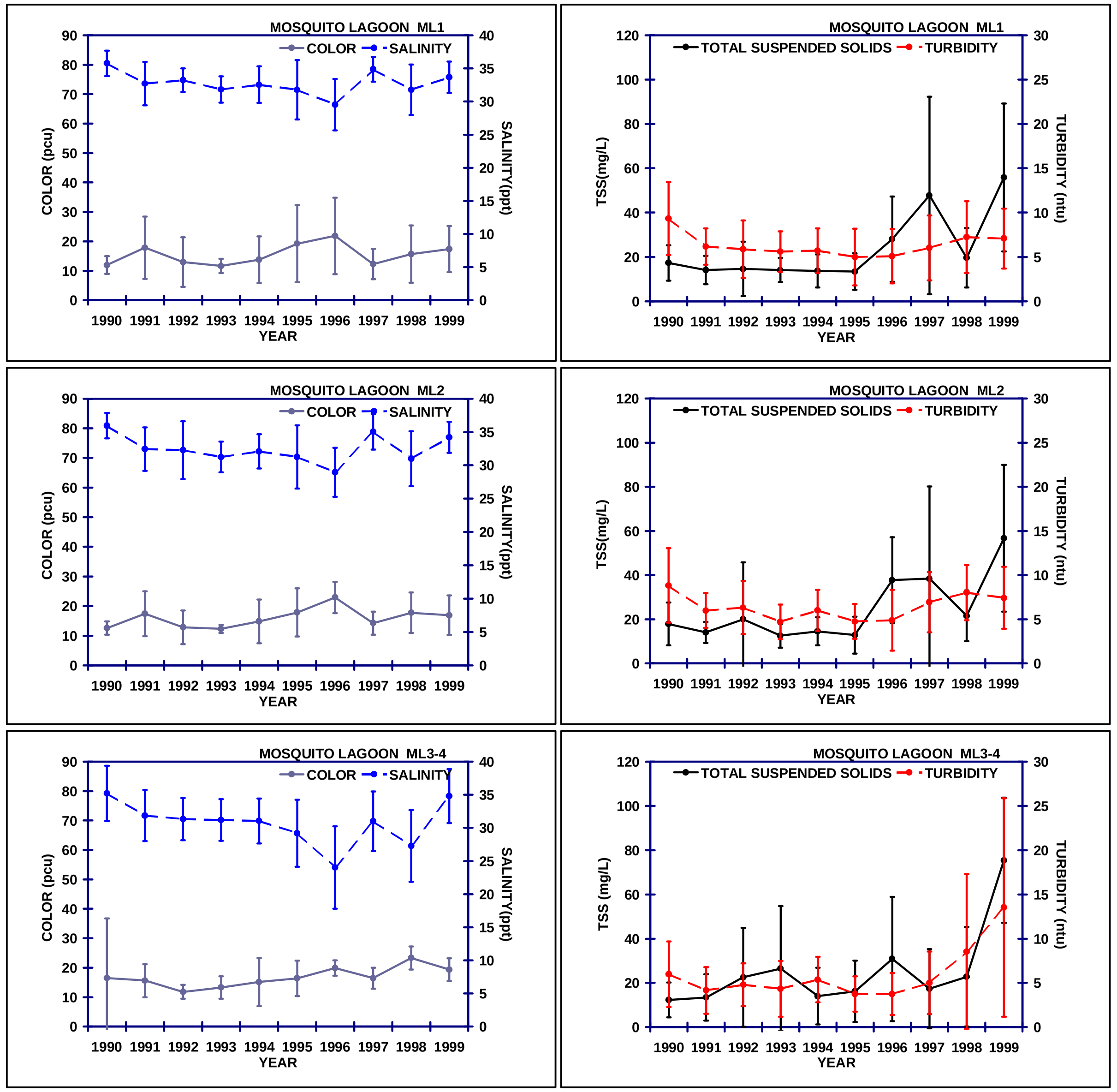


Figure 3-2a. Temporal distribution of color, salinity, TSS and turbidity in the Mosquito Lagoon ($\overline{x}$ ± 1sd, 1990-1999 period of record).

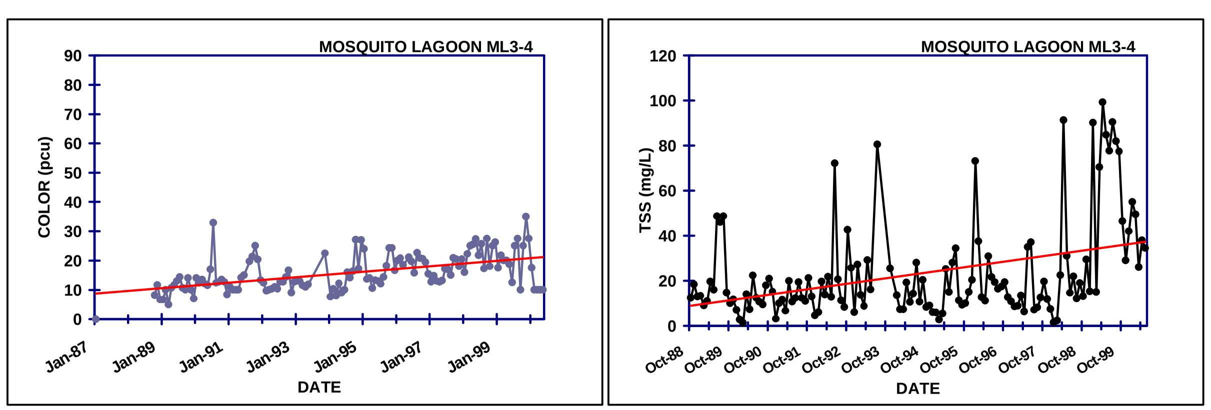
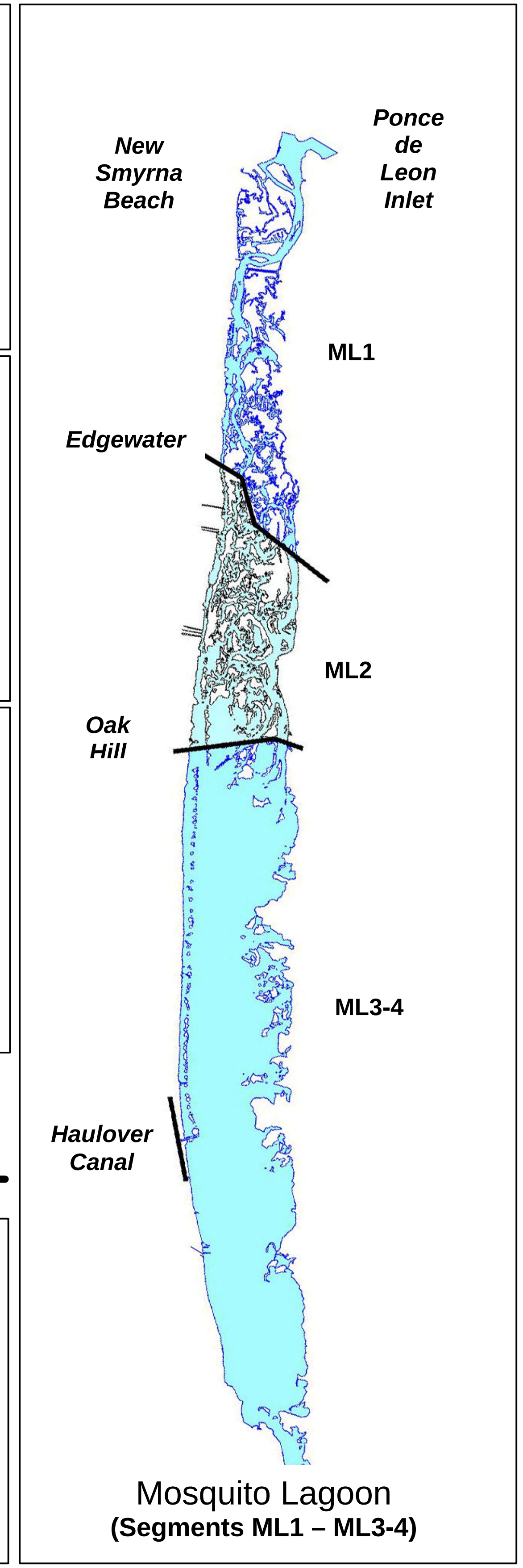


Figure 3-2b. Increasing trends in color and TSS in the southern reach of Mosquito Lagoon (monthly data with trendlines).



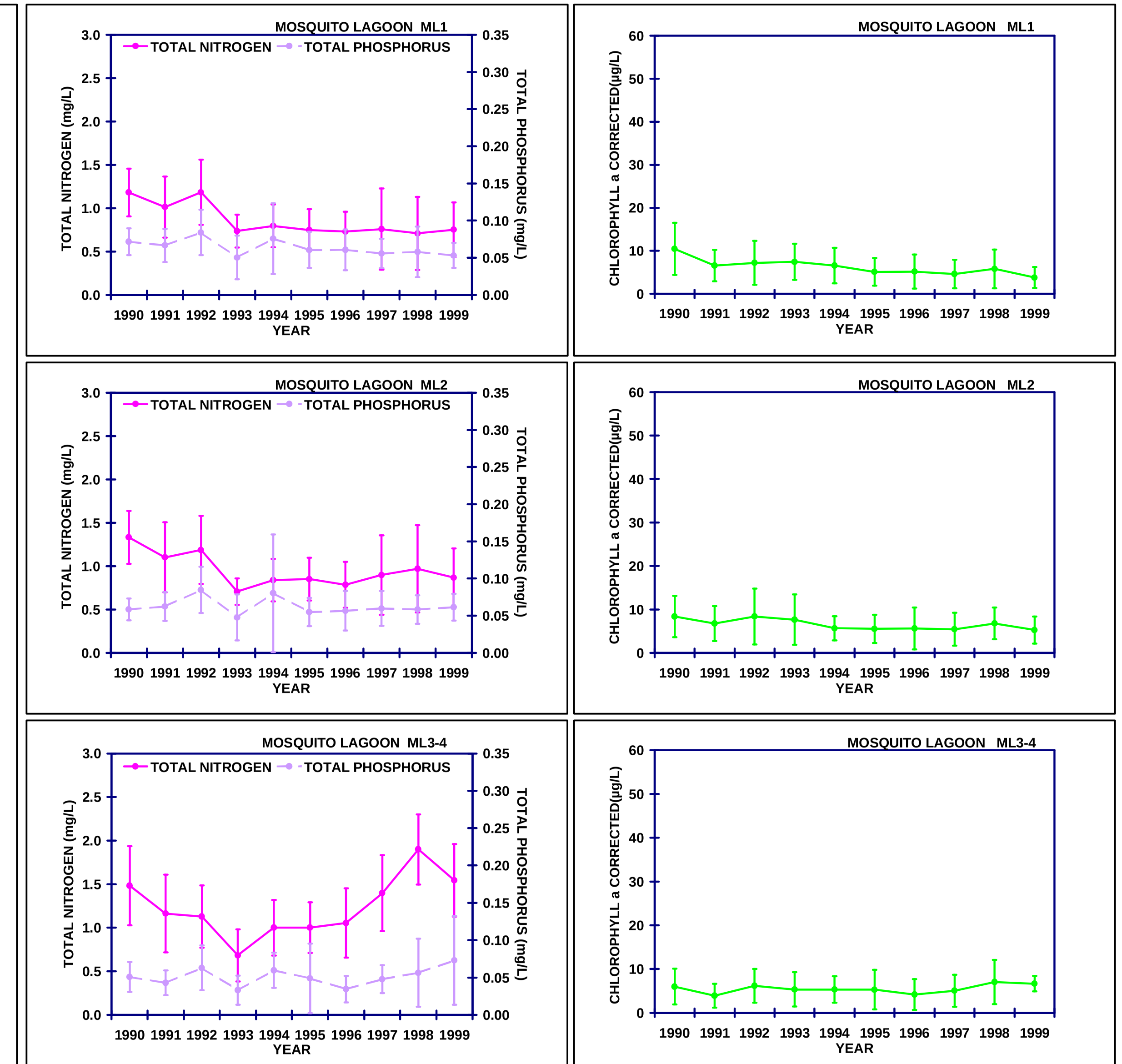


Figure 3-2c. Temporal distribution of total nitrogen, total phosphorus and chlorophyll *a* corrected in the Mosquito Lagoon ($\overline{x}$± 1sd, 1990-1999 period of record).

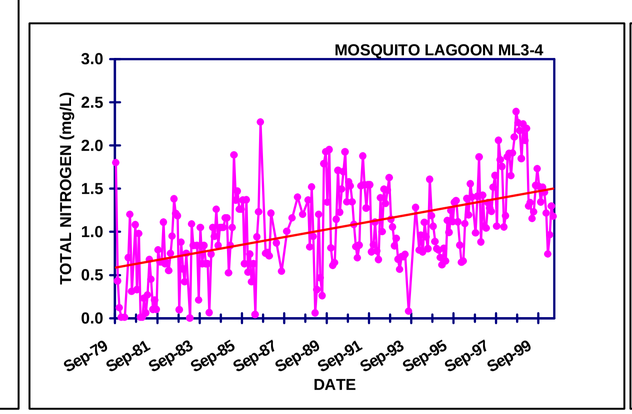


Figure 3-2d. Increasing trend in TN in the southern reach of Mosquito Lagoon (monthly data).

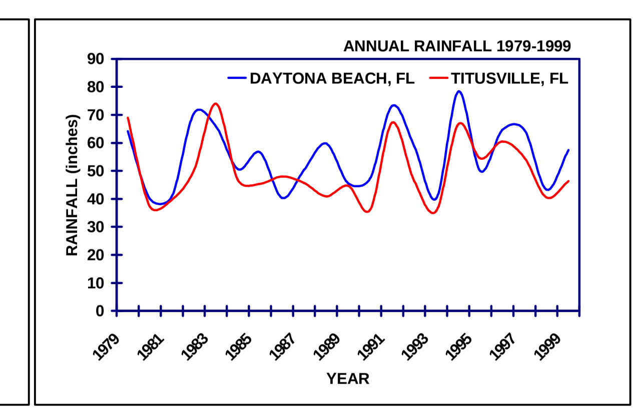


Figure 3-2e. Annual Rainfall since 1979 near the Mosquito Lagoon.

If TSS levels in Mosquito Lagoon can be kept low, turbidity should follow suit. Unfortunately, between 1995 and 1999, TSS levels generally increased, as did turbidity (Figure 3-2a). In 1999, the average TSS levels in the Mosquito Lagoon skyrocketed to >50 mg/l, about 3 times pre-1996 levels.

Perhaps as troubling as the increasing TSS trend, is the increase in TN levels in the southern Mosquito Lagoon from 1996 to 1999 (ML3-4) (Figure 3-2c and d). Even so, these TN levels have not promoted a similar phytoplankton (chlorophyll *a*) response. It is fortunate that chlorophyll *a* levels have remained relatively low and stable over the last 10 years (mean annual concentrations are ~5 to 6 µg/l, and below 6.7 µg/l provisional mean annual threshold). Nonetheless, considering that there may be a trend in increasing TN levels and that chlorophyll *a* (phytoplankton) concentration is a light-limiting co-factor with turbidity, better nutrient management in the Mosquito Lagoon basin is warranted[1].

It is possible that nitrogen has always been in abundant supply for phytoplankton growth. Nitrogen was often not the limiting nutrient in Mosquito Lagoon during a study conducted by Phlips et al. (2000). According to that study, phosphorus was revealed to be the "primary limiting nutrient or became limiting after the depletion of surplus nutrients." What that means is that Mosquito Lagoon may be sensitive to elevated inputs of phosphorus, even periodic "pulsed" loadings that would occur during and after storm events. Such an effect may be even more pronounced in developed or developing areas where land-use intensification and phosphorus loading are correlated (Perlstein, 1981). It's possible that chlorophyll *a* levels have remained low, despite elevations in TN, because the majority of TN is organic and less bioavailable than inorganic N and/or there were no increased phosphorus inputs sufficient to trigger higher phytoplankton densities.

Summary of Assessments

Mosquito Lagoon's shallow depth (average1.3 m or 4 ft) allows expansive coverage of seagrass, but its shallowness can also make it susceptible to elevated turbidities, maybe more susceptible than other IRL areas. Additionally, enrichment of nutrients is a special concern in the southern reach where the residence time may be on the order of 2 to 3 months in contrast to the northern reach where it's less than 1 month. We may now be seeing evidence of water quality decline as demonstrated by increases of TN, TSS, and color from 1995 through 1999. It's difficult to discern whether this is beginning to have a major impact on seagrass or not. But, we need to assume that the threshold of impact is near – the caution flag for Mosquito Lagoon has been raised.

[1] Large accumulations of unattached macroalgae (seaweed) observed in Mosquito Lagoon may also be an indication of excess nutrients, most likely nitrogen.

Progress on Projects

Strategies for Pollutant Load Reduction. It's becoming more evident that improvement in soil retention and nutrient management practices will play a significant role in improving water clarity conditions in the Mosquito Lagoon. Annual average pollutant loads of nutrients and TSS from non-point sources have increased about 1.5 times since 1943 (Figure 3-3). Pollutant loads will continue to increase with development if no further action is taken to ensure retrofit projects and best management practices are permanent fixtures in both the physical and cultural landscapes.

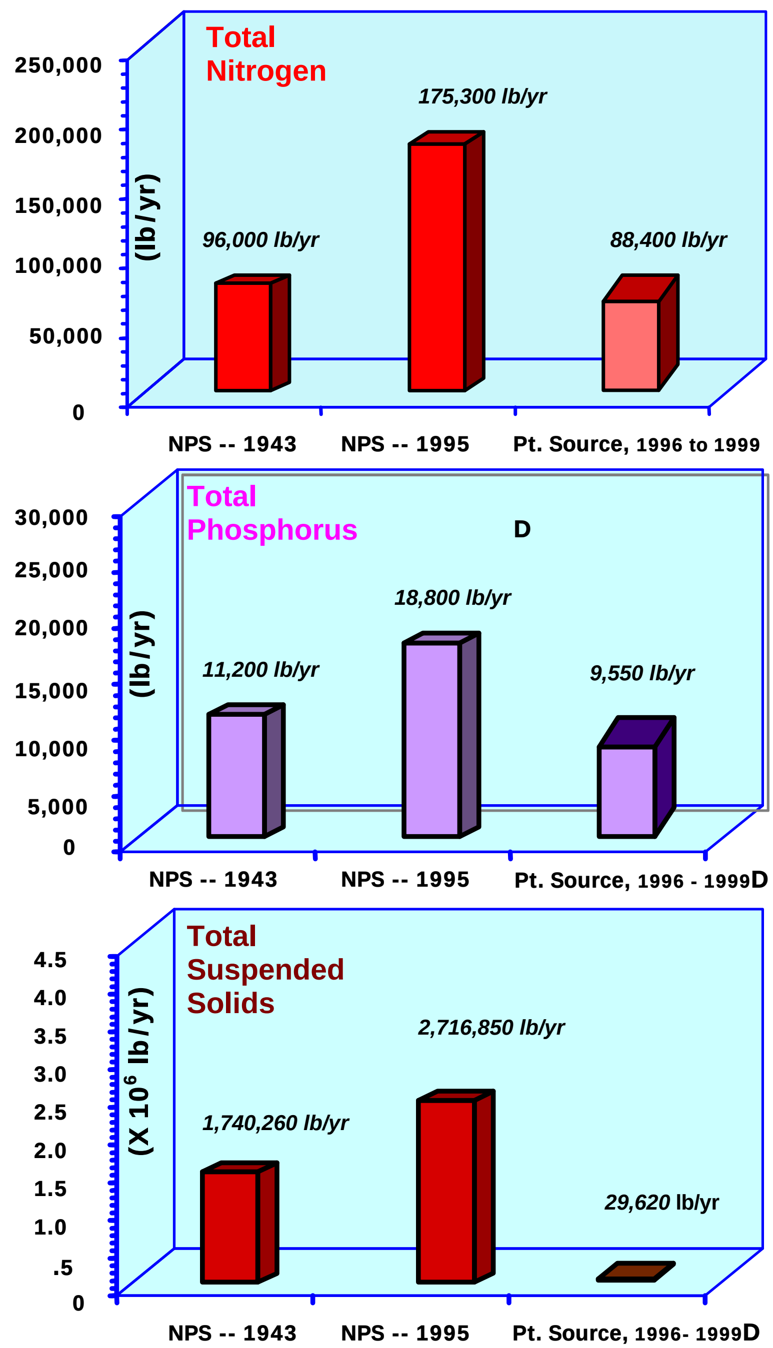


Figure 3-3. Mosquito Lagoon TN, TP, and TSS loading comparisons:

- **1943 vs 1995 Non-point source (NPS) run-off loadings**
- **1995 NPS vs annual point source or domestic WWTP loadings.**

Þ The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.

*NPS loadings estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

The District, along with state and federal partners, and local governments -- Volusia County, New Smyrna Beach (and adjacent barrier island communities), Edgewater, and Oak Hill – must re-vitalize or strengthen cooperative efforts toward that end.

Non-Point Source Strategy -- Stormwater. Volume reduction and treatment of surface water drainage, particularly urban runoff, are the major elements of the non-point source campaign in Mosquito Lagoon. Since the early 1990s, this campaign has focused on urban projects, primarily in New Smyrna Beach and its adjacent residential/commercial sub-divisions (refer to 1994 IRL SWIM Plan, Table 7, p. 49). More recent projects in New Smyrna Beach include:

- baffle box installation at intersection of Riverside and Wayne avenues in 1997/98; serving 15 acres of mostly commercial land use
- development of a plan to upgrade the drainage system along Riverside and Magnolia avenues serving 52 acres (construction of catch basins, exfiltration systems, etc.).

Non-Point Source Strategy – Muck. A muck sediment survey conducted in 1989 (Trefry et al., 1990) found no major deposits between New Smyrna Beach and Oak Hill. Three minor deposits were discovered south of Oak Hill in the Intracoastal Waterway (ICW). It is believed that those deposits may be a result of the transport of soil and organic material from the more developed northern and central reaches, and from a nearby drainage canal. Overall, very little muck sediment was found in Mosquito Lagoon during the 1989 survey and, consequently, was not considered to be an important loading source of nutrients to this estuary.

It is anticipated that the U.S. Army Corps of Engineers will eventually dredge the muck material from the ICW as part of its channel maintenance program. According to a statement made by the Florida Inland Navigation District, the dredging of the ICW in Mosquito Lagoon may begin no earlier than 2006 (Canaveral National Seashore Water Resources Management Plan, 2001).

Non-Point Source Strategy – Septic Tanks. Volusia County and the basin's mainland communities should renew efforts to expand centralized wastewater treatment service into areas served by septic tanks or OSDS (on-site disposal systems). In the mid-1990s, the county and New Smyrna Beach were successful in expanding sewer service to the barrier island communities that stretch from Ponce de Leon Inlet to Canaveral National Seashore. This action followed County reports that OSDS on the western side of Rt. A1A were likely contributors of nitrogen and pathogen loads to Mosquito Lagoon. Another report developed by Volusia County and SJRWMD to comply with the IRL "No Discharge" Protection Act (Chapter 90-262, Laws of Florida) found that the potential for OSDS contamination by certain mainland areas is high and those areas should also be considered for "hook-up" as soon as a centralized sewer service is available (Bielby, 1993).

Point Source Strategy – Domestic Wastewater Treatment Plants. By 1996, most of the major domestic wastewater treatment plants (WWTP) in the IRL system fully complied with the IRL "No Discharge" Protection Act. The State of Florida temporarily exempted the New Smyrna Beach and Edgewater WWTPS, allowing these facilities to continue discharging to Mosquito Lagoon[2] until they could implement the necessary treatment system upgrades and reuse plans.

[2] The New Smyrna and Edgewater plants are regulated by FDEP under "water quality-based effluent limitations" or WQBELs and the Florida APRICOT Act.

During the latter half of the 1990s, these two WWTPS discharged a combined annual loading of 88,400 lb of TN, 9,550 lb of TP, and 29,620 lb of TSS (Figure 3-3); which represented, respectively, 39%, 34% and 1% of the estimated total surface water loads to Mosquito Lagoon. However, substantial reductions in these point source loads will be realized over the next few years.

A new advanced WWTP for New Smyrna Beach was recently constructed and will eventually include a large capacity reuse system (6 MGD, nearly 100% of total design capacity). Wet weather (back-up) discharge is allowed, but large reductions in effluent discharge to the lagoon are expected.

The City of Edgewater is presently securing funds to construct a 2.25 million gallon storage tank to contain treated or reclaimed water during wet weather. This water can then be re-used for lawn irrigation during dry conditions[3]. The effect of this reuse is a targeted 34% reduction in annual effluent discharge volume to the Mosquito Lagoon. Eventually the Edgewater plant may have the capability to increase its reuse capacity and, thus, decrease effluent discharge even further.

As monitoring continues and PLRGs are developed, point and non-point source assessments will reveal whether additional pollutant load reductions from either or both sources are necessary.

Monitoring, Modeling, and Applied Studies. The SJRWMD, Volusia County, NASA, and other participating agencies will continue the seagrass and water quality monitoring networks described in Chapter 2 (pp. 2-15 and 2-16). The SJRWMD will also evaluate and refine the monitoring networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Analyses and biennial reporting of monitoring data will key in on those major optical pollutants that are significant in the Mosquito Lagoon; with special attention paid to TSS and nutrients. A re-survey of muck sediments and a reconnaissance of major upland sources of TSS and TN are recommended[4].

The SJRWMD may further investigate possible causes for the dramatic seagrass loss in northern Mosquito Lagoon (ML1). It seems that there may be other factors involved in this area besides those related to light limitation (e.g., hydrodynamics, lack of suitable substrate).

The Pollutant Load Reduction (PLR) Model is scheduled for completion at the end of 2002. That will be followed by the application of the model in the development of recommended *final* PLRGs for Mosquito Lagoon by end of 2004. In the meantime, provisional pollutant load reduction targets based on estimated, c. 1943 loading rates (i.e., provisional “allowable” or desirable loading rates) can be used in stormwater treatment designs. These provisional targets are intended to be conservative and, thus, be used to design municipal or regional stormwater treatment systems that should be able to meet final PLRGs. It is assumed that by meeting c. 1943 loading rates, water

[3] The SJRWMD is contributing $202,000 toward this project; Edgewater $141,815 (total cost = $343,815)

[4] In addition, Lagoon-wide investigations in sediment particle re-suspension and the optical properties of various types of suspended material may provide major clues as to what type of suspended material most influences turbidity and light penetration. That knowledge may be important in targeting tighter controls on very specific sources of TSS.

quality or clarity should improve sufficiently to enable seagrass to expand to the 1943 depth coverage. In the near future, application of the PLR Model will help ascertain whether these provisional targets are reasonable or too stringent.

Table 3-2. Provisional "allowable" loading rates of TN, TP, and TSS for Mosquito Lagoon based on estimated 1943 land cover loading rates (see Figure 3-1 or Figure 3-2 for map location of segments)

Segments	***TN*** lb/ac/yr (total lb/yr)	***TP*** lb/ac/yr (total lb/yr)	***TSS*** lb/ac/yr (total lb/yr)
N. Mosquito Lagoon ***ML1***	2.6 (44,659)	0.30 (5,254)	55 (946,470)
C. Mosquito Lagoon ***ML2***	2.0 (17,520)	0.20 (1,509)	35 (300,685)
S. Mosquito Lagoon ***ML3-4***	1.0 (33,822)	0.1 (4,437)	13 (493,100)

Land Acquisition. Acquiring lands is an important strategy to protect or restore wetlands (refer to the Coastal Wetlands sections in this and other chapters), but it can also be effective in mitigating pollutant loads – present and future. For example, the SJRWMD can assist local governments in acquiring lands that would be a necessary pre-requisite to constructing municipal or regional stormwater treatment systems. And, of course, upland parcels, purchased as a means of acquiring wetlands, can be preserved or managed in ways that will preclude or minimize development and future pollutant load increases.

For specific information on what lands in the Mosquito Lagoon basin are identified for purchase or "less-than-fee" acquisition under the IRL *Blueway* Project, refer to the Coastal Wetlands section in this chapter, pp. 3-15**,** and Chapter 2, Figure 2-11.

Coordination with Other Agency Plans. The IRLNEP, FDEP and EPA (section 319 non-point source reduction grant program), and the SJRWMD jointly review projects and combine cost-share dollars to financially support local projects. This is the case most recently with stormwater projects in New Smyrna Beach (see non-point source reduction strategies above). The SJRWMD will also fund additional local projects deemed appropriate under its local government assistance and IRL license plate programs.

The SJRWMD is encouraged by the planned activities covered in the Canaveral National Seashore's *Water Resources Management Plan* (2001). This plan not only proposes to tackle water resource issues within the Park boundaries -- which covers much of the central and southern Mosquito Lagoon (segments ML2 and ML3-4) -- but also states the need to coordinate with other agencies on improving the management of land use and user activities throughout the watershed to better protect park resources. For example, as stated in its plan, the Park is interested in conducting cooperative studies on possible impacts to seagrass and water quality (e.g., septic tank discharge, and commercial and recreational uses in Mosquito Lagoon). The SJRWMD has reviewed the plan with Park staff for possible collaboration on such studies, particularly those that may help answer some questions relative to the troubling water quality trends revealed in the southern Mosquito Lagoon.

The Next 5 Years

Strategies for Pollutant Load Reduction.

Non-point Source Strategy – Surface Water Drainage. Over the next 5 years, the SJRWMD and IRLNEP will be looking to expand the non-point source program throughout New Smyrna Beach and develop such cooperative projects in other communities, including Edgewater and Oak Hill.

Non-point Source Strategy – Muck. A new bottom survey of muck deposits in the southern Mosquito Lagoon should be conducted within the next 3 years, especially in view of the fact that TSS and TN concentrations showed dramatic increases there in the last few years. The last survey was done 11 years ago. If the new survey reveals an appreciable expansion of muck deposits, then a proposal to accelerate the Intracoastal Waterway (ICW) maintenance schedule can be submitted to the U.S. Army Corps of Engineers (USACE). The USACE has scheduled maintenance dredging of the ICW over the next 4 to 5 years (contingent upon congressional appropriations). However, the new bottom survey and the USACE/District IRL-North Feasibility Study may serve to accelerate the schedule and/or leverage a specific budget appropriation.

Non-Point Source Strategy – Septic Tanks (a.k.a. OSDS). Volusia County and the mainland communities such as Oak Hill should renew efforts to expand centralized wastewater treatment service into septic tank or OSDS areas. The potential for OSDS contamination by certain mainland areas is high and those areas should also be considered for "hook-up" as soon as a centralized sewer service is available (Volusia County, 1993).

Point Source Strategy – Domestic Wastewater Treatment Plants. The two WWTPS temporarily exempted from the IRL "No Discharge" Act[5] -- New Smyrna Beach and Edgewater – intend to comply in the near future as soon their treatment system upgrades are constructed and reuse systems are functional. The anticipated reductions in pollutant loadings from these WWTPs will mean that point source loadings to the Mosquito Lagoon could be regarded as negligible. Water quality restoration efforts can then focus on the management of surface water drainages and the Lagoon's internal processes that may exacerbate turbidity levels.

Monitoring, Modeling, and Applied Studies. The SJRWMD, Volusia County, and NASA will continue the seagrass and water quality monitoring networks. The SJRWMD will also evaluate and refine the networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Periodic reporting of status and trends will key in on those major optical pollutants that are significant in the Mosquito Lagoon; with special attention paid to TSS and nutrients. A re-survey of muck

[5] Chapter 90-262, Laws of Florida

sediments and a reconnaissance of major upland sources of TSS and TN are recommended[6].

The SJRWMD may further investigate possible causes for the dramatic seagrass loss in northern Mosquito Lagoon (ML1) near New Smyrna Beach. It seems that there may be other limiting factors besides those related to light limitation (e.g., hydrodynamics, unstable sediments, dredged depths below 1.7 m).

The PLR Model is scheduled for completion at the end of 2002. That will be followed by the application of the model in the development of *final* recommended PLRGs for Mosquito Lagoon by end of 2004.

Land Acquisition. For planned activities please refer to the Coastal Wetlands, Land Acquisition section in this chapter, pp. 3-15.

Coordination with Other Agency Plans. The SJRWMD and Canaveral National Seashore will collaborate on seagrass/water quality research as it relates to the causes or processes responsible for the troubling turbidity and nitrogen levels in the southern Mosquito Lagoon. The IRL-North Feasibility Study (USACE and SJRWMD, 2002) may offer additional federal support for recommended research as well as for remedial action, for example, muck removal from the Intracoastal Waterway.

Table 3-3. The 5-Year Plan List of Seagrass and Water Quality Projects for the Mosquito Lagoon

- **Continue monitoring in the Mosquito Lagoon as part of the Lagoon-wide monitoring networks***
    - **Water Quality Monitoring (Volusia County, NASA, SJRWMD)**
    - **Seagrass Mapping and Field Monitoring**
    - **Meteorological Monitoring**
    - **Hydrodynamic Monitoring**
    - **Atmospheric Nutrient Deposition Monitoring**
- **Develop final PLRGs by 2004**
- **Implement non-point, surface water projects aimed at reduction of nutrient and TSS loadings (Volusia County, New Smyrna Beach, Edgewater, and Oak Hill)**
- **Re-survey muck deposition areas**
- **Continue periodic inventory of domestic WWTPs**
- **Continue to support actions by local gov'ts and Canaveral National Seashore in the remediation of septic tank contamination areas (potential or actual)**
- **Pursue acquisition of lands identified under the *Blueway* program**
- **IRL – North Feasibility Study (USACE/SJRWMD)**
- **Identify major constituent(s) that contribute to Mosquito Lagoon's turbidity**
- **Identify other factors that could limit seagrass distribution, especially in segment ML1 (other than turbidity/light)**

*** descriptions of monitoring networks are found in Chapter 2, and listed in Table 2-4.**

[6] In addition, Lagoon-wide investigations in sediment particle re-suspension and the optical properties of various types of suspended material may provide major clues as to what type of suspended material most influences turbidity and light penetration. That knowledge may be important in targeting tighter controls on very specific sources of TSS.

Coastal Wetlands

Mosquito Lagoon contains about 20,000 acres of salt marsh wetlands. Over 6,750 acres of marsh is impounded; the remaining acreage is the largest un-impounded acreage in the IRL system (Figure 3-4). Most of the impounded marshes are actively managed by USFWS; the remaining impoundments have been restored or breached and do not require management. The vast majority of the impounded marshes are publicly owned; therefore, private ownership is not an issue in their rehabilitation and management.

Mosquito Lagoon also has the largest acreage of dragline-impacted marsh – nearly 1,300 acres (Figure 3-4). A small portion of these wetlands is privately owned and will probably need to be publicly acquired in order to accomplish any rehabilitation. Rehabilitation of the dragline-impacted wetlands will be jointly managed between SJRWMD and E. Volusia Mosquito Control District.

Progress on Projects

Please refer to the Coastal Wetlands section in Chapter II for a description of the general background and scope of the projects. What is provided below is strictly progress information.

Rehabilitation of Impounded Wetlands. All of the impoundments in Mosquito Lagoon outside of the Merritt Island National Wildlife Refuge have been breached or reconnected. Within the Refuge-managed area of Volusia County, four of the impoundments were restored (V-1, V-2, V-5, and T-45) and the remaining two will be reconnected (V-3 and V-4). With the exception of T-39 (restored), all of the barrier island impoundments in Mosquito Lagoon/Brevard County are targeted for future reconnection or restoration. The impoundments around the south and west shores of Mosquito Lagoon (T-27s in Brevard County) were reconnected.

In summary, about 4,420 acres of wetlands were reconnected, breached, or restored in Mosquito Lagoon.

Wetlands Management Research Initiative. Even though the Research Initiative is not being conducted in Mosquito Lagoon, its results and recommendations can be considered in the management of reconnected impoundments throughout Mosquito Lagoon.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. The pilot project to evaluate equipment and technique options in the rehabilitation of dragline-ditched wetlands should be completed by the time this plan update is published. The pilot project takes in Orange and Porkchop islands in Mosquito Lagoon, a combined area of 56 acres. The pilot project will provide practical results that will be applied to the planning of full-scale operations in Mosquito Lagoon. These operations will rehabilitate the 1,291 acres of dragline-ditched island wetlands in Mosquito Lagoon (Figure 3-4).

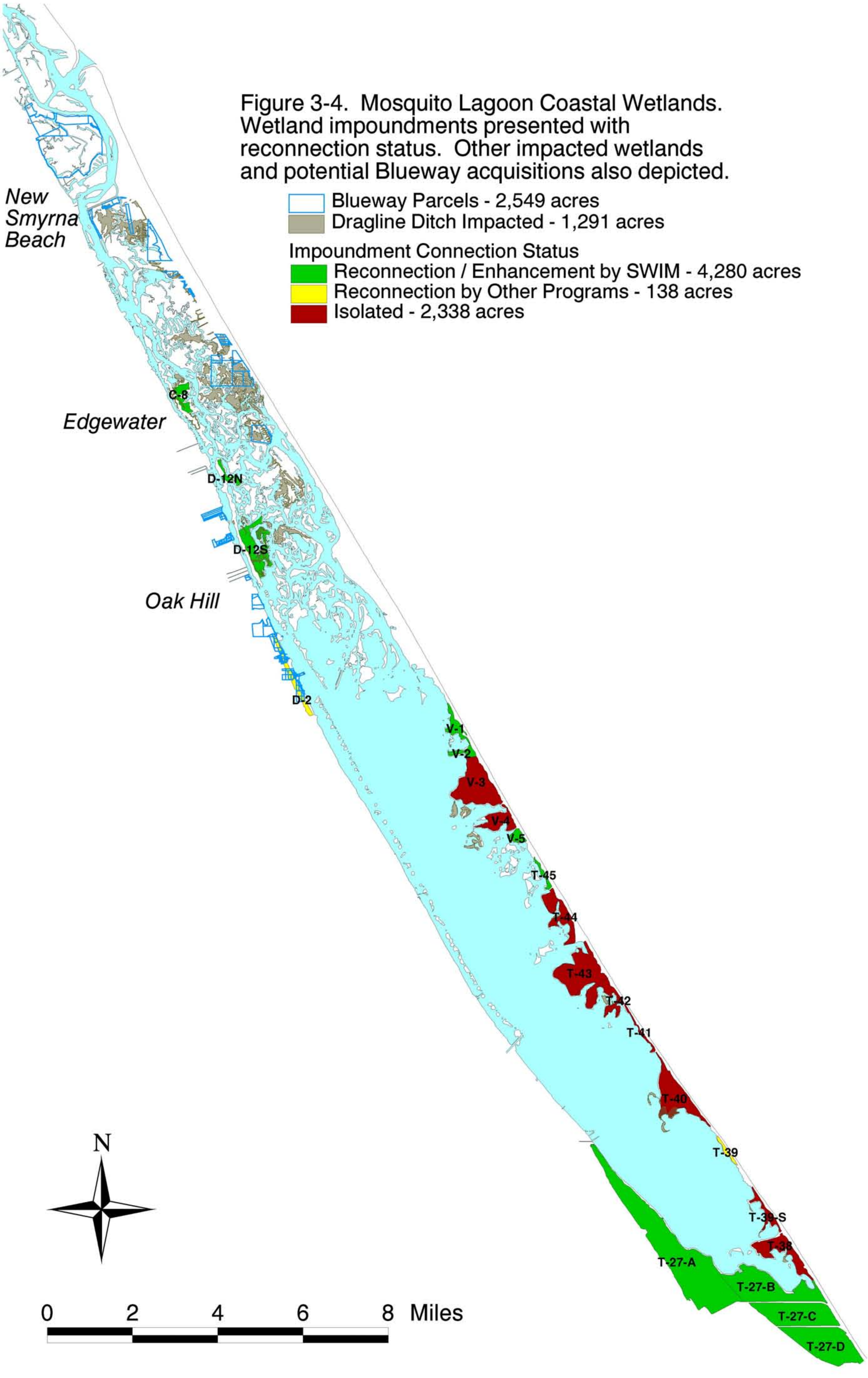


Figure 3-4. Mosquito Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.

Creation of Shoreline Vegetative Habitats. The project dealing with red mangrove (*Rhizophora mangle*) plantings is not conducted in Mosquito Lagoon because this area is the species' northern limit in range. Plantings of red mangrove may not survive the colder winters in Mosquito Lagoon and North IRL as compared to milder winters in Central and South IRL.

Relatively small planting projects involving cordgrass (*Spartina alterniflora*) and black mangrove (*Avicennia germinans*) have taken place as part of some stormwater treatment/erosion control projects (e.g., New Smyrna Beach Riverside Drive projects).

Preservation of Existing Wetlands – Land Acquisition. Most of the wetlands are in public ownership; therefore, land acquisition is not a major issue in Mosquito Lagoon as it is in the Indian River proper. Nonetheless, there are 2,549 acres of wetlands in the North and Central Mosquito Lagoon included in the IRL *Blueway* Project (Figure 3-4). In 1999, SJRWMD entered into a contract with The Nature Conservancy to provide assistance with this acquisition program. Though no properties have been purchased under the *Blueway* Project to date, owner responses indicate a high percentage of willing sellers. A map of land parcels identified for potential acquisition under *Blueway* is also found in Chapter 2, Figure 2-11.

<u>The Next 5 Years</u>

Rehabilitation of Impounded Wetlands. The goal over the next 5 years is to reconnect all the remaining isolated impoundments on the barrier island in Mosquito Lagoon – over 2,300 acres. The objective for the next year or two is to complete the work in on the "V" impoundments currently under contract with the U.S. Fish and Wildlife Service and E. Volusia Mosquito Control District.

Wetlands Management Research Initiative. The same agencies that manage wetlands in Mosquito Lagoon are involved in or are being made aware of the Research Initiative: USFWS, Canaveral National Seashore, and E. Volusia Mosquito Control District. These agencies can readily apply the research findings to their respective management policies and programs that affect impounded wetlands in this lagoon. It is expected that they will participate in the development of final management recommendations, which should begin within the next 3 years.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. A plan to rehabilitate ~1,290 acres of dragline-ditched impacts in Mosquito Lagoon should be developed within the year. The plan will scope out what can be practically achieved within budget year time frames. It's possible that the USACE, under the IRL-North Feasibility Study, may be able to significantly contribute toward this project. But it's not possible at this time to realistically determine how much of the plan can be implemented in 5 years. Some of the impacted wetlands are privately held and will need to be acquired to enable their rehabilitation.

Creation of Shoreline Vegetative Habitats. There are no plans (nor a compelling reason) for creating wetland habitat or conducting any major planting in Mosquito Lagoon.

Preservation of Existing Wetlands – Land Acquisition. The objective for the next five years is to acquire as much of the 2,549 acres of wetlands identified in the *Blueway* Project plan. Acquisition support services should be maintained to help ensure success. There are several willing sellers that could be contacted to negotiate acquisition agreements.

Table 3-4. The 5-Year Plan List of Coastal Wetland Projects for the Mosquito Lagoon

- **Reconnect/restore all remaining isolated impoundments (~2,300 acres)**
- **Initiate a plan to rehabilitate the ~1,290 acres of dragline-impacted wetlands**
- **Elicit federal support of wetland restoration activities via the USACE/SJRWMD IRL-North Feasibility Study**
- **Pursue acquisition of the 2,549 acres of wetlands and uplands identified under the *Blueway* program**

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CHAPTER 4. BANANA RIVER LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The status assessment of Banana River Lagoon's seagrass resource is based largely on the same measurement indices used in the Lagoon-wide and other sub-lagoon assessments. These indices are:

- ❖ Acres of seagrass coverage over time (net gain or loss),
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight at the target depth of 1.7 m.

For more information on why and how these measurement indices are used to assess the status of the seagrass resource, refer to Chapter 2, p. 2-3. Major findings about the status of the seagrass resource in Banana River Lagoon are summarized below.

- Banana River Lagoon exhibited stable seagrass coverage throughout the 1990s; even showing remarkable improvement in 1999 (Figure 4-1a and b).
- The north segment of the lagoon (BR1-2) is classified as good (Table 4-1) and is one of the better seagrass resource segments in the IRL system. The north segment is located within minimally developed watersheds, and its bottomland is federally protected, managed by the U.S. Fish and Wildlife Service. Close behind in status is the central segment (BR3-5), also classified as good (Table 4-1). Both segments have experienced little loss of seagrass since 1943 and have, in recent years, reached or exceeded 1943 acreage levels (Figure 4-1a and b).
- The north and central segments (BR1-2 and BR3-5) have good to excellent seagrass coverage because the deep edge of seagrass is close to the potential target depth (Figure 4-1d). The target depth of 1.7 m is not fully attained probably because the sub-surface light level at that depth falls short of the preliminary minimum '25%' requirement (BR1-2 and BR3-5 each receive 18% of surface light at 1.7 m; BR6 and BR7 receive 14% and 15%, respectively; see Figure 4-1c).
- The worst segment in Banana River Lagoon is the Newfound Harbor/Sykes Creek area (BR6). Not far behind is the south segment (BR7). Both segments are classified as poor (Table 4-1). In both segments, seagrass acreage has diminished more than 50% between 1943 and 1996. Also, the sub-surface light and seagrass depth indices are lower in these two segments than in the north and central segments (Figure 4-1c and d). However, despite their poor status, both segments (BR6 and BR7) showed dramatic gains in seagrass coverage in 1999 (Figure 4-1b).
- In Banana River Lagoon, a notable shift in seagrass species occurred in the latter half of the 1990s. The abundance of *Syringodium filiforme* decreased while *Ruppia maritima* became more abundant (SJRWMD data; Provancha and Scheidt, 2000). *Ruppia* is more tolerant of low salinity, and *Syringodium* is the least tolerant of the species found in this Lagoon[1]. The species shift was observed during a time of low

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[1] Four species of seagrass are found in Banana River Lagoon: *Halodule wrightii, Syringodium filiforme, Ruppia maritima*, and *Halophila engelmannii*.

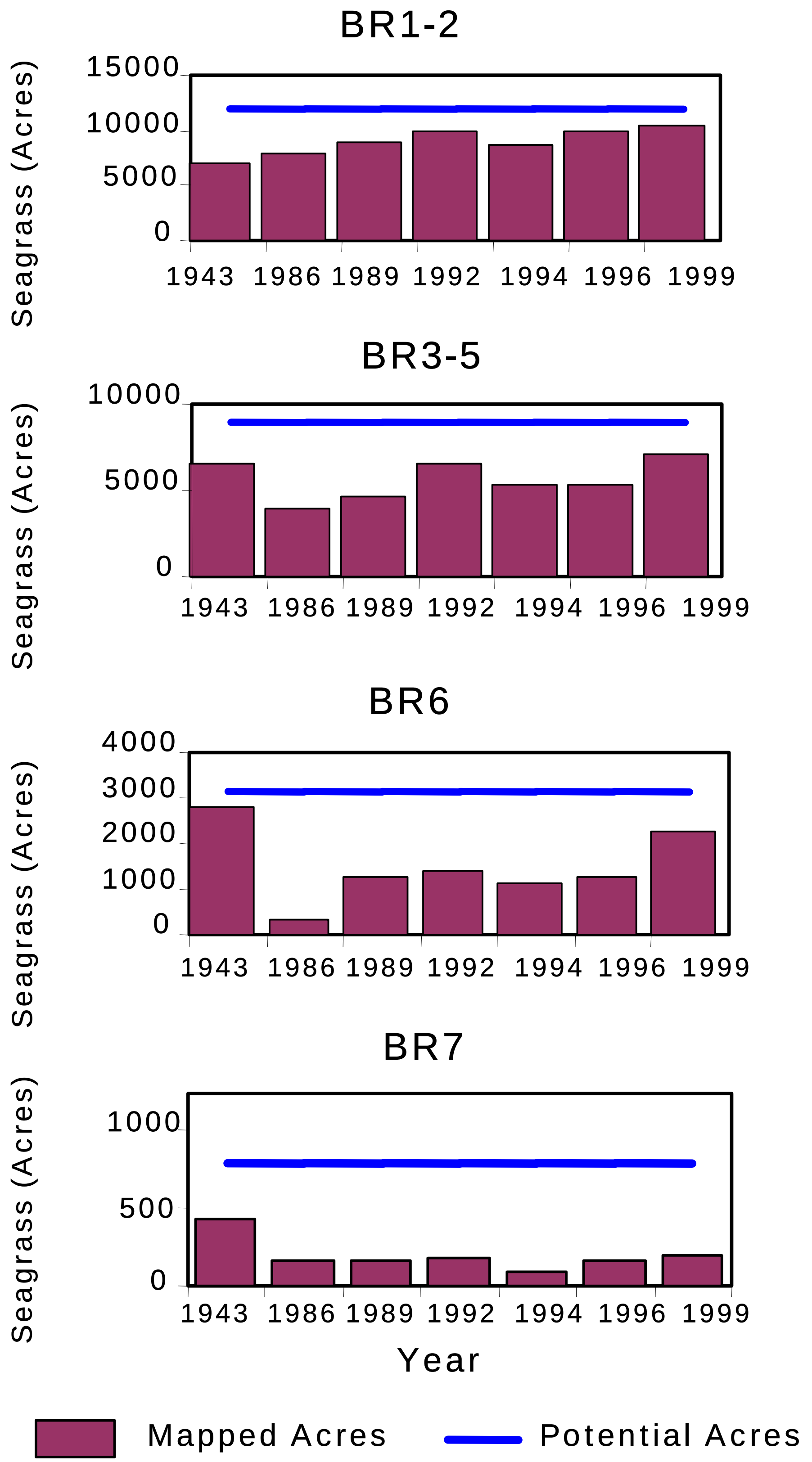

Figure 4-1 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note general long-term stability in segments BR1-2 and BR3-5 and a pattern of recovery from 1994 to 1999 in all segments.

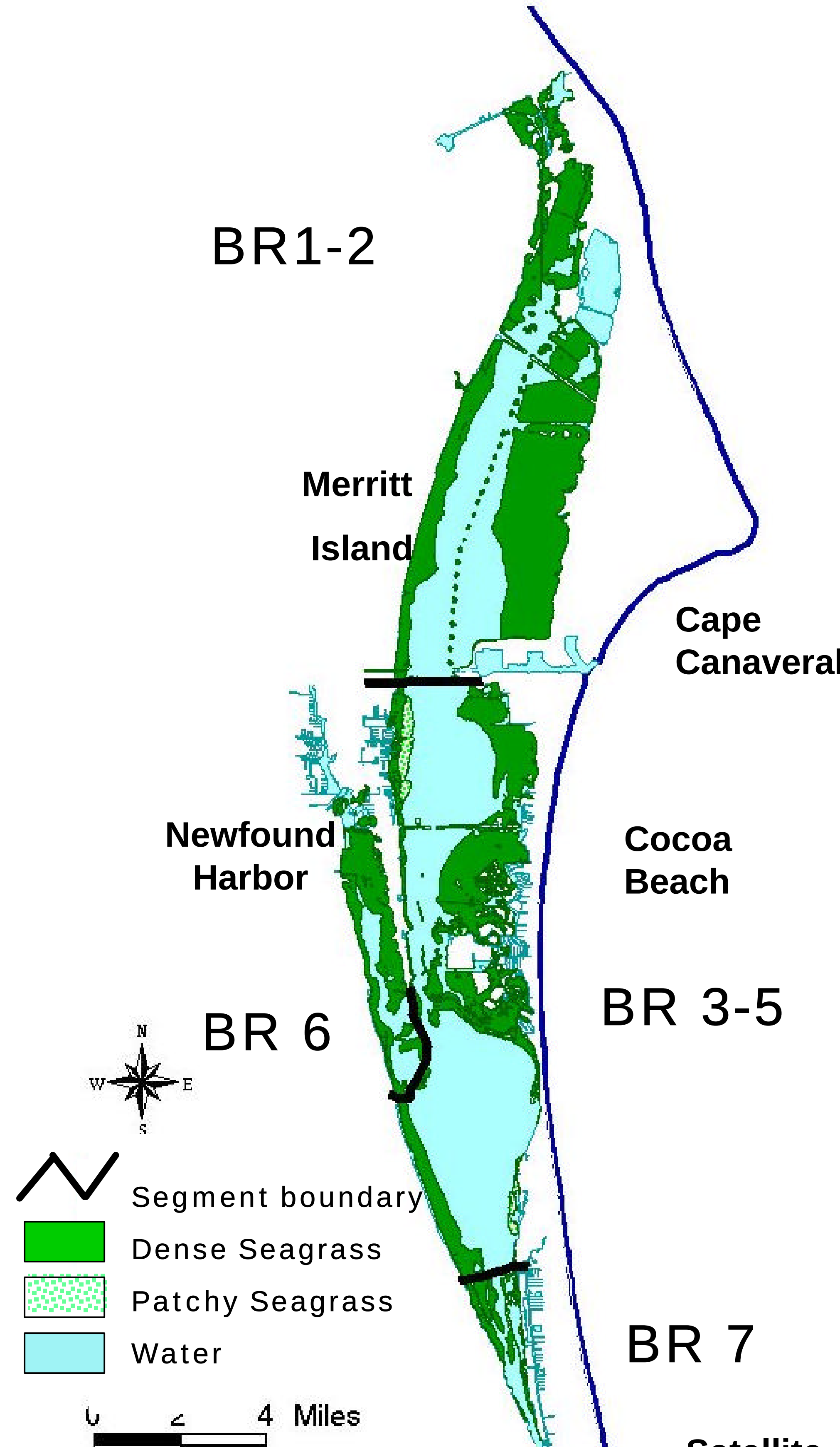

Figure 4-1a. Banana River Lagoon 1999 seagrass coverage and segment boundaries

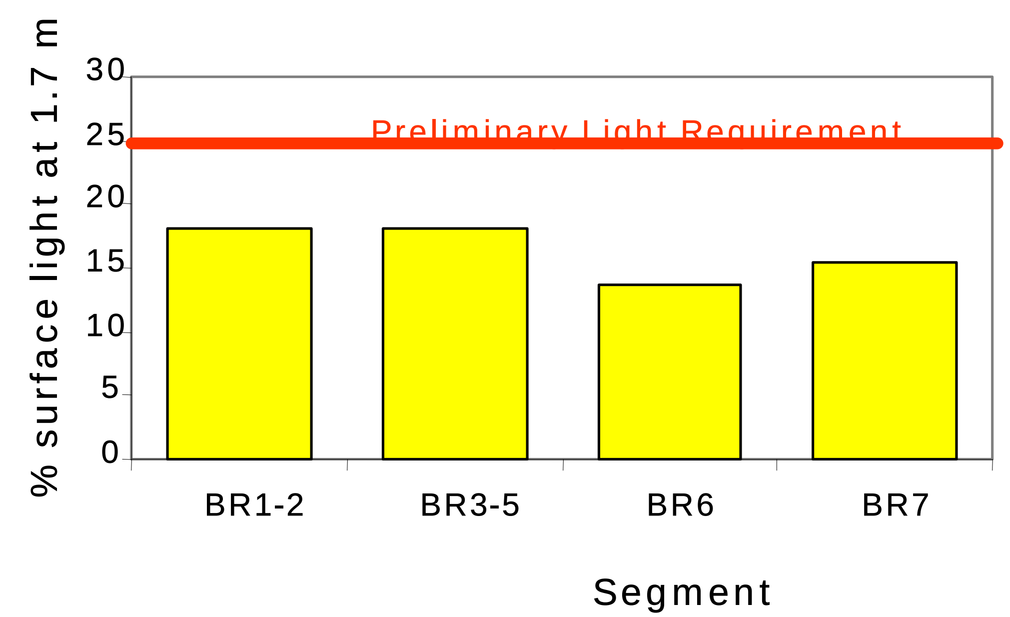

Figure 4-1 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

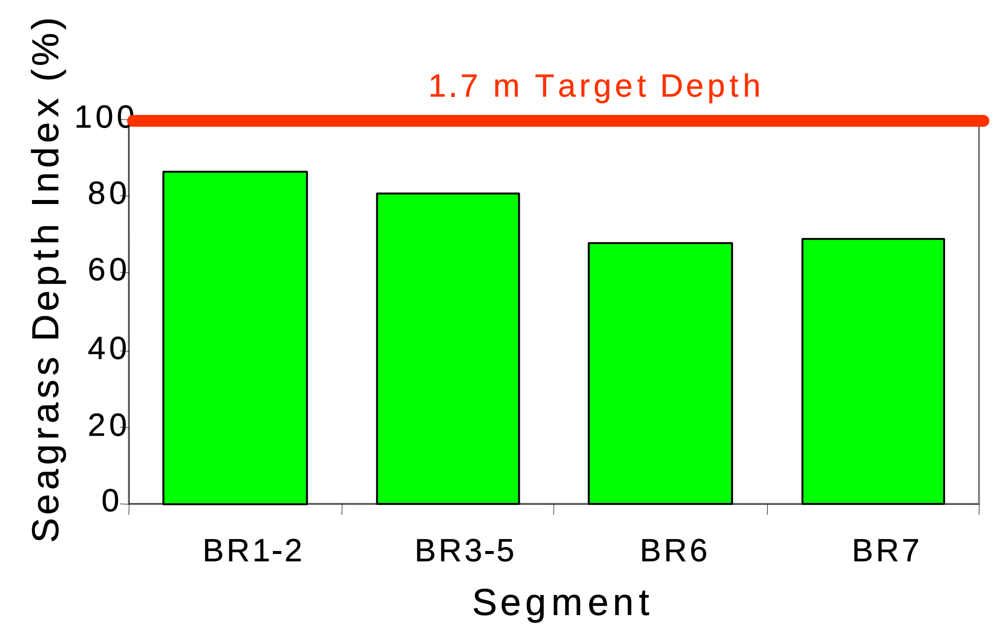

Figure 4-1 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

salinity (annual means <20 ppt). This phenomenon is discussed further in the water quality assessment section below.

Table 4-1. General classification of Banana River Lagoon segments – Good, Fair or Poor

Banana R. Lagoon Segments	= 20% surface light @ 1.7 m	SDI = 75%	loss since '43 = 50%	loss since '43 = 75%	Classification
BR1-2	X				Good
BR3-5	X				Good
BR6	X	X	X		Poor
BR7	X	X	X		Poor

Classification is based on the following indices criteria: % surface light @ 1.7 m (see Figure 4-1c), seagrass depth index (SDI; see Figure 4-1d), and % loss of seagrass since 1943: = 50% and = 75%.
Any segment receiving 3 or more marks is classified as poor, 2 marks fair, 1 mark or less good.

The Banana River Lagoon segments are fairly shallow (2 m average depth) and the most poorly flushed in the IRL system. It is estimated that it takes nearly 2 years for a complete turnover of water volume to occur throughout this Lagoon (SJRWMD's unpublished PLR Model results)[2]. Because it is shallow and poorly flushed, Banana River Lagoon may be quite susceptible to harm from pollutant loading. This susceptibility is probably best demonstrated in Newfound Harbor (BR6) and the south segment (BR7) where substantial seagrass loss has occurred in contrast to more stable seagrass coverage observed in the north and central segments. There are a few possible factors that may explain why this is the case.

-- The north segment (BR1-2) is largely undeveloped, and human activities are restricted (for example, the area is a powerboat exclusion zone).

-- The central segment (BR3-5), although developed, has a relatively small watershed and low runoff volume relative to its large receiving water volume.

-- Wind-forced circulation in these large open segments may play a more significant role in dispersing pollutants and reducing the build-up of organic material and muck sediments than is the case in the smaller, more confined areas of Newfound Harbor (BR6) and the south segment (BR7).

-- The central segment is host to a large abundance of drift macroalgae (4 to 100 times the drift algae biomass found in the other segments, 1997 - 1999, SJRWMD data). Macroalgae function well as a nutrient "sponge" (Davis et al., 1983), thus helping to limit populations of phytoplankton. As a result, the negative impact of phytoplankton as an "optical pollutant", with its attendant effect on seagrass, is minimized.

[2] The Port Canaveral lock system provides only a very minor, intermittent connection between the ocean and Lagoon. Its effect on flushing or hydrodynamics overall in the Banana River Lagoon is considered insignificant.

Water Quality Assessment

The factors listed in the previous section that may help explain why the Banana River Lagoon's north and central segments (BR1-2 and BR3-5) have better seagrass coverage than the Newfound Harbor and south segments (BR6 and BR7) are only marginally reflected in the water quality. Newfound Harbor (BR6) has appreciably higher median color and chlorophyll *a* concentrations than the better segments. The south segment's color and chlorophyll *a* levels are just slightly higher[3]. Otherwise, there are no major differences in the levels of other optical pollutants among the Banana River Lagoon segments.

Statistically, chlorophyll *a* and turbidity/TSS are the primary pollutants, followed by color, that affect light penetration in Banana River Lagoon. Temporal trends for these constituents and nutrients show general stability for most of the Banana River Lagoon through most of the 1990s (Figure 4-2a and b). However, in the north segment, both chlorophyll *a* and color levels recently increased (Figure 4-2a and b, BR1-2), exceeding concentrations in other Banana River Lagoon segments. This downward trend in the north segment is interesting (and hopefully short-lived), given the fact that the poorer segments in Banana River Lagoon are showing some improvement.

The salinity trend in Banana River Lagoon is probably the major story for this lagoon. Salinity levels dropped precipitously in 1995, following heavy rains, and remained low for several years (Figure 4-2a). The lowest sustained salinity levels were measured in the south segment (BR7), commensurate with low levels measured in the contiguous waters of the Indian River near Melbourne (Figure 4-3).

Because Banana River Lagoon is poorly flushed, prolonged salinity drops following or during heavy rainfall can be expected. Annual average rainfall from 1989 through 1994 was just under 48 inches; but from 1995 through 1999, the annual average was 60 inches (National Weather Service, Melbourne Airport). Salinity levels responded in kind, dropping and remaining below 20 ppt from 1995 through 1998 (Figure 4-4). This salinity drop may explain the decline in *Syringodium* coverage and the corresponding increase in *Ruppia*, a species more tolerant of low salinity than other Lagoon seagrasses. Salinity below 20 ppt restricts the growth of most seagrass species found in Banana River Lagoon (except *Ruppia*) (Reid, 1954; Voss & Voss, 1954; Humm, 1956). It is possible that the prolonged period of low salinity may have offset the benefits of any water quality improvements observed in the poor segments (BR6 and BR7), lessening the potential for seagrass expansion. Then, in 1999, salinity increased, fluctuating around 20 ppt. This rebound in salinity along with the water quality improvements may have enabled seagrass coverage to expand that year (Figure 4-1b).

Summary of Assessments

Moderate, but apparently crucial differences in water quality (especially color and chlorophyll a) and sub-surface light conditions exist between Banana River Lagoon's *good* seagrass segments, north and central, and the *poor* segments in Newfound Harbor and the extreme southern end. From 1997 through 1999, the margin of difference

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[3] 10-year medians of color and chlorophyll *a*: *BR 1-2*: 16 pcu and 5 µg/l; *BR 3-5*: 17 pcu and 7 µg/l
BR 6: 25 pcu and 12 µg/l; *BR 7*: 19 pcu and 7.5 µg/l

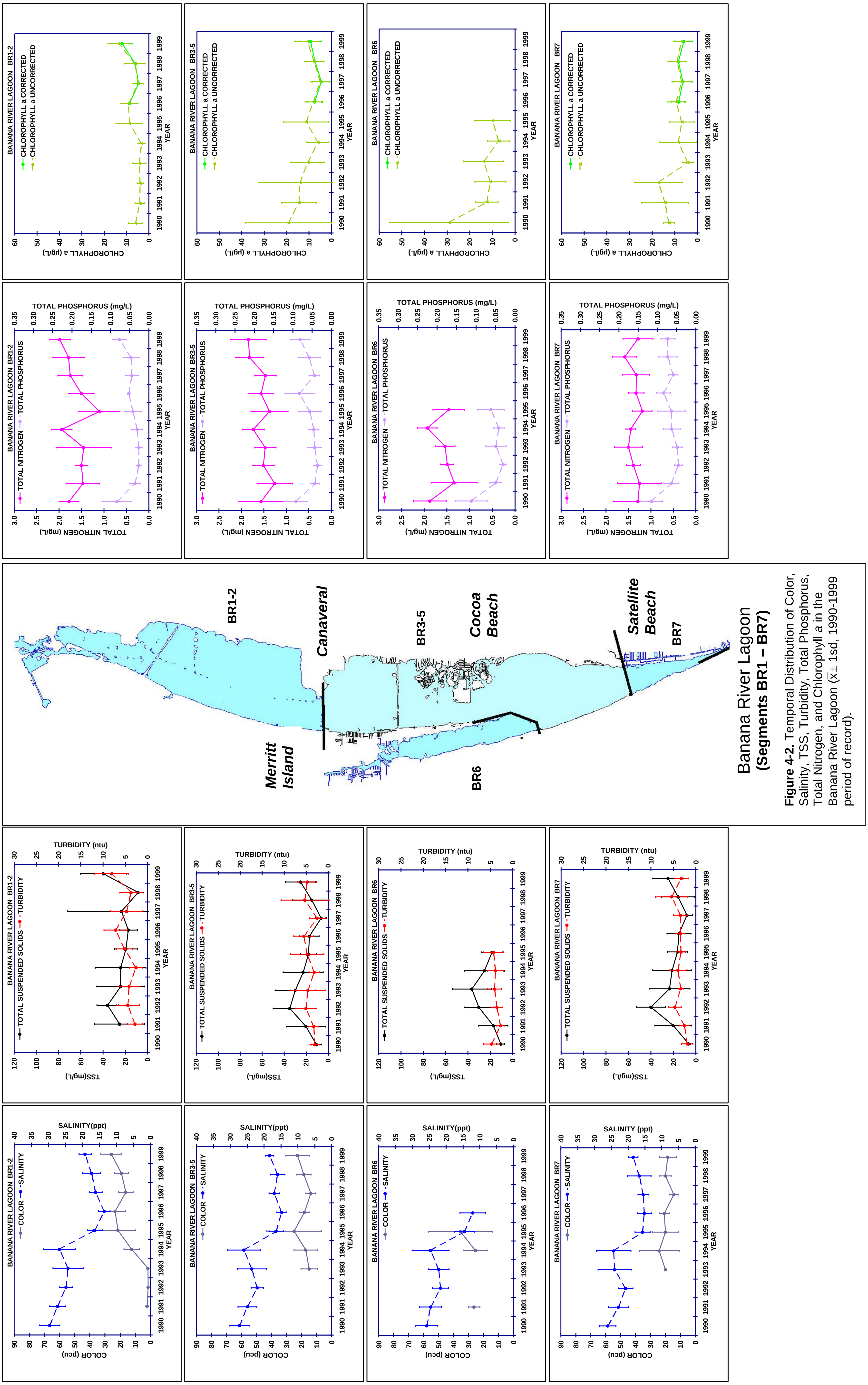

Figure 4-2. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll a in the Banana River Lagoon (X̄± 1sd, 1990-1999 period of record).

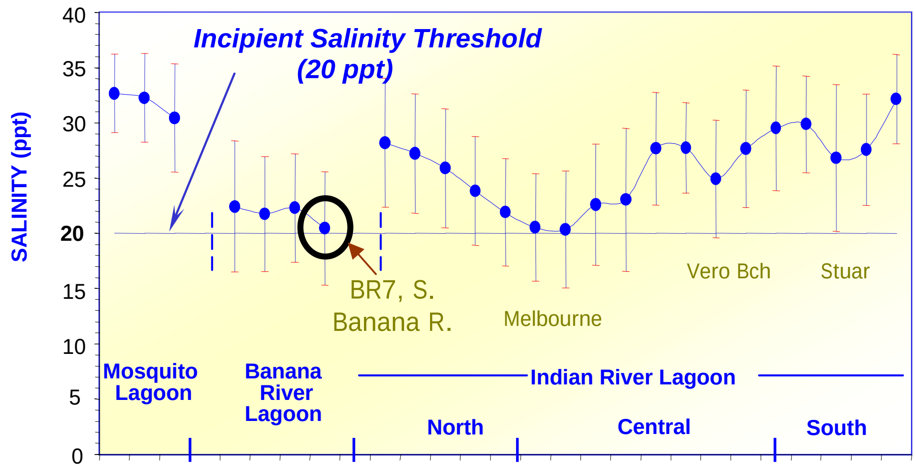

Figure 4-3. North to south distribution of salinity levels in the IRL system (means +/- S.D., 1990 – 1999)

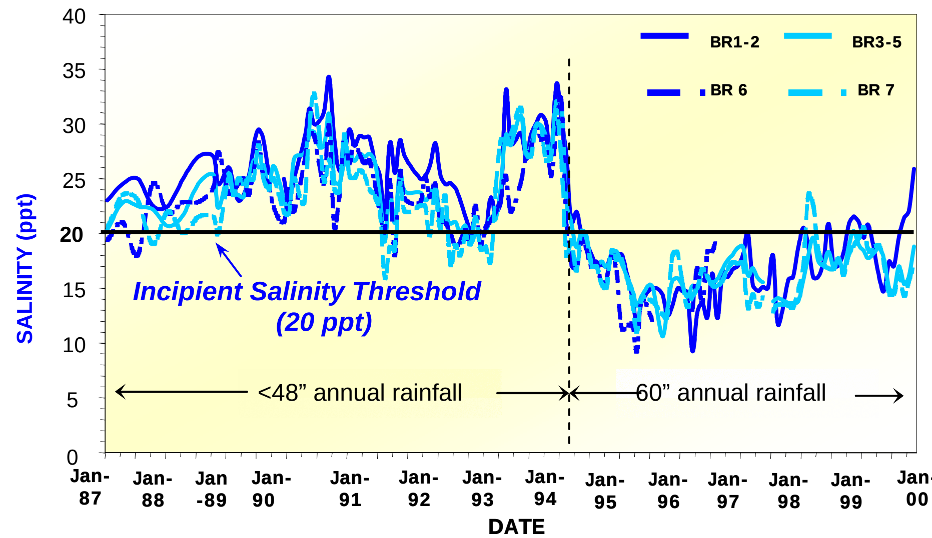

Figure 4-4. Monthly salinity levels from 1987 - 2000 in the Banana River Lagoon

between the good and poor segments closed even further; the result of a small decline in water quality in the good segments as well as a small degree of water quality improvement in the poor segments. But, any potential gains in seagrass coverage in the poor segments could have been stymied by low salinity (<20 ppt) from 1995 through 1998. In 1999 salinity slightly increased as did seagrass coverage.

The seagrass and water quality trends observed in Banana River Lagoon during the 1990s highlight the fact that optical pollutants and water clarity aren't all that need to be understood and addressed to manage seagrass. Other processes that affect salinity and nutrient dynamics – rainfall/evaporation, groundwater discharge rates, and macroalgae densities – may be more important in this semi-enclosed Lagoon than in the more open and better flushed segments of the IRL system. These processes should be examined more closely in the development of PLRGs in Banana River Lagoon.

Progress on Projects

Strategies for Pollutant Load Reduction. Volume reduction and water quality treatment of non-point surface water drainage are the key elements of the pollution abatement strategy in Banana River Lagoon. Since 1943, the non-point loadings of nutrients and suspended solids have doubled (Figure 4-5). A substantial portion of that increase originates in the central and southern segments of Banana River Lagoon (BR3-7 segments, Figure 4-5). Consequently, these same segments are receiving assistance from the SJRWMD and IRLNEP to plan and construct drainage treatment projects for both storm and non-storm drainage.

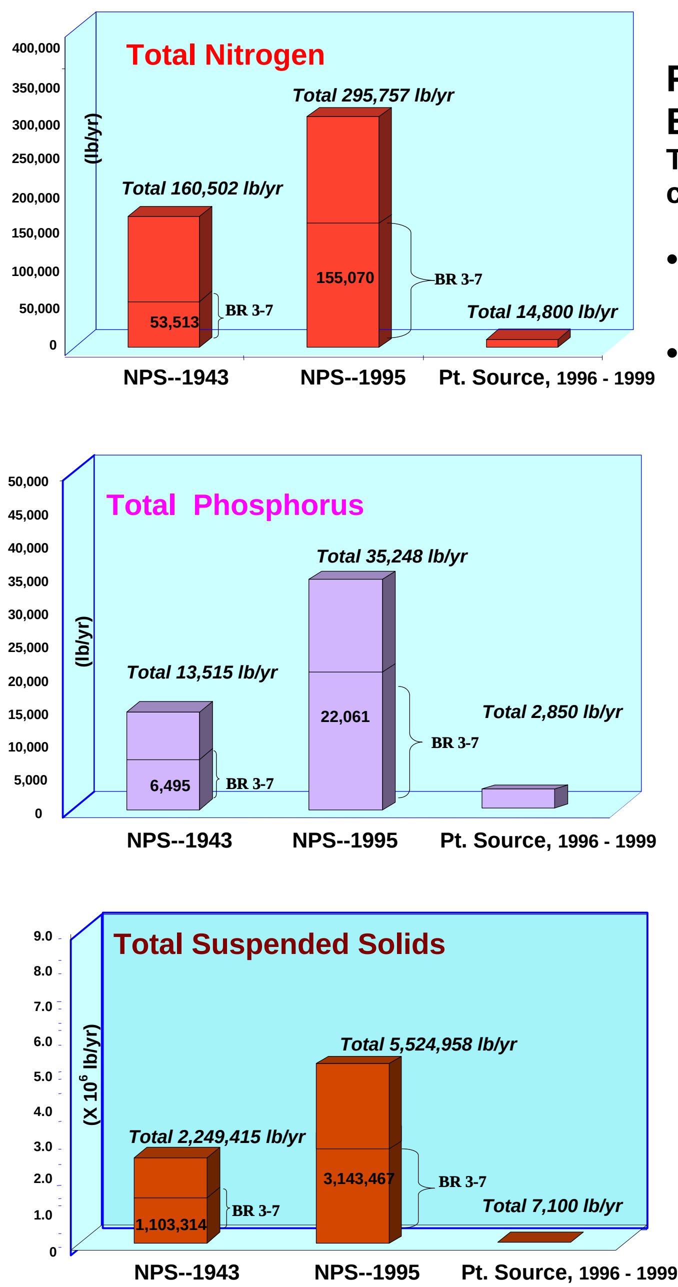

Figure 4-5.
Banana River Lagoon
TN, TP and TSS loading comparisons:

- **1943 vs 1995 Non-point source (NPS) run-off loadings***
- **1995 NPS vs annual point source or domestic WWTP loadings.**

Þ The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.

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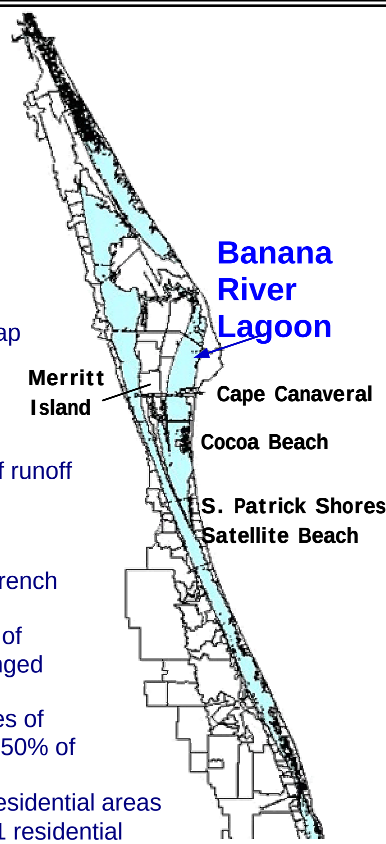
*NPS loading estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

Non-point Source Strategy – Surface Water Drainage. Plans for the quantity and quality treatment of urban drainage are either completed or nearing completion for the major population centers that stretch along the barrier island: the cities of Cape Canaveral, Cocoa Beach, and Satellite Beach. Concurrent with their planning, the cities have proceeded with several, small-scale treatment projects when the funding was available. For example, over the last 6 years the SJRWMD's IRL program provided cost-share support to county and city projects, most of which primarily handle soil and debris removal from drainage systems that serve less than 25 acres of moderate to high density residential development (Table 4-2).

Table 4-2. Non-point, surface water treatment projects in the Banana River Lagoon basin supported by SJRWMD and local government cost-share funds, 1995 - 2001

- Merritt Island (Brevard County) -- Merritt Island airport detention pond serving a 190-acre residential basin with nutrient & TSS removal efficiency of ~ 50% for storms up to 1".
- Merritt Island (Brevard County) -- Trash collection traps (a.k.a. curb/grate inlet baskets) installed in storm drains throughout Merritt Island. Some include oil absorbance pillows.
- South Patrick Shores -- *Thrush St.* baffle box serving about 2.4 acres of residential land (1,608 lb of sediment removed in 9 months)
- City of Cape Canaveral – a CDS/Vortech™ sediment trap serving the city's WWTP/public works site (mfr claims 88% TSS removal efficiency).
- Cocoa Beach:
  - *Brevard Ave.* "bioretention" project (1,350 ft linear vegetated swale/retention system with 10,800 ft^3 of runoff storage) serving ~ 5 acres of old downtown
  - Curb inlet baskets installed in storm drains
- Satellite Beach:
  - *Wilson Ave.* permeable pavement and exfiltration trench serving 5 acres of residential land
  - *Roosevelt Ave.* baffle box serving almost 20 acres of residential land (TSS removal efficiencies have ranged from 30-80% for <1" storm)
  - *Jackson Ave.* exfiltration trenches serving ~20 acres of mixed res./com. by reducing flood frequency and >50% of annual pollutant loads
  - installation of 30 storm drain traps in finger canal residential areas
  - *Jamaica Blvd.* wet detention ponds (3) serving 201 residential acres



The current priority is the completion of the master surface water management plans for Canaveral, Cocoa Beach and Satellite Beach. A city that can boast a completed plan along with some level of financial commitment to carry it out, has the greatest potential to leverage substantial external funds from several, non-point source programs (SJRWMD, state, and federal). With respect to SJRWMD and state funding, it is important for the local governments to include in their plans practical project designs that can effectively meet provisional or final PLRG allocations assigned to their watersheds. The SJRWMD assists local governments in setting pollutant reduction targets and reviewing project designs intended to help meet those targets.

Brevard County is responsible for surface water management on Merritt Island. The county developed a drainage treatment plan for the area and has proceeded with many construction projects called for in the plan. The SJRWMD cost-shared with the county on one of the larger projects in the basin, the Merritt Island airport detention pond, designed to handle and treat runoff from a 190-acre residential basin (see first project described in Table 4-2).

Non-point Source Strategy – Muck. The 1989/90 muck survey (Trefry et al., 1990) included the reconnaissance of the central and southern segments of Banana River Lagoon (segments BR3-7). The northern area (BR1-2 segment) of the lagoon was not surveyed; it is federally managed with minimal development and was presumed to be essentially free of muck (confirmed by observations of other investigators doing work in the area). Banana River Lagoon's muck deposits are thickest and most extensive in its most southern reach (BR7 segment) south of the Pineda Causeway bridge (S.R. 404). This southern reach contains muck throughout its many miles of barrier island finger canals (Satellite Beach and South Patrick Shores) and in its main navigational channels from just north of Pineda Causeway to Dragon Point, the southernmost tip of Merritt Island.

Satellite Beach has taken an active interest in removing muck from its residential canals and controlling its sources of input. The SJRWMD supports this interest and has included this area in its ranking of probable sites for future muck removal. It is possible that muck deposits in this segment are exacerbating water column suspended solid and phytoplankton concentrations (via re-suspension and nutrient flux processes). Therefore, the removal of muck and the reduction of suspended matter loading are considered important restoration measures in this segment.

A feasibility study of muck removal from the canals and other bottom areas in southern Banana River Lagoon was conducted in 1999/2000 (BCI Engineers and Scientists, Inc., 2000). The study concluded that the limiting factor is open land area; at least enough land area needed to economically de-water and produce dry, "truckable" dredge material. A schedule of several years may be necessary to complete the dredge operation given the following: 1) the tens of miles of residential canal and navigational channel and the volume of material to be dredged (~1 million cubic yards), 2) a de-watering operation confined to a limited area locally or to an area many miles away, and 3) the long distances to haul material to various disposal or beneficial use sites.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). During the initial 5 years of the SWIM program, the SJRWMD contracted with Brevard County to conduct inspections of septic tanks or OSDS (on-site disposal systems) in areas that were known to have documented failures. The County also performed a survey of all OSDS areas to determine their potential to contaminate surface waters (White and Wiggins, 1995; in compliance with the IRL "No Discharge" Protection Act). In the Banana River Lagoon basin, OSDS use was prevalent on southern Merritt Island, but not on the barrier island where centralized WWTPs are used. The inspections confirmed problems with OSDS use in the Newfound Harbor area. The County then moved rapidly to provide centralized WWTP service to many homes in that area.

Most of the OSDS that remain in use today are found on Horti Point, the eastern peninsula that separates Newfound Harbor from the Banana River Lagoon. Collectively, these OSDS pose a comparatively low pollution risk when considering the collective magnitude of non-point sources. Additionally, the County's general survey found that OSDS areas in the Banana River Lagoon basin pose a low to moderate surface water contamination risk (White and Wiggins, 1995).

Consequently, the OSDS issue is a low management priority in the Banana River Lagoon basin. It is most important in this basin to focus resources on managing surface water drainage. Nonetheless, the SJRWMD encourages County expansion of centralized WWTP service to any remaining OSDS areas.

Point Source Strategy – Domestic Wastewater Treatment Plants. The cities and Brevard County have achieved remarkable reductions in pollutant loading from domestic WWTPs to the Banana River Lagoon. For instance, WWTP loadings of nitrogen and phosphorus to the Banana River Lagoon have decreased by an order of magnitude since 1986 (SJRWMD and SFWMD, 1987). Currently (1996 – 1999), WWTP contributions of TN (14,800 lb/yr), TP (2,850 lb/yr), and TSS (7,100 lb/yr) represent <5% of the total surface water loading of nutrients and <17% of the total TSS loading to the Banana River Lagoon (Figure 4-5). The City of Cape Canaveral WWTP discharges the majority of the point source loadings, which is expected to decrease as plant upgrades and reuse expansion progress.

Like OSDS, domestic WWTPs appear to be a minor source of pollution thanks to local government action in response to the IRL "No Discharge" Act (Chapter 90-262, Laws of Florida). Most of the attention paid to pollution abatement can now be turned to the volume reduction and treatment of surface water drainage.

Monitoring, Modeling, and Applied Studies. The SJRWMD and NASA (via Dynamac, Inc.) will continue the seagrass and water quality monitoring in Banana River Lagoon as part of the Lagoon-wide networks (as described in Chapter 2, pp. 2-15 and 2-16). The SJRWMD will also evaluate and refine the monitoring network in Banana River Lagoon to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Analyses and biennial reporting of monitoring data will key in on those major optical pollutants that are significant in this lagoon.

Data from both the water quality and seagrass monitoring networks were invaluable in the calibration of the Pollutant Load Reduction (PLR) Model, which will be applied toward the development of final PLRGs. PLRGs, expressed as both "allowable" loading rates and reduction levels for a lagoon segment, will be allocated among the drainage basins associated with that segment. For example, a TSS PLRG established for segment BR7, the southern Banana River Lagoon, would need to be allocated among its contributing urban drainage basins: Satellite Beach/South Patrick Shores, Indian Harbor Beach, and the southern tip of Merritt Island.

Each local government that is responsible for drainage in these sub-basins would be made aware of its assigned allocation of the total load reduction and would hopefully strive to meet it through their drainage management plans. As stated above (in *Non-point Source Strategy – Surface Water Drainage*), the SJRWMD is willing to participate in a cooperative venture to implement such plans as long as they adequately address either provisional or final PLRGs.

Provisional pollutant load reduction targets are based on estimated 1943 loading rates (i.e., provisional "allowable" or desirable loading rates) and can be used in surface water treatment designs (for storm and non-storm drainage). These provisional targets (Table 4-2) are intended to be conservative and, thus, the design of stormwater treatment systems based on those targets should be able to meet the final PLRGs. It is assumed that by meeting c.1943 loading rates, water quality and clarity in the affected lagoon segments should improve sufficiently to enable seagrass to expand to the 1943 coverage depths. Application of the PLR Model will help ascertain whether these provisional targets are reasonable or too stringent (and thus should be revised).

For Banana River Lagoon, the determination of final nutrient PLRGs may, in part, be hinged on the role of macroalgae (*Gracillaria* spp., *Caulerpa prolifera*) in regulating nutrient concentrations in the water column. Banana River Lagoon, particularly its central area (segments BR3-5 and BR6), typically contains large masses of drift macroalgae, which function as a nutrient "sponge" and can thereby limit the availability of nutrients to phytoplankton. Phytoplankton can effectively compete with seagrass for available light in the water column and, as mentioned before, may be the primary "optical" pollutant in Banana River Lagoon (as indicated by chlorophyll *a* concentrations). If macroalgae densities were to decline, would phytoplankton levels increase, further restricting available light to seagrasses? Are the relatively high macroalgae densities in Banana River Lagoon an indication that nutrient levels may already be excessive? Answers to these questions are not known, which suggests that it may be wise to explore the ecological role of macroalgae in the IRL system in the context of both nutrient and seagrass management.

Table 4-3. Provisional "allowable" loading rates for TN, TP, and TSS for Banana River Lagoon based on estimated 1943 land use loading rates
(see Figure 4-1 or Figure 4-2 for map location of segments)

Segments	**TN** lb/ac/yr (total lb/yr)	**TP** lb/ac/yr (total lb/yr)	**TSS** lb/ac/yr (total lb/yr)
N. Banana R. ***BR1-2***	3.2 (106,989)	0.21 (7,020)	34 (1,146,101)
C. Banana R. ***BR3-5***	3.3 (26,820)	0.38 (3,145)	90 (739,603)
Newfound Harbor ***BR6***	2.2 (13,530)	0.37 (2,275)	35 (217,851)
S. Banana R. ***BR7***	2.9 (13,163)	0.23 (1,076)	32 (145,860)

Land Acquisition. The acquisition of lands and "buffer" shorelines is viewed as a key strategy toward the protection and restoration of wetlands and seagrasses. This strategy is pursued largely through the IRL *Blueway* program. The *Blueway* program, its scope and progress, is described in the section on Coastal Wetlands found in this and the other chapters.

In addition to the acquisition of lands that comprise critical habitats or habitat buffers, other lands are sought for the purpose of constructing and operating surface water storage/treatment systems. Open land areas, if appropriately sized and strategically located in the drainage basin, may be good sites for such a purpose. But, these lands need to be acquired first and that can be a very expensive proposition considering the market value of coastal Florida real estate. To meet that financial challenge head-on, funding partnerships are formed among governmental agencies, and even nonprofit entities, on a routine basis. For example, SJRWMD has assisted and will consider assisting local governments in the acquisition of lands intended as sites for surface water management, particularly if the site serves a substantial portion of a watershed.

Unfortunately, open land of sufficient size is scarce in the urbanized central and southern sub-basins of Banana River Lagoon. Therefore, the feasibility of a single, large-scale project meeting sub-basin PLRGs or other major drainage improvements is relatively low. Consequently, street-by-street or individual subdivision drainage treatment projects incorporated within the existing drainage infrastructure are the types of projects that are being conceived and constructed.

An exception can be made for the minimally developed northern watershed of Banana River Lagoon. If it is determined that non-point sources in this area require significant treatment and it is economical to construct a large-scale project to achieve PLRGs, then the pre-requisite land requirements should be much easier to meet than farther south. Moreover, these lands are federally owned and managed; thus the need to publicly acquire land is not an issue.

Coordination with Other Agency Plans. Since urban non-point source pollution is the major problem in the central and southern Banana River Lagoon, it is important for the local governments to continue developing surface water plans with input from SJRWMD. Currently, SJRWMD is working with the cities of Cape Canaveral, Cocoa Beach and Satellite Beach to complete their respective master plans. The SJRWMD (including IRLNEP), the FDEP and EPA (section 319 non-point source reduction grant program), can then review city projects in the context of their master plans, and provide cost-share funding to support qualified projects.

With respect to the northern reach of Banana River Lagoon, NASA and U.S. Fish and Wildlife Service (USFWS) are consulting with SJRWMD on a full range of land development mitigation measures intended to improve estuarine water quality (e.g., runoff containment/treatment) and wetland functions (e.g., reconnection, breaching, etc.).

SJRWMD and NASA are engaged in a fairly comprehensive set of monitoring and data base coordination activities. NASA has agreed to applying its resources in acquiring and managing a variety of environmental data (e.g., seagrass coverage, water and air quality data, meteorological data, etc.). This data base coordination will benefit all agencies interested in the Banana River Lagoon and the IRL system as a whole.

The Next 5 Years

Strategies for Pollutant Load Reduction

Non-point Source Strategy – Surface Water Drainage. The completion of master surface water management plans and their implementation is the key objective that should play out over the next 5 years in the basin's major urban centers: Canaveral, Cocoa Beach, Satellite Beach, and unincorporated Merritt Island. The SJRWMD will consider cost-share agreements with these local governments to implement their plan projects and will provide what grant application assistance it can to the local governments to procure other funding support.

*Non-point Source Strategy – Muck***.** Approximately one million cu yd of muck reside in southern Banana River Lagoon, including the residential canals (Mr. Shailesh Patel, BCI, Inc., personal communication, Oct., 2000). It is here where the removal of muck would be most beneficial relative to other Banana River Lagoon segments where comparatively little muck has accumulated. Unfortunately, there is not sufficient land area in southern Banana River Lagoon to support a de-watering operation that could handle any more than 50,000 to 100,000 cu yd of dredge material per year (and the dredge window is typically between December and March when manatees are not present in large numbers).

De-watering technology is, at present, fairly expensive; approximately $10 per cu yd of dredged material (in addition to the dredge cost of $4 to $7 per cu yd). Hopefully the cost will drop as demand for such technology grows. Current funding priorities for muck removal projects place southern Banana River Lagoon at fifth position, or fourth position at best, behind Crane Creek (completed), Turkey Creek (completed), and Sebastian and Eau Gallie rivers (planning is underway; therefore beginning and completion dates for dredging are unknown at this time).

Consideration should be given to developing a long-range plan for the removal of major muck deposits at all priority sites throughout the IRL basin (10 major sites, including southern Banana River Lagoon). The plan would include the method and results of the site prioritization, and an estimated permit and dredge schedule for each project site along with general budget information.

Non-point Source Strategy – Septic Tanks. Septic tanks are now considered a fairly low management priority in the Banana River Lagoon basin because of the remedial work accomplished in 1990s. It is most important in this basin to focus resources on the volume reduction and treatment of urban drainage. Nonetheless, the SJRWMD would support county expansion of centralized WWTP service to Horti Point, the only remaining and significant area that still relies on septic tanks.

Point Source Strategy – Domestic Wastewater Treatment Plants. Like septic tanks, domestic WWTPs appear to be a minor source of pollution to Banana River Lagoon thanks to local government action in response to the IRL "No Discharge" Act (Chapter 90-262, Laws of Florida). The IRL program should turn its full attention to the volume reduction and treatment of urban drainage, and to muck sediment management.

Monitoring, Modeling, and Applied Studies. The SJRWMD, Brevard County, NASA and other participating agencies will continue the seagrass and water quality monitoring networks described in Chapter 2 (pp. 2-15 and 2-16). These same agencies will also jointly evaluate and refine the monitoring networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass. Analyses and reporting of monitoring data will key in on salinity trends and those major optical pollutants that may be significant in the Banana River Lagoon: color, TSS, and phytoplankton (measured as chlorophyll *a*).

The role of macroalgae (e.g., *Gracillaria spp.*) in controlling the availability of nutrients to phytoplankton may be important in an estuary that exhibits an extremely sluggish flushing rate like Banana River Lagoon. This phenomenon will be further explored with respect to its nutrient management implications.

An updated survey of muck distribution, volume, and characteristics (physical and chemical) will be conducted as a planning requirement for any future dredge operations, which would likely occur in southern Banana River Lagoon (segment BR7). Also, a post-dredge sediment survey and monitoring of water quality characteristics will help document the utility of muck removal in achieving water quality objectives.

By 2004 the PLR Model should be verified and ready to be applied toward the development of recommended final PLRGs for the Banana River Lagoon. In the meantime, provisional pollutant load reduction targets can be used in stormwater treatment designs (see Table 4-2). These provisional targets are intended to be conservative and, thus, be used to design municipal or regional stormwater treatment systems that should be able to meet the final PLRGs. The SJRWMD will use the PLR Model to “test” the adequacy of the provisional targets. If they are determined to be too stringent, the targets may need to be relaxed or re-set at levels that are more economically achievable but can still meet the water quality/light requirements for seagrass restoration.

Land Acquisition. Acquisition of relatively large parcels of open land, in order to construct stormwater treatment basins, is not part of any existing plan to treat surface water drainage in the urban corridors on the barrier island and Merritt Island. Treatment facilities sized to serve several acres or one to two sub-divisions at best appear to be the most viable options. Brevard County and the barrier island cities are planning on constructing numerous small or modest sized projects whose collective treatment capabilities should meet both water quality and flood protection objectives.

For information on wetland acquisition and other lands for the sake of restoration or preservation, refer to the Coastal Wetlands section below (and in the other chapters).

Coordination with Other Agency Plans. NASA is consulting with SJRWMD on a range of mitigation measures related to future development of their space facilities. Some of the mitigation measures could be directed at the treatment or full containment of runoff from hundreds of acres of both new and old development areas for the benefit of the northern reach of Banana River Lagoon. This mitigation plan should also incorporate wetland reconnection/restoration projects as well as water quality improvement measures.

SJRWMD and NASA have entered into a formal collaboration (via memorandum of understanding) to coordinate both agencies’ monitoring and data base management efforts. It is believed that this will tremendously boost data and information exchange not just between the two agencies, but also among all the key management agencies interested in the IRL system.

With respect to the central and southern Banana River Lagoon, it cannot be emphasized enough that it is most important to reduce and treat the discharge of urban storm drainage. The cities of Cape Canaveral, Cocoa Beach, and Satellite Beach are developing plans that should strive to address both the quality and quantity of runoff, and more specifically the PLRGs or “allowable” loading rates for TSS and nutrients. It is hoped that the cities will finalize their project plans by 2002 followed by aggressive implementation of projects over the next 5 years and beyond. Toward that end, the SJRWMD can assist the cities with technical guidance, direct funding support, and by applying for other sources of funds.

Table 4-4. The 5-Year Plan List of Seagrass and Water Quality Projects for the Banana River Lagoon

- **Continue monitoring in the Banana River Lagoon as part of the Lagoon-wide monitoring networks***
  - **Water Quality Monitoring (NASA, SJRWMD)**
  - **Seagrass Mapping and Field Monitoring**
  - **Meteorological Monitoring**
  - **Hydrodynamic Monitoring**
- **Develop final PLRGs by 2004**
- **Implement non-point, surface water projects aimed at reduction of nutrient, TSS, and freshwater inputs (Brevard County, Cape Canaveral, Cocoa Beach, Satellite Beach, Indian Harbor Beach)**
- **Re-survey muck deposition areas**
- **Continue periodic inventory of domestic WWTPs**
- **Continue to support actions by the county in any further remediation of septic tank areas (e.g, Horti Point on eastern Merritt Island)**
- **Pursue acquisition of lands identified under the *Blueway* program**
- **Investigate the value of macroalgae as a habitat and as a potentially major mediator of nutrient loadings**

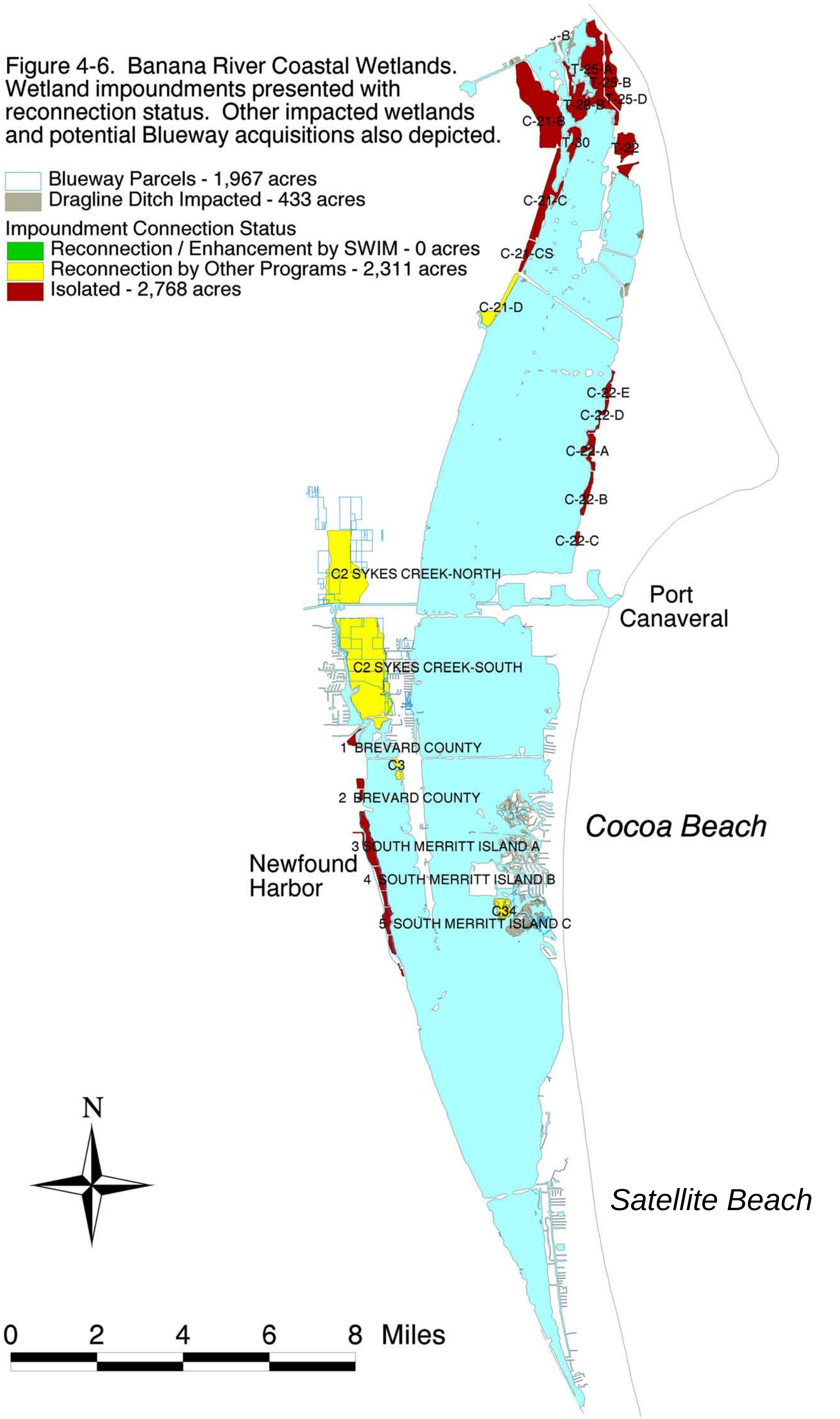
*** descriptions of monitoring networks are found in Chapter 2, and listed in Table 2-4.**

Coastal Wetlands

Banana River Lagoon contains approximately 5,600 acres of coastal wetlands, which includes 5,079 acres of impounded wetlands (Figure 4-6). Just under half of these impounded wetlands (2,311 acres) have adequate connection to the Banana River Lagoon; the majority of those are the Sykes Creek impoundments (2,074 acres). Out of the remaining impoundments, 2,668 acres are targeted for reconnection. Although many of these targeted impoundments are publicly held, others are threatened by imminent development. Acquisition of these wetlands is critical for their rehabilitation and protection.

Banana River Lagoon also has dragline-impacted marsh -- over 430 acres. A portion of these wetlands is privately owned and will probably need to be publicly acquired in order to accomplish any rehabilitation. Rehabilitation of these wetlands will include cooperative efforts by SJRWMD, Brevard Mosquito Control District, USFWS, NASA, and the U.S. Air Force (Cape Canaveral Air Force Station).

Figure 4-6. Banana River Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.



Progress on Projects

Please refer to the Coastal Wetlands section in Chapter 2 for a description of the general background and scope of the projects. Progress information is provided below.
Rehabilitation of Impounded Wetlands. About half of the 5,079 acres of impoundments in Banana River Lagoon are under Federal ownership. Most of these are part of the Kennedy Space Center and are managed by USFWS. The rest are part of the Cape Canaveral Air Force Station. Except for one breached impoundment, all of the impoundments in Federal ownership are still isolated and are targeted for reconnection and restoration. As stated above, the largest group of reconnected wetlands is the Sykes Creek impoundments (2,074 acres), which were reconnected as part of a mitigation project. SWIM project funds have not been used to date to reconnect any of the impoundments in the Banana River Lagoon. Among the privately held wetlands, the ones most threatened by development are impoundments 3, 4, and 5 along the western shore of Newfound Harbor (Figure 4-6). These wetlands are high on the priority list for the IRL *Blueway* Project. In summary, 2,311 acres of wetlands were reconnected, breached, or restored in Banana River Lagoon.

Wetlands Management Research Initiative. Although the Wetlands Management Research Initiative is not being conducted in Banana River Lagoon, its results and recommendations can be considered in managing reconnected impoundments throughout Banana River Lagoon.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. No work on these impacted wetlands has been done or is currently underway. A plan that includes a schedule and cost for rehabilitation is in progress.

Creation of Shoreline Vegetative Habitats*.* Kelly Park, a county recreational park, located on Merritt Island immediately south of the S.R. 528 causeway, was the site for two mangrove planting projects. Both projects dealt with red mangrove (*Rhizophora mangle*) planting, but each differed in the type of planting method used. The first planting took place in early spring 1997 using the traditional and simple method of inserting nursery grown stock (mature propagule showing shoot and leaf growth) directly into submerged sediments along the shoreline without the aid of any wave barrier or other means of protection. The second planting occurred in the fall of 1998 using the recently developed "encasement planting technique" described by Riley and Kent (1999). The encasement is a PVC pipe cut to 3 ft lengths, inserted into the shoreline sediment, and into which the mangrove propagule and sediment growing media are placed. The PVC encasement protects the propagule from wave and wind disturbance, floating debris, and foot traffic. The latter plantings using the encasement method enjoyed a 96% survival rate over a 21-month period; whereas only 24% of the first plantings survived in the first 6 months. The latter plantings are stilling maturing, showing excellent promise as a means to re-vegetate and stabilize shorelines and improve wildlife habitat.

Preservation of Existing Wetlands – Land Acquisition. Many of the wetlands are in public ownership; nonetheless, land acquisition is a critical issue in the Banana River Lagoon basin. There are 1,967 acres of wetlands included in the IRL *Blueway* Project, mostly in the Sykes Creek/Newfound Harbor area. Some of the Newfound Harbor wetlands are under imminent development threat. This is considered by the SRJWMD as the highest priority area for public acquisition under the *Blueway* Project.

The Next 5 Years

Rehabilitation of Impounded Wetlands. The objective for the next year or 2 is to acquire and reconnect the Newfound Harbor impoundments. Over the next 5 years, the objective is to reconnect or restore all the remaining isolated impoundments on federal land in the Banana River Lagoon basin. The NASA mitigation plan should move the program closer to that end.

Wetlands Management Research Initiative. The same agencies that manage most of the wetlands in Banana River Lagoon are involved in or are being made aware of the Research Initiative: Brevard Mosquito Control District, USFWS, NASA, and the U.S. Air Force. These agencies can readily apply the research findings to their respective management policies and programs that affect impounded wetlands in this lagoon. It is expected that they will participate in the development of management recommendations, which should begin by latter half of 2003.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. The pilot project to evaluate equipment and technique options in the rehabilitation of dragline-impacted wetlands was conducted in Mosquito Lagoon. The evaluation report should be completed by December 2002 or by early 2003. A work plan for the 430+ acres of dragline-impacted wetlands in Banana River Lagoon will follow. At this time, it is not feasible to accurately project the amount of work or progress possible (schedule and cost) over the next 5 years.

Creation of Shoreline Vegetative Habitats. There are no plans for creating wetland habitat or conducting any future plantings in the Banana River Lagoon under the SJRWMD IRL program.

Preservation of Exisiting Wetlands – Land Acquisition. The objective over the next 5 years is to acquire as much of the 1,967 acres of wetlands that are identified in the *Blueway* Project plan. Acquisition support services should be maintained to ensure momentum and success. Because of the imminent threat of development of the Newfound Harbor impoundments, most of the acquisition effort in the Banana River Lagoon should be directed toward those lands.

Table 4-5. The 5-Year Plan List of Coastal Wetland Projects for the Banana River Lagoon

- **Acquire and reconnect the Newfound Harbor impounded wetlands, a high priority under the *Blueway* program**
- **Acquire all remaining *Blueway* parcels (1,967 acres)**
- **Reconnect any of the available impounded wetland acreage on Federal property (up to 2,768 acres)**
- **Initiate plan to rehabilitate dragline-impacted wetlands (~430 acres) in Banana River Lagoon basin**

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CHAPTER 5. NORTH & CENTRAL INDIAN RIVER LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The status assessment of the seagrass resource in the North and Central IRL is based on the same measurement indices used in the Lagoon-wide and other sub-lagoon assessments. These indices are:

- ❖ Acres of seagrass coverage over time (net gain or loss),
- ❖ Maximum depth of the edge of seagrass beds, and
- ❖ Percent of photosynthetically active sunlight reaching the target depth of 1.7 m.

For more information on why and how these measurement indices are used to assess the seagrass status, refer to Chapter 2, p. 2-3. Major findings on the status of seagrass in North and Central IRL are summarized below.

- The northernmost segments of the Indian River Lagoon (segments IR1-5) exhibited good to excellent seagrass conditions over the last decade, showing even modest gains over the 1943 coverage (Figures 5-1a and b). The segment immediately south of Titusville (IR5) is consistently one of the best in terms of acreage and depth coverage, and routinely surpasses the preliminary 25% light requirement (Figures 5-1b, c and d; Table 5-1). The excellent condition of this segment is exceeded only by Hobe Sound in the South IRL (see Chapter 6).

Table 5-1. General classification of North and Central Indian River Lagoon segments – Good, Fair or Poor

Classification is based on the following indices: *% surface light @ 1.7 m* (as an annual median, see Figures 5-1c and 5-2c), *seagrass depth index* (SDI; see Figures 5-1d and 5-2d), *% loss of seagrass since 1943* (= 50% and = 75%).
Any segment receiving 3 or more marks is classified as poor, 2 marks fair, 1 or zero marks good.

North IRL Segments	= 20% surface light @ 1.7 m	SDI = 75%	loss since '43 = 50%	loss since '43 = 75%	Classification
IR1-3					Good
IR4					Good
IR5					Good
IR6-7	X	X	X		Poor
IR8			X	X	Fair
Central IRL Segments					
IR9-11	X	X	X	X	Poor
IR12	X	X	X		Poor
IR13A	X	X			Fair
IR13B	X				Good
IR14	X				Good
IR15	X	X			Fair
IR16-20	X	X	X		Poor
IR21	X		X		Fair

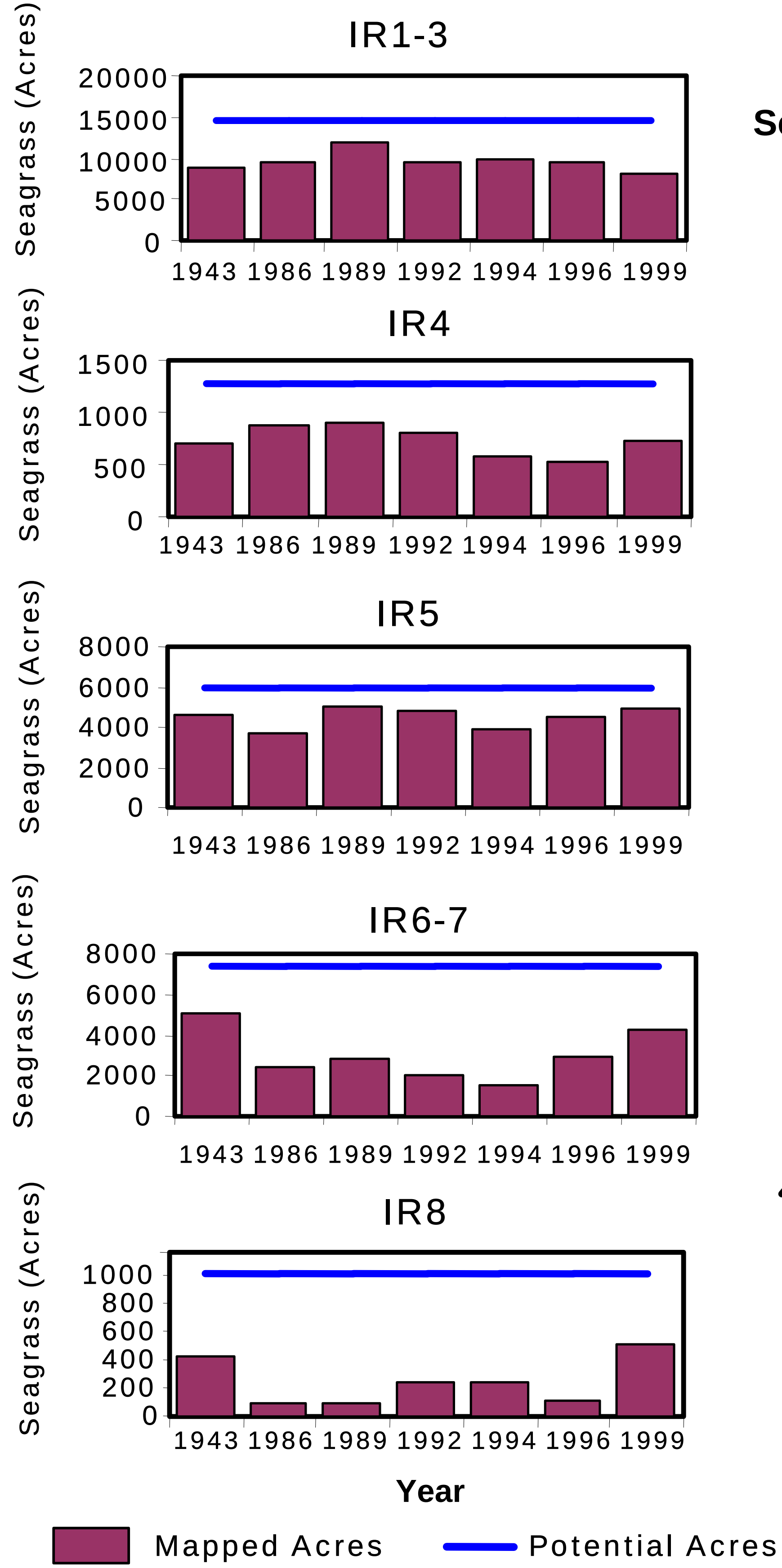

Figure 5-1 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line.

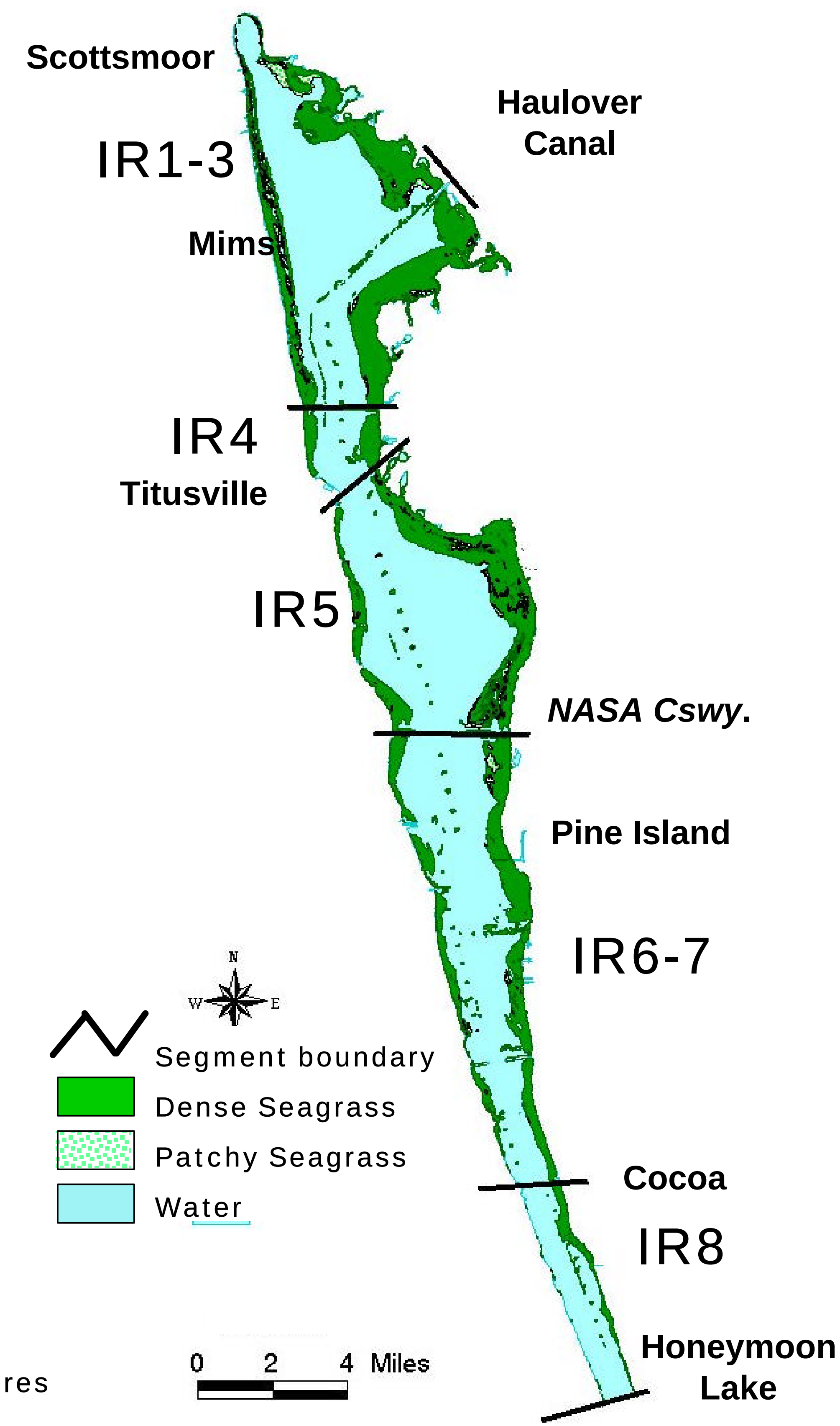

Figure 5-1a. North Indian River Lagoon 1999 seagrass coverage and segment boundaries

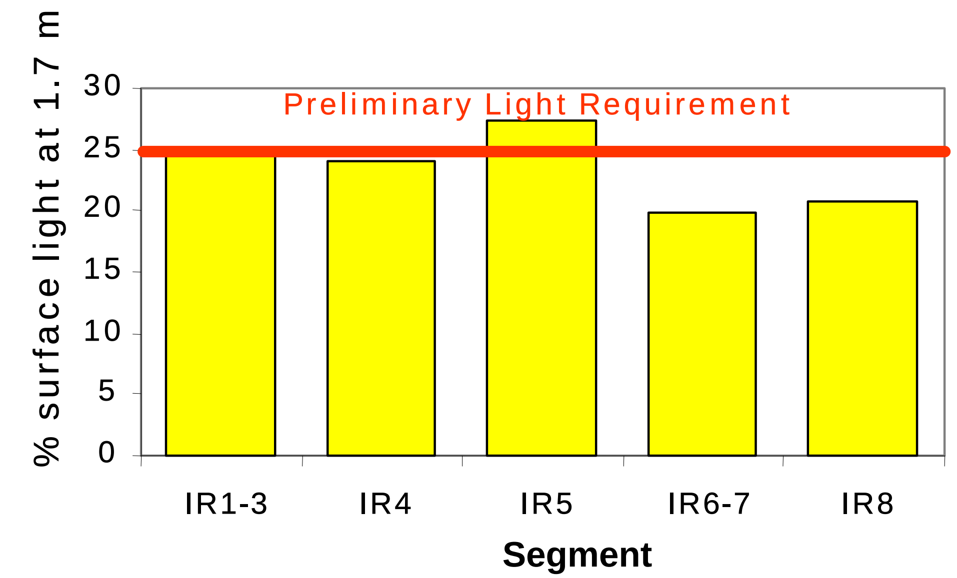

Figure 5-1 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999. Note how closely the northern three segments meet the target.

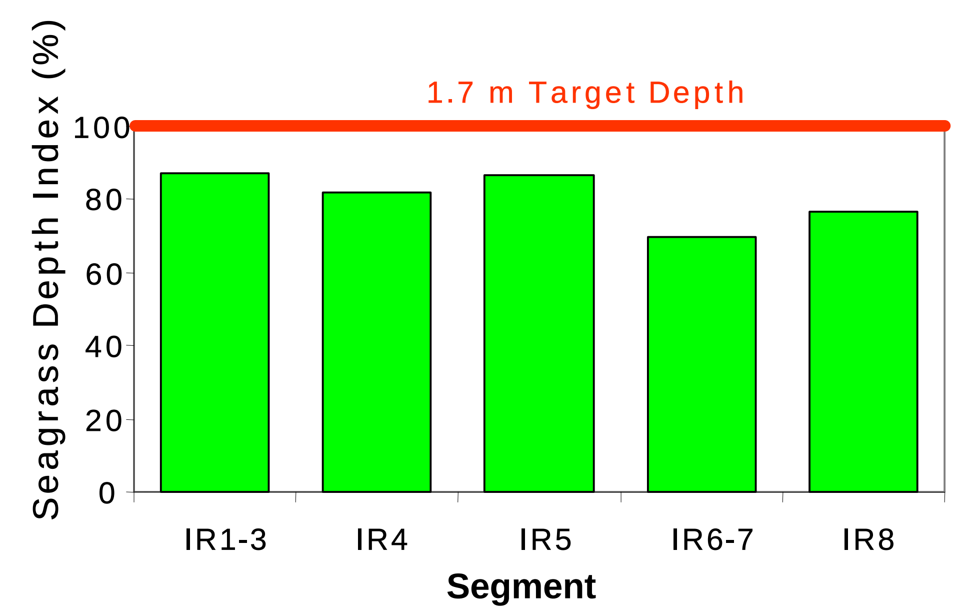

Figure 5-1 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

- Segments near Sebastian Inlet (IR14 and IR13B) in the Central IRL are also considered in good condition; displaying more extensive seagrass coverage in the 1980s and 1990s than in 1943 (Figures 5-2a and b; Table 5-1). A similar trend is observed in the neighboring segment to the south (IR15) (Figure 5-2b).
- The probable factors that allow good seagrass conditions are different in the North than in the Central IRL. The northernmost segments are poorly flushed (about 150 days for complete volume exchange[1]), but their sub-basins are not extensively developed and do not generate the large pollutant inputs characteristic of the Central and South IRL sub-basins. Alternatively, the central segments adjacent to Sebastian Inlet (IR14-15) are located in highly developed sub-basins, but are well flushed primarily due to the inlet tide[2] influence (up to 5 days for complete volume exchange).
- All seven species of seagrass of the IRL system are found in the Central IRL from Sebastian Inlet southward. Only four of the species exist north of Sebastian Inlet[3]. In contrast to its high species diversity, the seagrass status of the Central IRL is the poorest of all the lagoon areas in the IRL system based on the indices above. Most of its segments are classified as poor or fair, except the good segments near Sebastian Inlet (Table 5-1). Most of the Central IRL segments are moderately to poorly flushed (30 to 120 days for complete volume turnover) and are recipients of major inflows of drainage and pollutant loads from large and intensively developed sub-basins (from Eau Gallie south to Vero Beach).
- The worst segments are the Melbourne segments (IR9-12) and Vero Beach segments (IR16-20) (Figure 5-2b and Table 5-1). While the Melbourne area showed modest gains in seagrass coverage in the late 1990s, the coverage in the Vero Beach segment remained quite low (Figure 5-2b). The Vero Beach area is one of the narrowest reaches of the Lagoon, containing a comparatively small basin volume that receives one of the largest annual loads of nitrogen and phosphorus in the IRL system[4].
- Many of the fair and poor segments in the North and Central IRL are noted for their temporal instability; i.e., seagrass coverage fluctuates more widely than in the good segments of the IRL system. One reason for this coverage fluctuation may be the hydrologic variability in the poor segments. The poor segments reside in developed watersheds with extensive drainage systems and thus can be affected by large year-to-year variations in drainage inflows, pollutant loadings, and salinity levels.

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[1] Flushing rate or residence time estimates are based on a preliminary run of the hydrodynamic model component of the IRL PLR Model (Sheng, 1997).

[2] Sebastian Inlet was not routinely maintained as a permanent opening until 1948 (Mehta et al., 1976). Prior to that time, the inlet throat was more narrow, shallow, and often closed, allowing brief and limited exchanges between the ocean and the Lagoon. Therefore, in 1943, the Lagoon at Sebastian was probably more poorly flushed than it is today. This could explain why seagrass coverage was less in 1943 than in recent times.

[3] The seven species are *Thalassia testudinum* (turtle grass), *Halophila johnsonii* (Johnson's seagrass), *Halophila decipiens* (paddle grass), *Halophila engelmannii* (star grass), *Syringodium filiforme* (manatee grass), *Halodule wrightii* (shoal grass), and *Ruppia maritima* (widgeon grass). Only the latter four species are found north of Sebastian Inlet.

[4] The three major canals in Vero Beach and Indian River Farms WCD collectively discharge ~450,000 lb/yr N and ~77,000 lb/yr P to segments IR16-20. Those loadings are equaled or exceeded by only two other riverine inputs -- Sebastian and St. Lucie rivers [Sebastian R.: avg. values of ~631,000 lb/yr N, ~73,000 lb/yr P; St. Lucie R.: median values of ~2 million lb/yr N, and 310,000 lb/yr P (derived from G. Hu, SFWMD, 4/22/02 e-mail)].

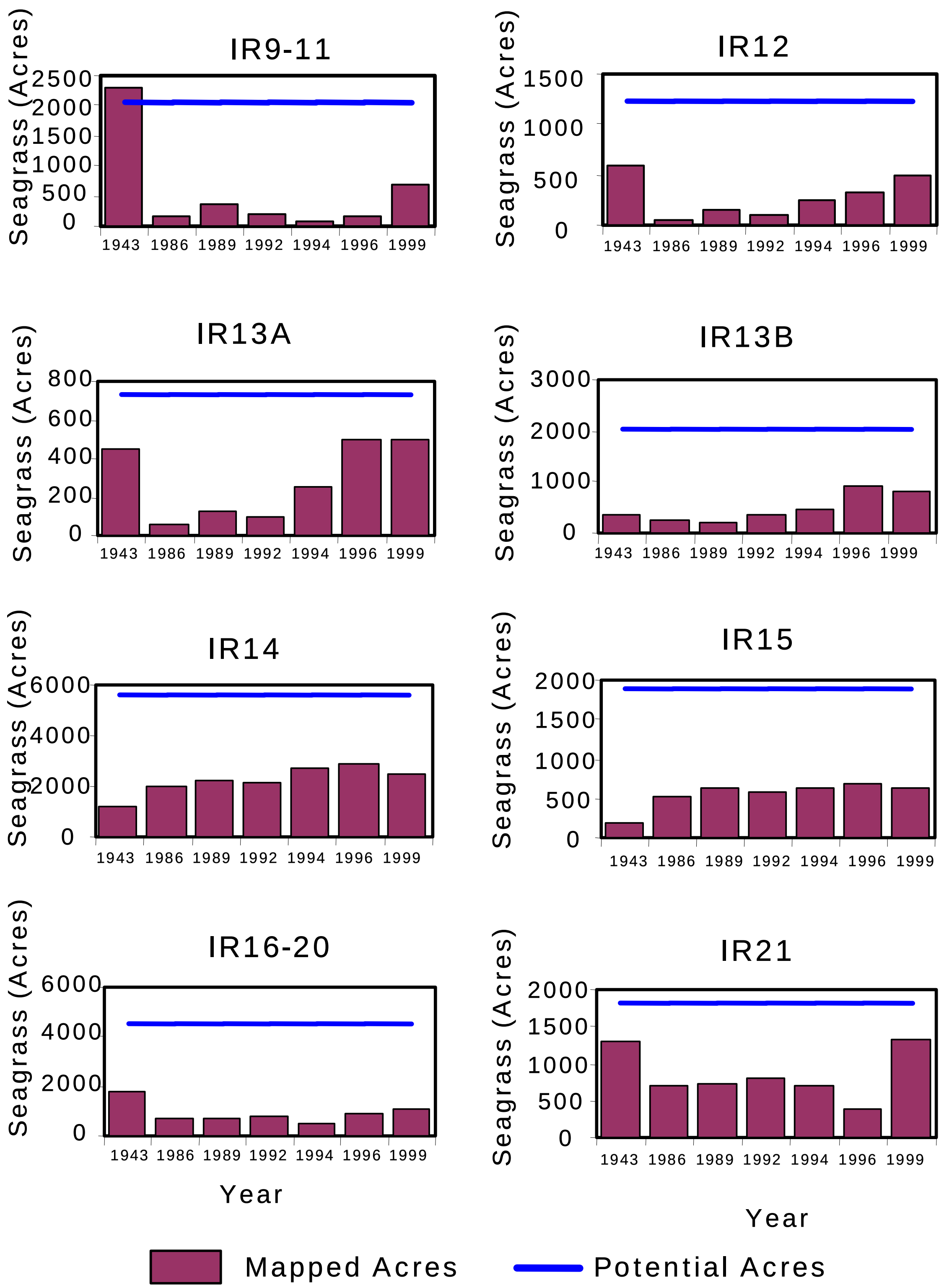

Figure 5-2 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line. Note large historical loss in segments IR9-11, 12, and 13A and recent recovery to near historical levels. Segments IR13B through IR16-20 were never near potential acres. Segments 13B through 15 have more seagrass now than in 1943 – Sebastian Inlet in was not permanently opened until 1948.

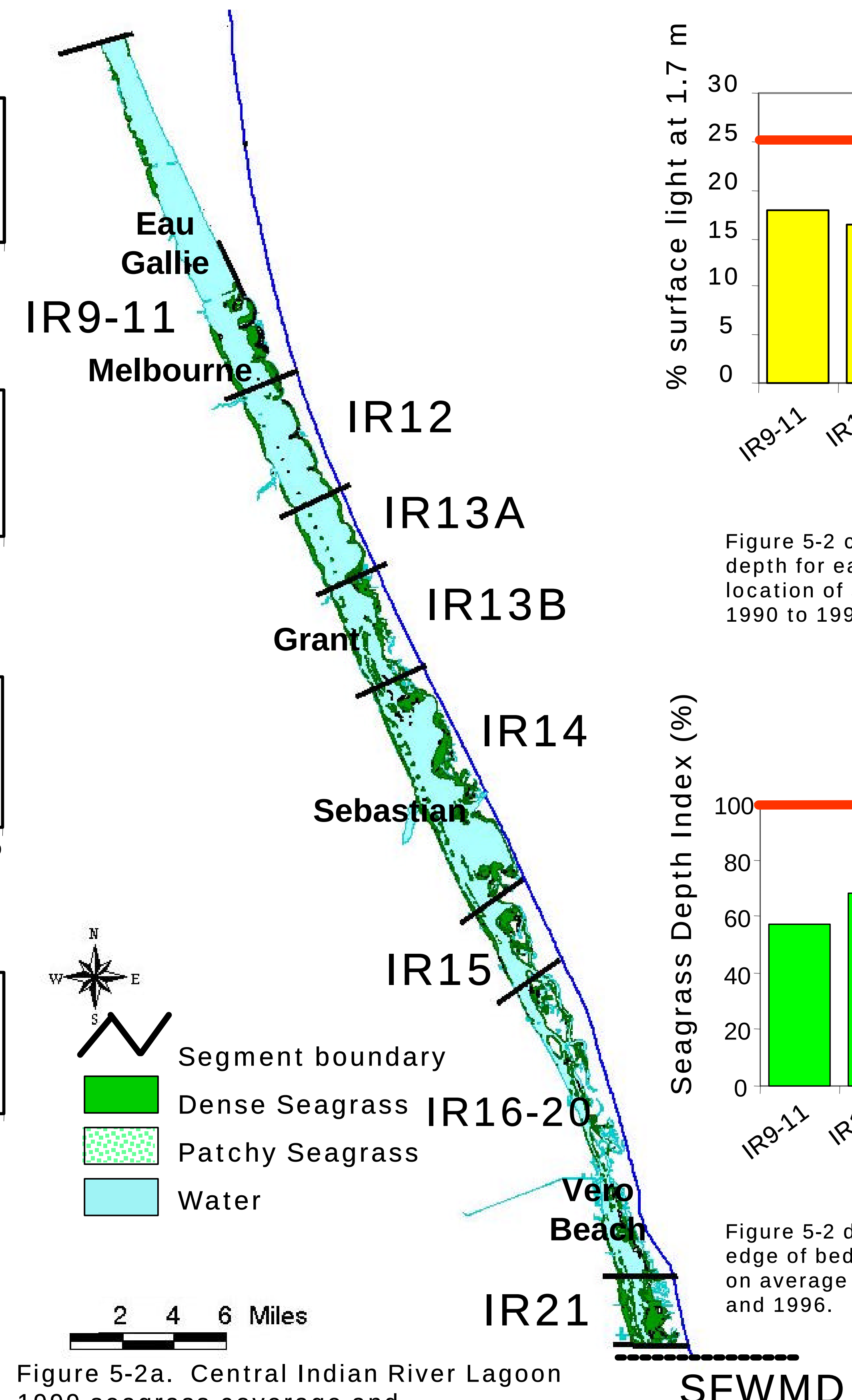

Figure 5-2a. Central Indian River Lagoon 1999 seagrass coverage and segment boundaries

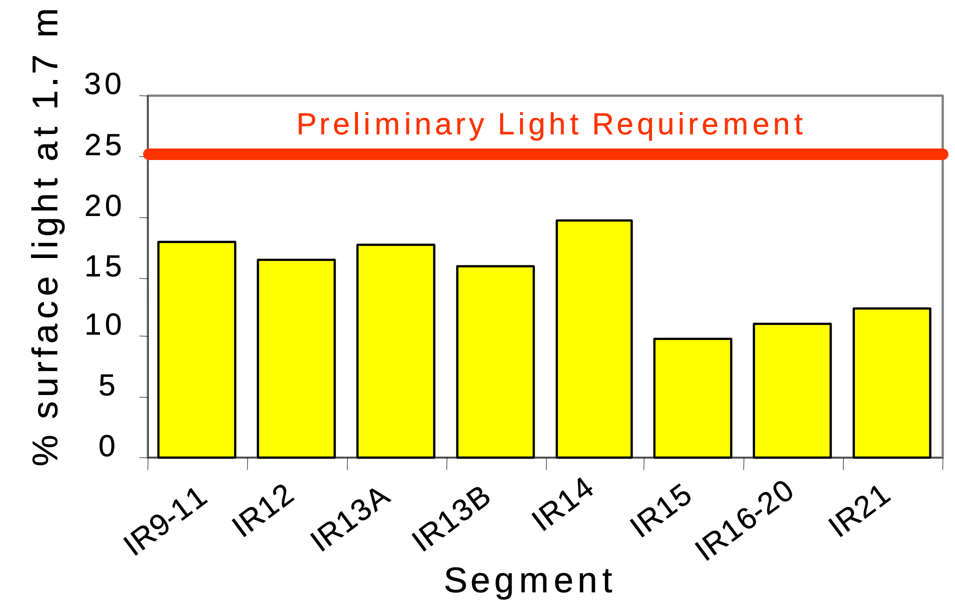

Figure 5-2 c. Median percent surface light at the 1.7-m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

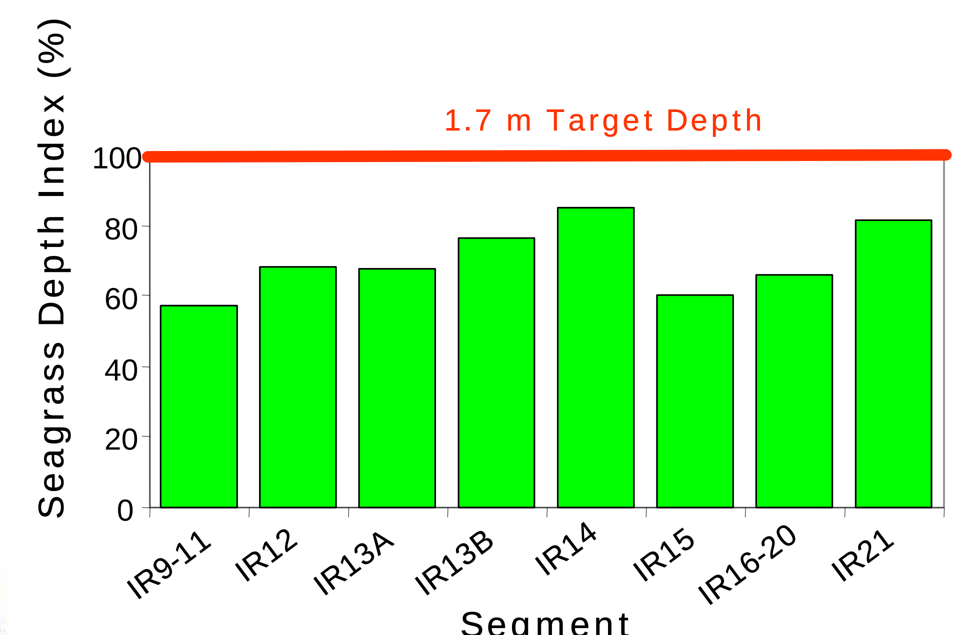

Figure 5-2 d. Average Seagrass Depth Index = depth of edge of bed as a percent of the 1.7-m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NAVD88 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

- Many segments throughout the North and Central IRL showed steady increases in seagrass coverage in the late 1990s (Figures 5-1b and 5-2b), particularly in the poor and fair segments! Is that trend a result of a recent water quality improvement? If so, is the improvement a consequence of relatively dry weather during the seagrass growing season observed in 1998 and 1999[5]; or a result of recent projects that reduced or mitigated pollutant loadings? Or a combination of both? The water quality assessment below should answer the first question, but there are no clear answers to the other speculative questions of causation.

Water Quality Assessment

Within the North and Central IRL, the lowest 10-year average salinity -- slightly above 20 ppt -- was measured in the Cocoa-Melbourne area (segments IR8 – IR13A). These waters are contiguous with the southernmost reach of Banana River Lagoon (south of S.R. 404, Pineda Causeway), which measured a similar low 10-year average salinity of 20.5 ppt. These low 10-year averages apparently occurred because salinities dropped and periodically stayed well below 20 ppt from late 1994 through 1998 (Figure 5-3).

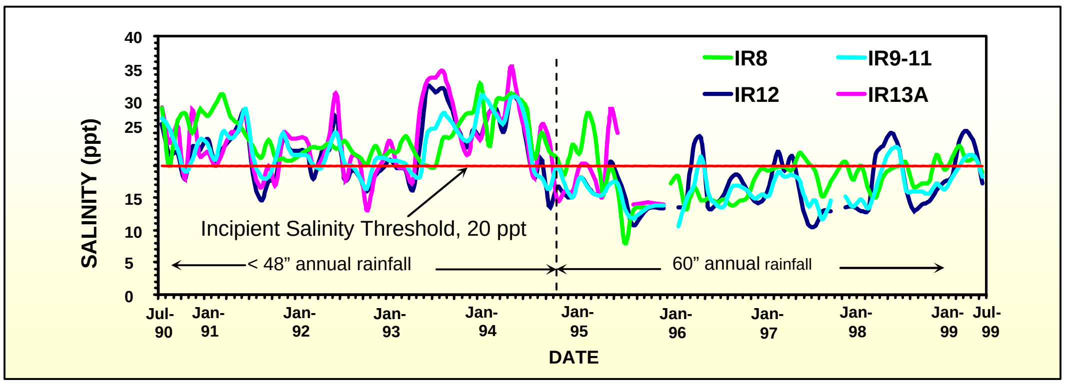

Figure 5-3. Monthly salinity levels from 1990 - 1999 in the Cocoa-Melbourne area (segments IR8, IR9-11, IR12, and IR13A)

Above-average rainfall from 1994/95 through 1998 is one likely factor contributing to the salinity decline in the Cocoa-Melbourne reach. The severity of this impact is compounded by improved drainage systems surrounding several tidal creeks in the area (Horse, Eau Gallie, Crane, and Turkey Creeks). Distance from the oceanic influence of Sebastian Inlet is another important factor in the slow recovery of salinities (25 to 40 miles to Sebastian Inlet from Melbourne and Cocoa, respectively). Salinity spiked above 20 ppt during the drier spring and early summer months. The 20 ppt level has been demonstrated as the minimum salinity to sustain long-term growth of all the IRL seagrass species except for *Ruppia maritima*, which can tolerate lower salinities. Even if water clarity and other environmental conditions are excellent, most seagrasses fare poorly in salinities below 20 ppt. Thus, persistently low salinities in the Cocoa-Melbourne reach probably contributed to the comparatively low seagrass abundance and diversity in the mid to late 1990s (Figure 5-4).

[5] In 1998 and 1999, very dry conditions existed during the first 5 months of the 7-month seagrass growth season (March – September). Less than 16 inches of cumulative rainfall was recorded during the 5-month period (March – July) in each year, which is about 10 inches below the average for the same 5 months during the previous 8 years (National Weather Service data, Melbourne Airport).

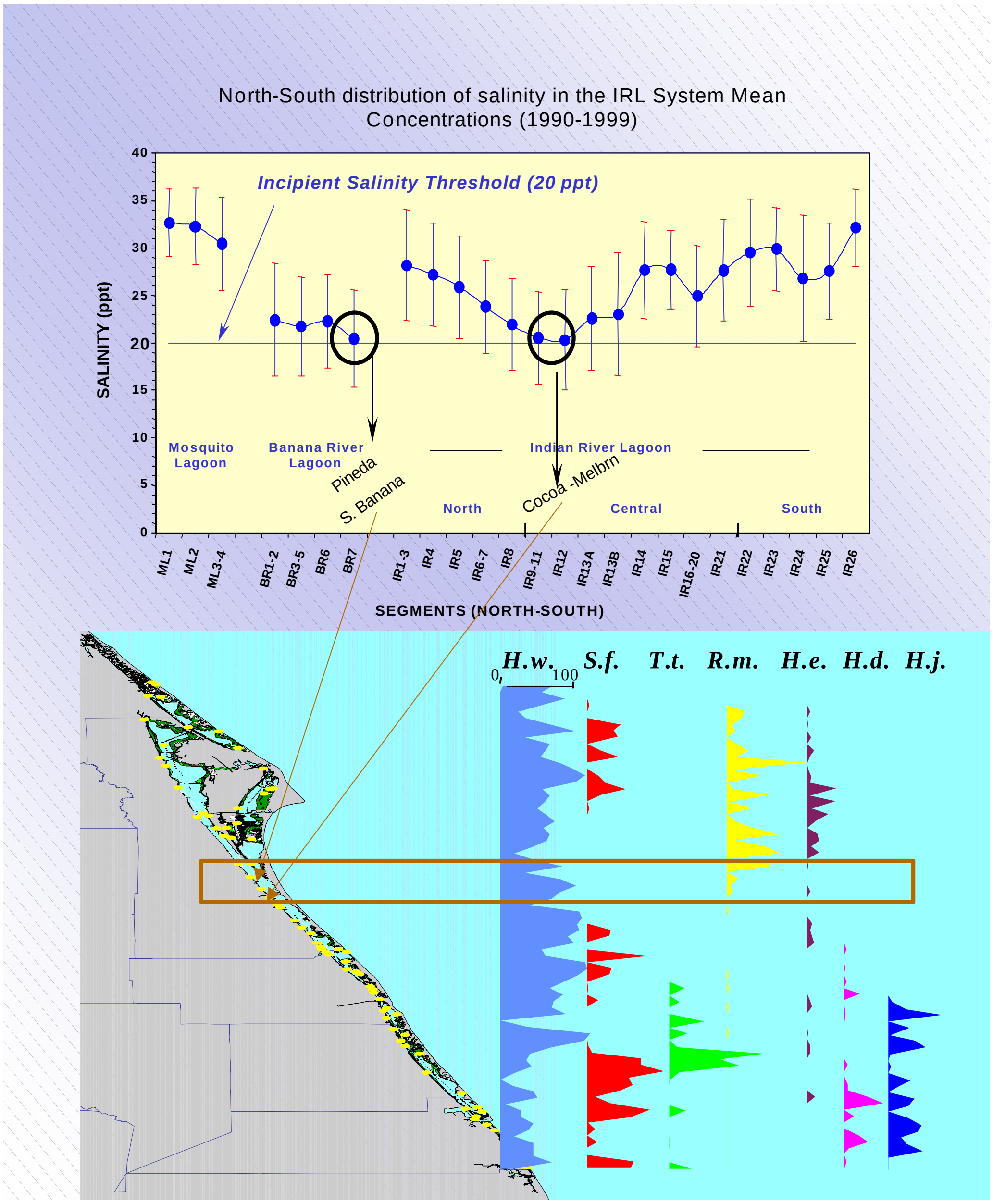

Figure 5-4. 10-year mean salinities +/- S.D. in the IRL system by segment (top plot) and the relative abundance and diversity of seagrasses with an emphasis on the south Banana River Lagoon and Cocoa-Melbourne reach (bottom graphic) where both low salinities and low seagrass abundance and diversity exist

Seagrass Species:
H.w. – *Halodule wrightii* **S.f.** – *Syringodium filiforme* **T.t.** – *Thalassia testudinum*
R.m. -- *Ruppia maritima* **H.e.** – *Halophila engelmannii* **H.d**. – *Halophila decipiens*
H.j. – *Halophila johnsonnii*

Interestingly, *Ruppia maritima* briefly emerged as the second or third most abundant seagrass species in the Cocoa-Melbourne area during the low salinity period of 1996 – 1998 (SJRWMD seagrass transect data).

Elsewhere in the North and Central IRL, salinity levels are typically well above 20 ppt, even reaching annual means of 25 to >30 ppt in the northernmost segments (IR1-3) and in the Sebastian-Vero Beach area (segments IR14 – 21) (Figures 5-5 and 5-6b). Consequently, salinity throughout most the IRL is generally maintained above the 20 ppt threshold and is not considered a problem except in the Cocoa-Melbourne reach (and in south Banana River Lagoon). It is quite probable that low salinity is not acting alone in its presumed impact on Cocoa-Melbourne seagrasses (refer to Figures 5-1 and 5-2 for seagrass status information).

Other water quality factors, specifically any or all of the "optical" pollutants, are likely antagonists as well. The most likely of these are turbidity and color. Two independently conducted studies, one by SJRWMD (analysis of the 10-year record of ambient data) and the other by Harbor Branch Oceanographic Institution (Hanisak, 2001), both concluded that turbidity and color are the primary pollutants inhibiting light penetration in the North and Central IRL. In combination, turbidity and color may account for up to 50% of the attenuation of light through the water column (Hanisak, 2001).

One might expect color to be elevated in certain areas of the Central IRL where there are numerous creeks and canals discharging colored surface water. Indeed, the Central IRL is noted for some of the highest color of any sub-lagoon area. The10-year means range from about 20 to 30 pcu, whereas for most of the other sub-lagoons, the 10-year means range from 15 to 20 pcu.

The Melbourne and Vero Beach vicinities measured the highest color levels in the IRL system. The Melbourne segment (IR12) usually exceeded 20 pcu from 1994 through 1998 (Figure 5-6a). Even higher color levels were measured in the Vero Beach vicinity (segments IR16-20) -- often exceeding 30 pcu as an annual mean from 1990 through 1998. Then, in 1999, while salinities were noticeably increasing, color decreased below 20 pcu in Melbourne, Vero Beach, and throughout the North and Central IRL (Figures 5-5 and 5-6a and b).

One should also expect wet season[6] color levels to be higher than in the dry season. This seasonal pattern is most notable in the Vero Beach segments where the wet season color levels can be 2 to 3 times the dry season levels (from <15 pcu to >30 pcu) (Woodward-Clyde, 1994b).

Turbidity levels need to be quite low in marine or estuarine systems if they are to support healthy beds of seagrass. For the Lagoon proper, turbidity targets in the range of 2.8 to 4 ntu are being considered by SFWMD and SJRWMD. Such levels are routinely exceeded throughout the North and Central IRL (Figures 5-5 and 5-6a and b) (as well as in Mosquito Lagoon and Banana River). The highest levels are found in the Vero Beach area where turbidities are above 6 and 7 ntu as annual means (Figure 5-6b). Unfortunately, turbidity appears to be a problem throughout the IRL system.

Presumably, total suspended solids (TSS) and phytoplankton (measured indirectly as chlorophyll a) are the main constituents that collectively control turbidity levels. Turbidity levels in the North IRL (segments IR1-8) are controlled nearly equally by TSS and chlorophyll a[7]. This trend appears to continue, though weakens somewhat, into the Central IRL from Melbourne to Sebastian. From Sebastian southward through the Vero Beach segments (IR15-20), TSS predominates as the turbidity controlling factor.

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[6] June-October, which overlaps with the seagrass growth season, March - September

[7] Based on the degree of correlation between turbidity and other constituent data (step-wise regression analysis of SJRWMD data)

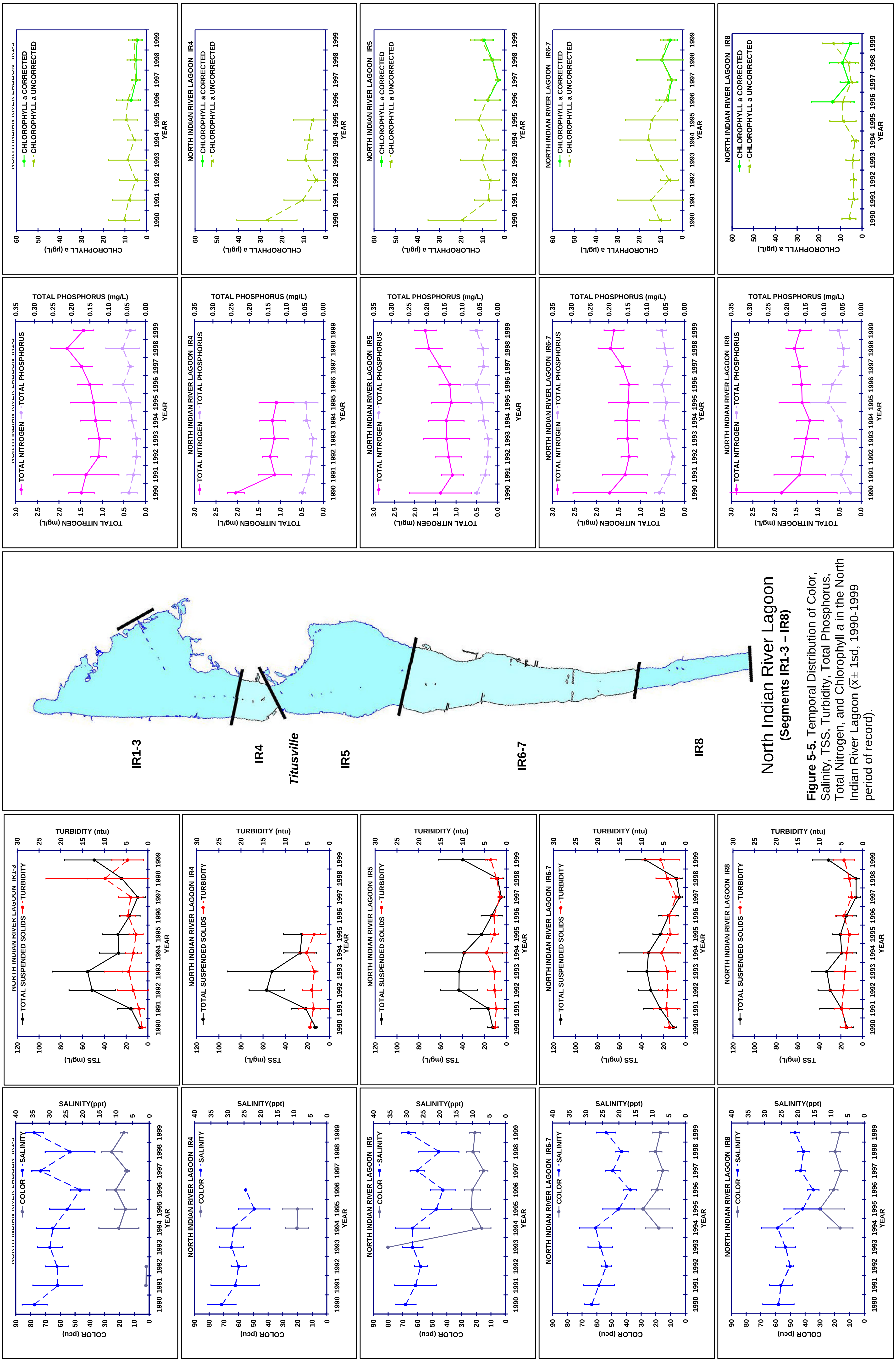


Figure 5-5. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* in the North Indian River Lagoon ($\bar{x}$± 1sd, 1990-1999 period of record).

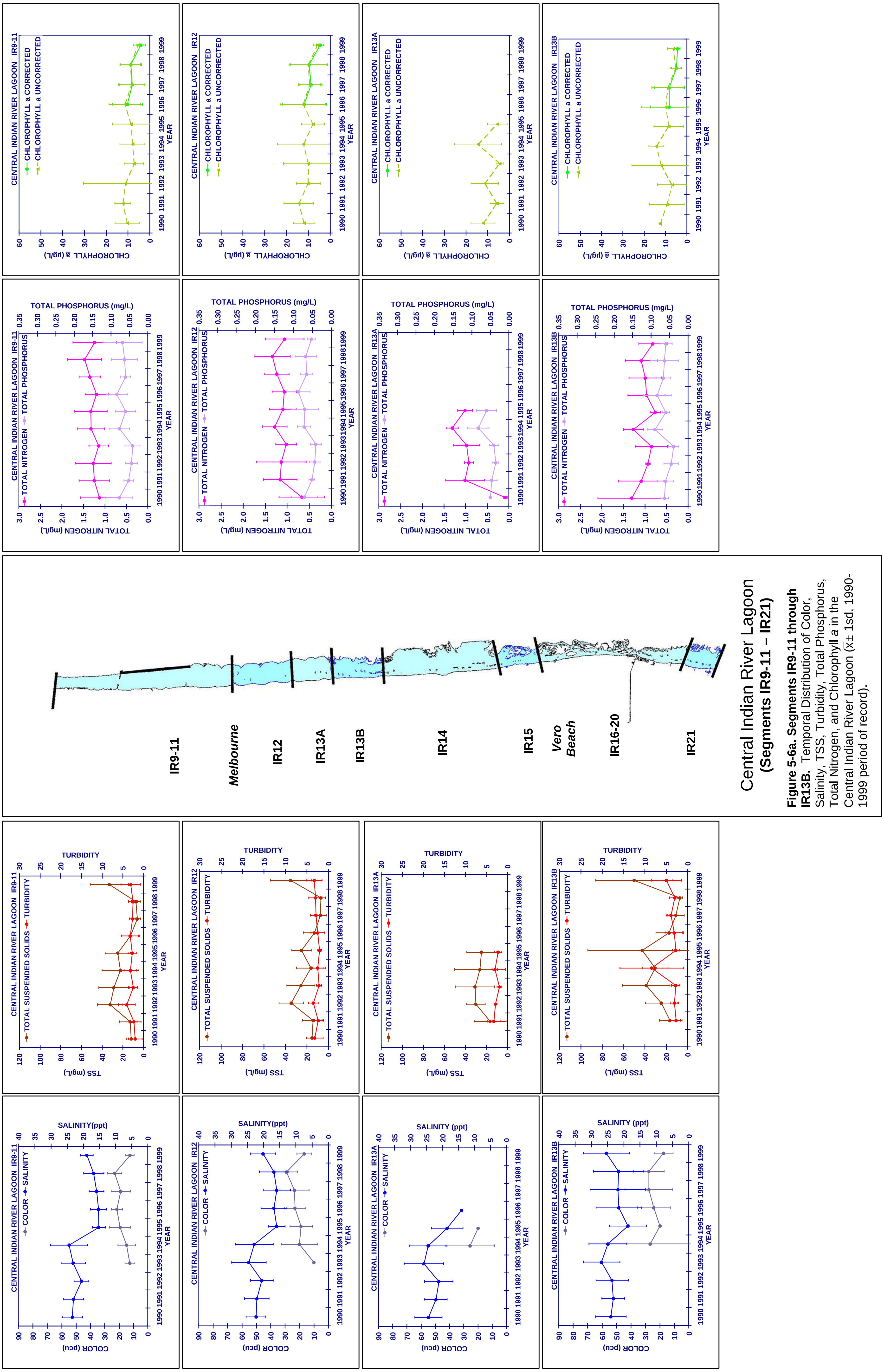
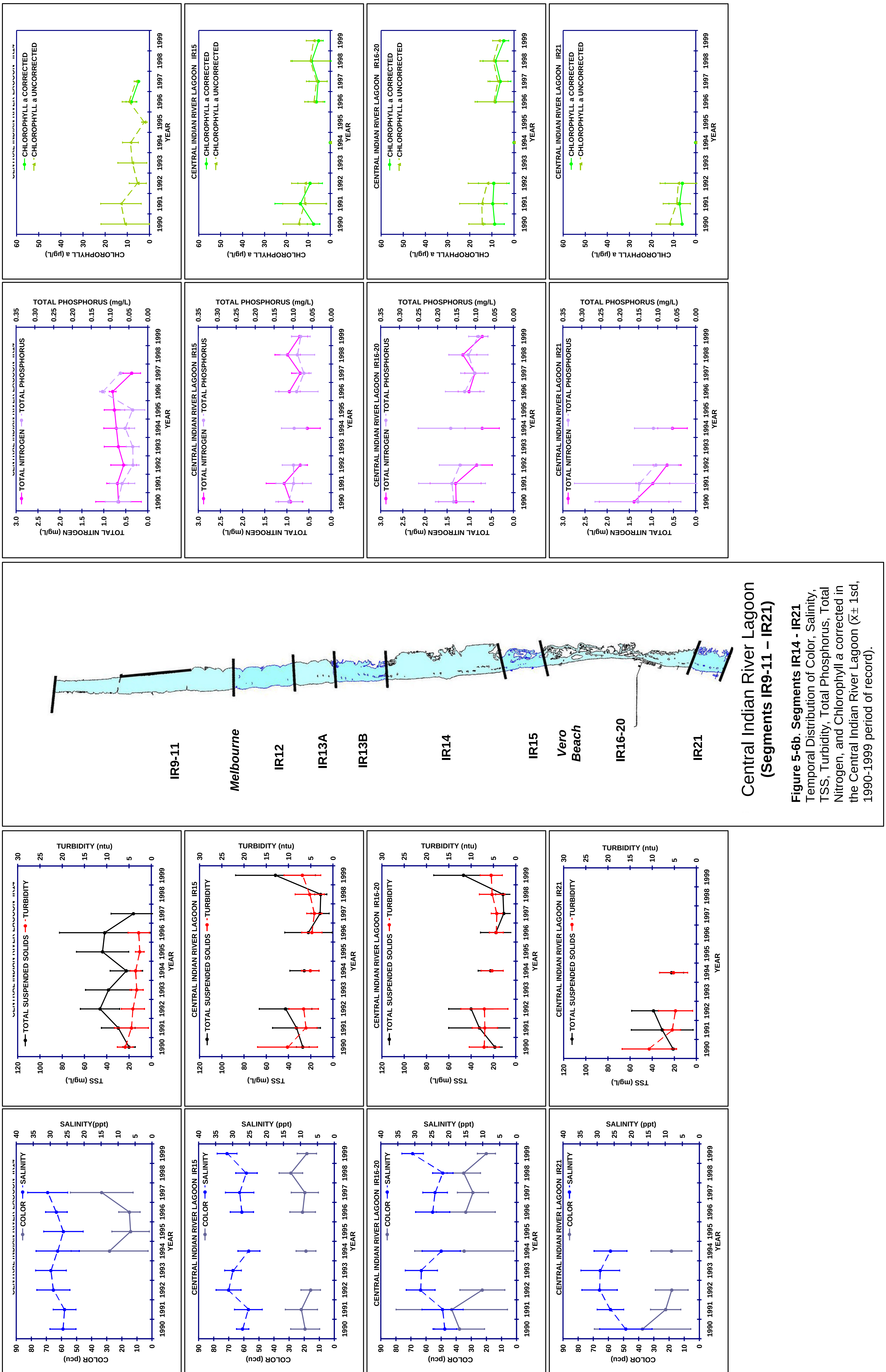


Figure 5-6a. Segments IR9-11 through IR13B. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* in the Central Indian River Lagoon ($\bar{x}$± 1sd, 1990-1999 period of record).



Central Indian River Lagoon
(Segments IR9-11 – IR21)

Figure 5-6b. **Segments IR14 - IR21** Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll a corrected in the Central Indian River Lagoon (X̄± 1sd, 1990-1999 period of record).

TSS in the IRL contains a mineral to organic content ratio of about 2.5 to 1 (SJRWMD data), which is similar to that of muck sediment. Muck is largely mineral soils (clays and silts) eroded from land and mixed with organic detritus (Trefry et al., 1990). The Vero Beach segments contain some of the more extensive deposits of muck in the IRL system (excluding Sebastian and St. Lucie Rivers). Nonetheless, like Vero Beach, other highly developed areas in the North and Central IRL also contain large or numerous deposits of muck – Titusville, Cocoa-Rockledge, and the Melbourne-Palm Bay reach (Trefry et al., 1990). Resuspension of deposited muck and inputs of new material via land runoff and stream discharges are probably the processes that result in suspended material in the Lagoon. Given that these processes are more pronounced in the Central IRL than in the North IRL[8], it is conceivable that suspended solids would be a significant influence on turbidities in Central IRL and especially in the Vero Beach segments.

TSS fluctuates widely within and between years throughout the North and Central IRL, even in the good seagrass segments (IR1-5, IR13B, and IR14), with mean annual concentrations ranging between <10 mg/l and more than 50 mg/l (Figures 5-5 and 5-6). Some of the lowest concentrations were observed from 1996 through 1998 (and into early 1999 in many areas), dropping well below 10 mg/l, only to dramatically rise in mid-1999 to 40+ mg/l (Figures 5-5 and 5-6).

In contrast, mean annual chlorophyll *a* concentrations throughout the North and Central IRL were fairly stable over the last decade; tightly fluctuating around a mean of 10 µg/l. For most segments, mean annual concentrations even declined to less than 6 µg/l from 1997 through 1999 (Figures 5-5 and 5-6). While 'bloom' concentrations of 30-50 µg/l do occur sporadically, this evaluation of the ambient data and other studies (SFWMD, 2000; Kenworthy and Fonseca, 1996) suggest that phytoplankton production has not reached and maintained levels that would substantially impinge on light penetration. Nonetheless, chlorophyll *a* or phytoplankton is a contributory factor, particularly in the Central IRL (Hanisak, 2001), and nutrient management is important as a means to *prevent* this factor from taking a larger role. The need for nutrient management is further emphasized by studies that show epiphytic growth (attached algae) on seagrass blades may shade as much as 50% of available light to seagrass blades (Harden, 1994; Dixon, 2000).

Based on spatial and temporal trends in nutrient concentrations (Figures 5-5, 5-6, and 5-7) and a study to identify the limiting nutrient(s) in the IRL system (Phlips et al., 2001), it is clear that nutrient management in the IRL basin must consider both nitrogen and phosphorus. It was concluded by Phlips et al. (2001) that the IRL is nutrient-rich and that phytoplankton production is held below its potential because of two factors: flushing and grazing. Another conclusion of the study was "while nitrogen appears to be the most widely limiting nutrient in the IRL, phosphorus also plays a relatively important role… [especially] where the influence of freshwater inflow on water chemistry is most pronounced." Increasing concentrations of total nitrogen in North IRL (Figures 5-5 and 5-7) and the very high concentrations of total phosphorus in the Vero Beach vicinity (Figure 5-7), also indicate the need to target both nutrients in pollutant reduction strategies.

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[8] Over 65% of the muck volume in the entire IRL system resides in the Central IRL. The Central IRL basin non-point loading of suspended solids is about 4 times that in the North IRL: **>**32 million lb/yr in Central IRL vs. ~8 million lb/yr in North IRL. There is more discussion of suspended solids and nutrient loadings later in this chapter.

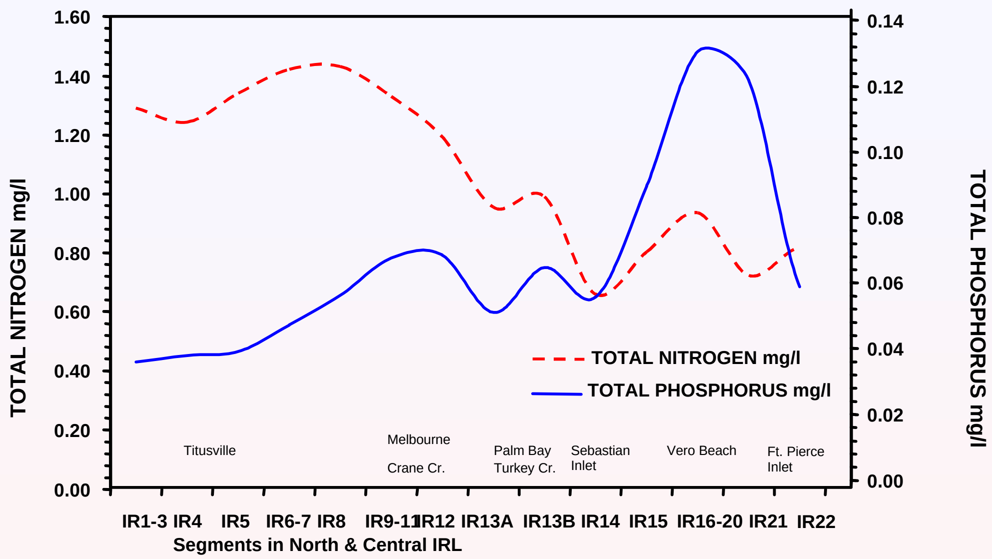


Figure 5-7. North to south spatial trends in total nitrogen and phosphorus concentrations in the IRL

<u>Summary of Assessments</u>

The seagrass resource in the northernmost IRL segments (segments IR1-5) and in the Sebastian segments (IR13B and IR14) in the Central IRL are considered to be in good condition. The probable factors that allow good seagrass conditions are different in the North than in the Central IRL. The northernmost segments are poorly flushed but their watersheds are not extensively developed and do not generate the large pollutant inputs characteristic of the Central and South IRL. Alternatively, the segments adjacent Sebastian Inlet are located in large and developed watersheds, but are well-flushed due to the inlet tide (up to a week for a nearly complete volume exchange; Sheng, 1997).

The worst segments are the Cocoa-Melbourne segments (IR6-7 and IR9-12) and Vero Beach segments (IR16-20). Both are relatively narrow, low volume reaches receiving large drainage and pollutant load inputs from highly developed watersheds. While the Cocoa-Melbourne area did show modest gains in seagrass coverage in the late 1990s, the coverage in the Vero Beach segment remained quite low.

Turbidity and suspended solids fluctuate greatly and both are a problem throughout the IRL in good, fair, and poor seagrass segments alike. So, what appears to set apart the good and poor seagrass segments is color and salinity. Color is comparatively higher in Cocoa-Melbourne (usually >20 pcu annual average) and especially in the Vero Beach segments (usually >30 pcu annual average) than in other North and Central IRL segments. Additionally, the Cocoa-Melbourne area is susceptible to prolonged periods of low salinity (<20 ppt) and problems of light attenuation related to color and turbidity.

The significant gains in seagrass coverage observed in 1999 in most of the fair and poor segments occurred when salinities rebounded to >20 ppt, color levels were <10 pcu (annual mean), and chlorophyll *a* concentrations were <6 µg/l (annual mean). However, turbidities and suspended solid levels showed no declining trend. Indeed, turbidities and suspended solids seem to be persistent problems throughout the IRL system.

Projects and Progress To Date

Strategies for Pollutant Load Reduction. In the North and Central IRL, several long-term strategies were enacted at the inception of the SWIM program (1987/88) to control the major sources of nutrient and suspended solids loadings. The treatment of non-point surface water drainage is foremost among the strategies to effect significant reductions in pollutant loadings. Other strategies include muck source control, muck sediment removal, and further improvements in domestic waste management via remediation of septic tank problem areas and further reductions of treated waste discharge to the IRL.

Non-point Source Strategy – Surface Water Drainage. Water quality treatment and volume reduction of non-point surface water drainage, along with a comprehensive erosion control program, are the key steps toward significant pollution abatement, especially in the Central IRL (segments IR 9-21). Increases in pollutant loading rates since 1943 in both the North and Central IRL are not surprising (Figures 5-8 and 5-9), but the magnitude of the loading increase in the Central IRL poses greater environmental harm and management challenges than in the North IRL.

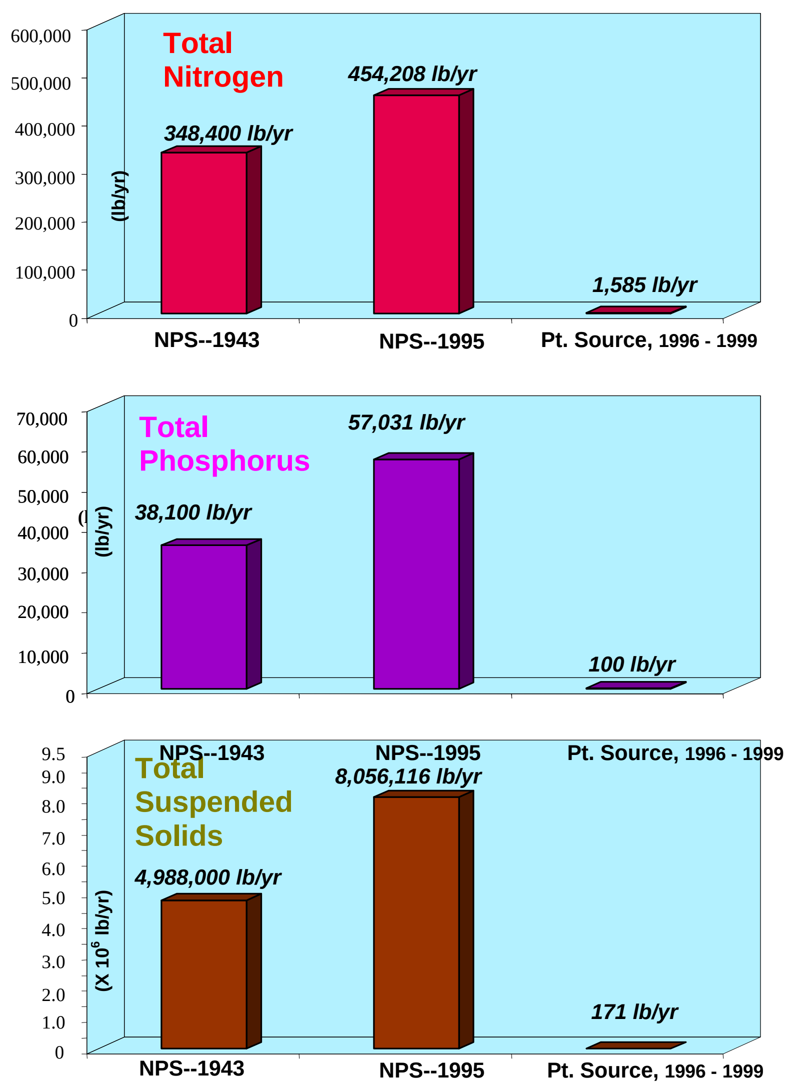


Figure 5-8. North IRL surface water TN, TP, & TSS loading* comparisons:

- **1943 vs. 1995 Non-point source (NPS) run-off loadings**
- **1995 NPS vs. annual point source or domestic WWTP loadings.**

Þ **The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.**

*NPS loadings estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

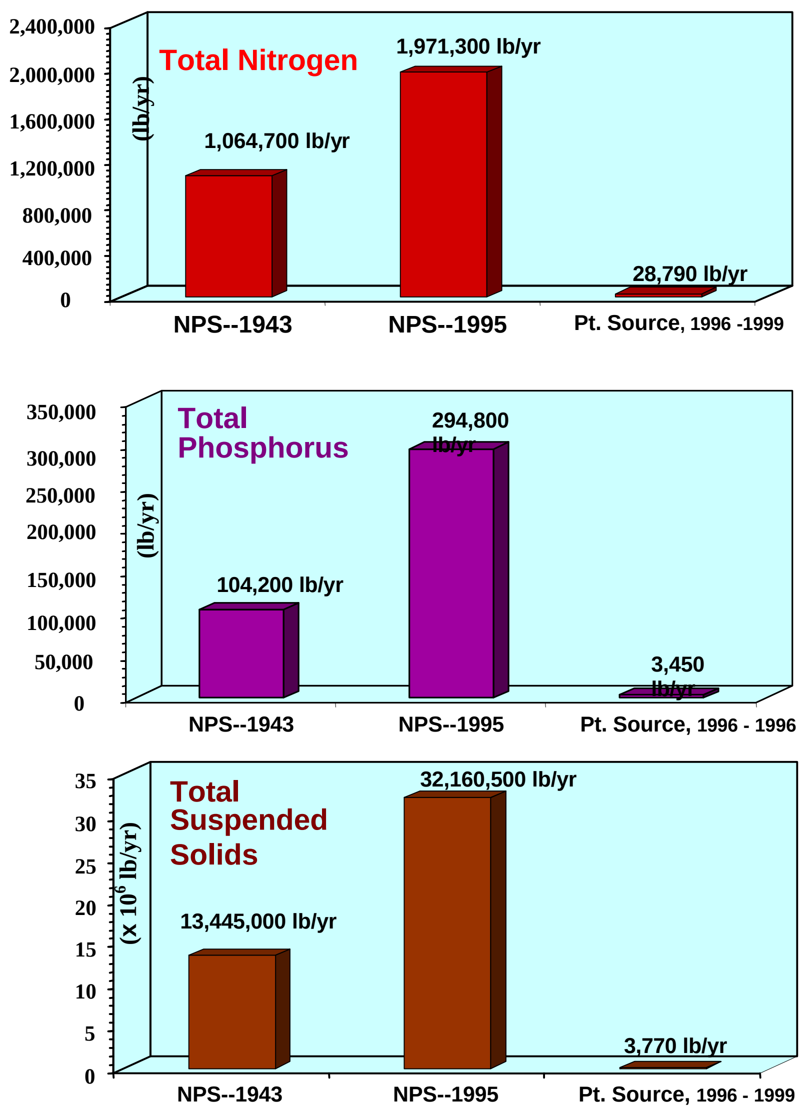


Figure 5-9. Central IRL

surface water TN, TP, & TSS loading* comparisons:

- **1943 vs 1995 Non-point source (NPS) run-off loadings**
- **1995 NPS vs annual point source or domestic WWTP loadings**

Þ **The 1943 loading estimates are adopted as provisional PLRGs; intended for planning purposes only.**

*NPS loadings estimates derived from SJRWMD's IRL-specific Pollutant Load Screening Model (PLSM). Loadings do not include atmospheric and groundwater inputs. Point source loadings are from domestic WWTPs derived from FDEP records.

The current or estimated1995 annual loadings of nutrients and TSS to the Central IRL are 3 to 6 times higher than the annual loadings to the North IRL (Figures 5-8 and 5-9) and 6 to 15 times higher than to either the Banana River Lagoon or Mosquito Lagoon! The main reasons for this large disparity in loading rates is that the Central IRL is home to more numerous and more developed tributary sub-basins, several of which have been enlarged 15% to 700% beyond their natural boundaries by major drainage diversion projects that were constructed between 1920 and 1970[9]. In the Central IRL, non-point pollution abatement plans that address the larger sub-basins and their inter- and intra-basin drainage projects are a programmatic priority (these sub-basin projects are described in more detail in the next section).

[9] Crane Creek watershed increased ~65% (additional lands within and west of Melbourne Village), Turkey Creek watershed increased ~700% (Melbourne-Tillman Water Control District), Sebastian River watershed increased ~100% (lands draining to Sottile Canal and lands within Vero Lakes and Fellsmere Water Control Districts), and the watershed draining to segment IR16-20 increased ~15% (includes Indian River Farms Water Control District).

In addition to the sub-basin plans and projects, the SJRWMD and IRLNEP foster smaller scale surface water treatment projects in both the North and Central IRL that primarily serve a pollutant reduction purpose; but some projects also improve flood protection of city neighborhoods. For example, over the last 5 years many local governments cost-shared with the SJRWMD and IRLNEP to plan and construct such projects. These local projects are briefly described below (Tables 5-2 and 5-3).

Table 5-2. North IRL basin non-point, surface water treatment projects supported by SJRWMD/IRLNEP and local government funds, 1995 - 2001 (North IRL comprises segments IR1-8: Turnbull basin to Honeymoon Lake, Merritt Island)

- Titusville
  - *Sand Point Park Marina* -- pond and swales serving ~60 acres of largely commercial development; design removal efficiencies of 94% TSS, 76% TN, and 69% TP for up to 1 inch rainfall
  - *Garden St. basin* – treatment train system (e.g., swales, check dams, inlet skimmers, & baffle boxes) to treat drainage from a 114-acre urban basin
  - *Chain-of-Lakes Stormwater Park* (under design)– large municipal stormwater treatment system with public park amenities.
- *Cocoa* –
  - *Riverfront Park* – installation of 3 baffle boxes and underground storage reservoir to collect stormwater from 30 acres of old downtown, which will be pumped to the city WWTP to supplement the city's reuse supply for lawn irrigation
- *Rockledge* –
  - *Rockledge Dr./Barton Ave./Orange Ave.* – 3 baffle boxes (more are pending) serving ~42 acres of old residential development
- Brevard County and Merritt Island --
  - *Mainland, south of Titusville* – Kennedy Point Yacht Club retention weir intended to trap solids from drainage of a 320-acre basin.
  - *Port St. John, Sunrise Village* – baffle box serving approximately 66 acres of residential land use (captured 150,000 lb of sediment in 6 months)
  - *Port St. John, Broadway Blvd. Detention pond* – off-line detention of drainage from a 127-acre residential area with a design targets of at least 50% reduction in TSS and nutrient loads and with no increase in peak dis*charge for up to a 25-year/24-hour storm event.*
  - *N. Cocoa* – off-line detention basin and diversion structures at Indian Trail near U.S.1 serving 70 acres of rural residential
  - *Merritt Island, Winter Apartment area* – baffle box serving about 3.5 acres of commercial land use (1,670 lb of sediment removed in 8 months)
  - *Merritt Island, Granada St. area* – baffle box serving 100 acres of residential development (6,750 lb of sediment removed in 8 months)
  - *Merritt Island, Merritt Park Place sewer and stormwater drainage upgrades* – connection of over 75 residences and businesses with failing septic systems to central sewer and an upgrade of drainage system with inclusion of stormwater treatmen*t*
  - *Merritt Island, curb and grate inlet baskets* -- installed in storm drains throughout the island. Some baskets include oil absorbance pillows.

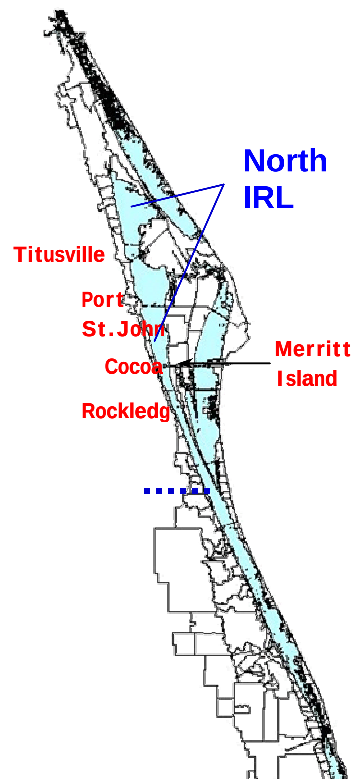
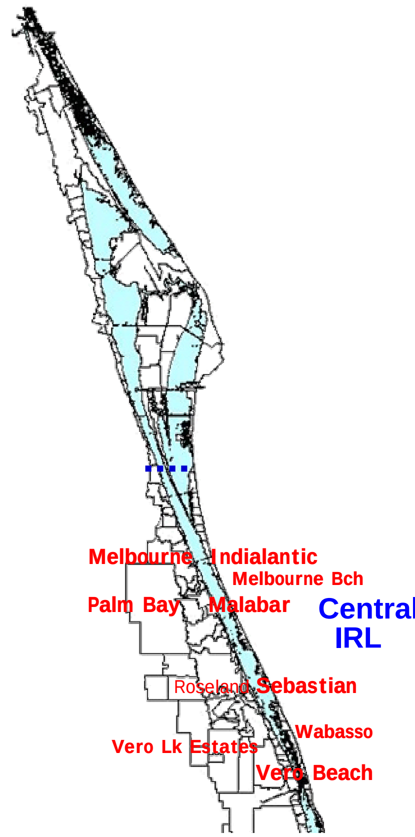


Table 5-3. Central IRL basin non-point, drainage treatment projects supported by SJRWMD/IRLNEP and local government cost-share funds, 1995 – 2001 (Central IRL comprises segments IR9-21: Honeymoon Lake to St. Lucie/Indian River county line)



- *Melbourne –*
  - *Goode Park Terrace Sediment Control* – paving dirt road & swale construction, provides treatment for ~10 acres of residential land use in Crane Creek sub-basin
- *Malabar –*
  - *Cory St. baffle box* -- affects 23.5 acres of rural residential in Turkey Cr. sub-basin
- *Palm Bay --*
  - *Norwood Street (C-1/ Turkey Creek drainage basin)* – two baffle boxes installed for "tandem" treatment of residential drainage for this 25-acre development
  - *Basin 1 surface water treatment train project (Indian River basin)* – wet detention basin & sediment trap system that serves 100-acre res./com. drainage area.
  - *Basin 7 surface water treatment train project (Turkey Creek/IRL)* – wet detention basin and wetlands treatment serving ~100 acres of res./com. area
- *Indialantic --*
  - *Street Sweeper* -- (also subject of a study to compare efficiencies between street sweeper & baffle boxes); sweeper operates twice monthly collecting ~2,000 lb of sediment per trip
  - *Fourth Ave. to Indian R. Dr.* - swale system constructed that serves 30 acres of moderate to high density residential land use
- *Melbourne Beach –*
  - *Ocean Ave.* -- baffle box, treats ~10 acres of res./com. properties
- *Brevard County --*
  - *Dove St. drainage treatment project* -- (Melbourne, Crane Cr. sub-basin)
- *City of Sebastian --*
  - *Main Street baffle box* -- treats drainage from 5 acres of old downtown Sebastian
  - *Elkcam waterway dam and Stonecrop basin surface water management projects* – flood control and treatment of drainage from southern portion of the City of Sebastian (~2,100 acres).
- *Vero Beach –*
  - *Mockingbird Lane baffle box* -- treats 15 acres residential (drains to Main Canal).
- *Indian River County --*
  - *Vero Lakes Estates (Sebastian River, South Prong)* – modification of upland ponds into more effective wet detention systems; swale improvements included. Expected reduction in TSS annual load by 80% from this 3,871-acre residential development.
  - *Roseland (Collier Creek, a tributary to South Prong of Sebastian River)* – Wet detention system and enlargement of conveyances to reduce flooding and pollutant loading along Bay Street; south detention pond expected to provide 72% reduction in annual TSS loading; t*he north detention pond about 65%.*
  - *Gifford Area near City of Sebastian* – Wet detention ponds and improvements to conveyances to improve flood protection, erosion control, should achieve ~50% reduction in TSS and TP annual loadings & ~30% reduction in TN loading.
  - *Wabasso Causeway Park* – shoreline stabilization with native planting & coquina revetments to reduce erosion; dry detention; restroom upgrades with sewer connection.

Sub-basin Water Management Plans (Central IRL). As was previously stated, water management plans concerning the larger sub-basins in the Central IRL are a programmatic priority, particularly those that receive diverted drainage from the Upper St. Johns River Basin. These sub-basins are: Crane Creek, Turkey Creek and Melbourne-Tillman Water Control District (MTWCD), Sebastian River (including the North and South Prongs, Fellsmere Canal and C-54), and Indian River Farms Water Control District (Figure 5-10). The sub-basin plans are in various stages of development, from conceptual design to detailed engineering. Planning is a collaborative effort between the SJRWMD and the local jurisdictions that are the drainage management authorities in these sub-basins -- the cities, counties and water control districts (WCDs).

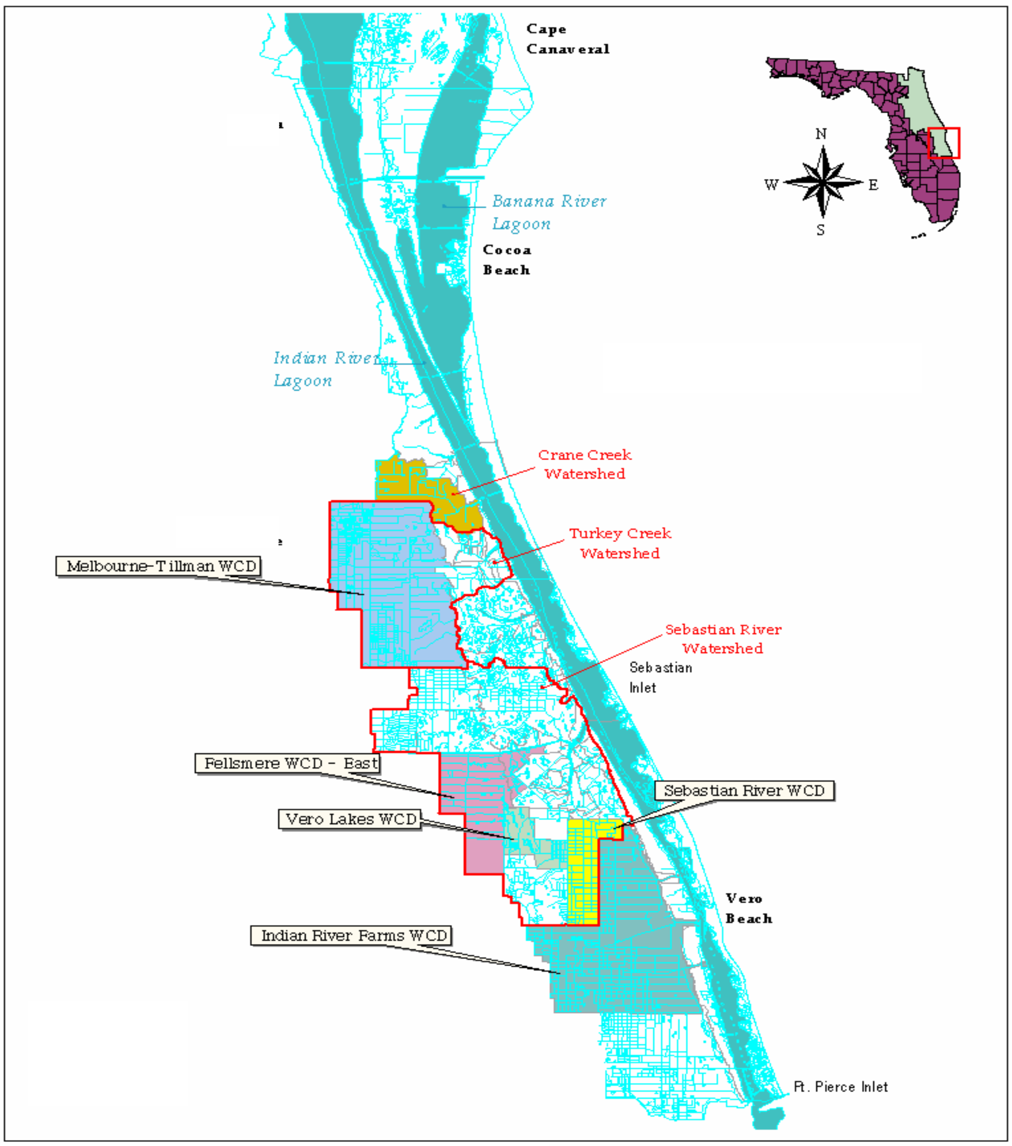


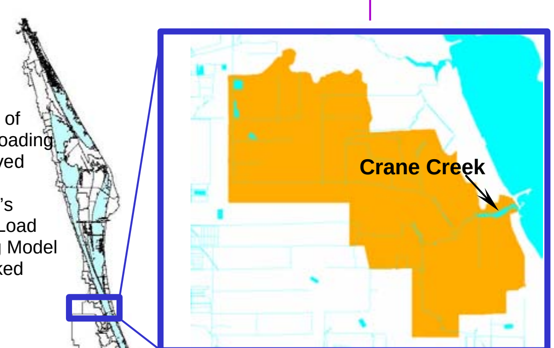
Figure 5-10. Location of Priority Sub-basins and Water Control Districts (WCDs) in the Central IRL

It is the SJRWMD's intent to achieve, to a significant degree, the PLRGs in the Central IRL by implementing sub-basin plans described below. For the time being and until *final* PLRGs are established, *provisional* PLRGs are recommended as planning targets. Provisional PLRGs are generally based on estimated 1943 loading rates calculated by the SJRWMD Pollutant Load Screening Model (Adamus and Bergman, 1995). This model was slightly modified to better match land use conditions in the IRL Basin. The provisional PLRGs or "allowable" loading rates are intended to be fairly conservative; thus, the design of stormwater treatment systems based on those targets should be able to meet final PLRGs. It is assumed that by meeting 1943 loading rates, water quality and clarity in the affected lagoon segments should improve sufficiently to enable seagrasses to expand to the 1943 coverage, the historical coverage target for most IRL segments (which is very close to the 1.7 m depth target).

The SJRWMD would like to develop cooperative funding partnerships with local governments, water control districts, and U.S. Army Corps of Engineers (via the IRL-North Feasibility Study) to implement these sub-basin plans as long as they adequately address either provisional or final PLRGs. The partnership arrangement can even be expanded to cover other water issues as part of the PLRG strategy process and be included in a sub-basin plan. Some of these other water issues may include improved flood protection, water supply, and groundwater protection.

Provided below are the description and status of each of the sub-basin planning projects in the Central IRL: Crane Creek, Turkey Creek/MTWCD, Sebastian River, and Indian River Farms WCD.

Crane Creek. Crane Creek is a major tributary to the Central IRL draining a developing 21 sq mi urban watershed. The Creek conveys drainage from Melbourne, Melbourne Village, most of West Melbourne, and some unincorporated areas whose drainage is managed by Brevard County. Between 1920 and 1965, the watershed area was expanded westward, taking in about 7 sq mi beyond the Ten-Mile Ridge[10] as a consequence of development. (It was more expedient and hydraulically effective to have drainage canals cut to Crane Creek rather than to the St. Johns River marshes.)



Estimates of pollutant loading were derived from the SJRWMD's Pollutant Load Screening Model and checked against measured loading.

Crane Cr. Sub-basin	*TN* lb/ac/yr	*TP* lb/ac/yr	*TSS* lb/ac/yr
Est. 1995 loading	8.7	1.1	178
"allowable" loading target	4.4*	0.6*	<50**

* provisional, based on 50% reduction of current loadings (c. 1995), and approximates c. 1943 loading rates
** provisional TSS target based on 75% reduction level, which is below c. 1943 loading rates

The combined effects of drainage improvements and urban development -- augmenting creek flows and runoff pollutant concentrations – have

10 Ten-Mile Ridge is one of the major hydrologic divides between the IRL and the Upper St. Johns River basins. The other, more significant divide is the Atlantic Coastal Ridge, which is within 1 to 2 miles west of the IRL.

significantly elevated annual loadings of nutrients and TSS. For example, from 1943 to 1995, loadings increased as follows: ~66,000 to 117,000 lb/yr TN; ~6,000 to 15,000 lb/yr TP; and ~963,000 to 2.4 million lb/yr TSS. The Crane Creek sub-basin generates the highest areal loading rates (lb/ac/yr) of any sub-basin in the IRL system. And, by the time the Crane Creek sub-basin is built out, the 1995 pollutant loadings will have increased by an additional 20%.

What is being done to reverse this trend; that is, what is being done to effect pollutant load reductions while population growth and development continue? This challenge is being addressed through a surface water management planning effort, whose dual mission is improved drainage and the water quality treatment of drainage waters. Plan development is spearheaded by Brevard County, with financial assistance and technical reviews provided by SJRWMD. It is intended that both agencies will pool their financial resources, both general revenue and external funding sources (state and federal), to carry out the plan. The cities in the watershed will also be encouraged to participate since they will definitely be beneficiaries of an implemented plan.

From the standpoint of flood protection, it is clear that the western portion of the watershed will receive serious attention. The drainage infrastructure in certain western areas where the flood risk is high will require significant retrofit to meet both water quantity and quality objectives. Toward that end, sizeable parcels of western lands may need to be acquired in order to construct facilities to store and treat drainage waters. Lands are quite scarce in the eastern half of the watershed where it is more heavily developed and populated; therefore, smaller scale drainage treatment projects incorporated within the existing drainage conveyances would be a likely consideration. Furthermore, given the enormous increase in suspended solids loading and muck build-up over time, a comprehensive soil erosion control program should be established in this sub-basin. This program should target development construction, existing development, and drainage canal side-slope erosion[11].

Brevard County recently prepared a proposed watershed plan. This plan describes management alternatives and costs designed to meet up to a 50% reduction in the current annual loading of pollutants (c. 1995)[12]. The reduction levels are translated as "allowable" loading rates which should be achieved even under build-out conditions. Based on a 50% reduction level, the provisional "allowable" loading targets for Crane Creek sub-basin would approximate 4.4 lb/ac/yr TN and 0.6 lb/ac/yr TP. The targets approach the c. 1943 loading rates, more so for TN than TP. Since TSS is a critical pollutant of concern, at least 75% reduction of current loading (c. 1995) is recommended by SJRWMD. That translates to an "allowable" loading of <50 lb/ac/yr, which approximates the c. 1943 loading rate for TSS.

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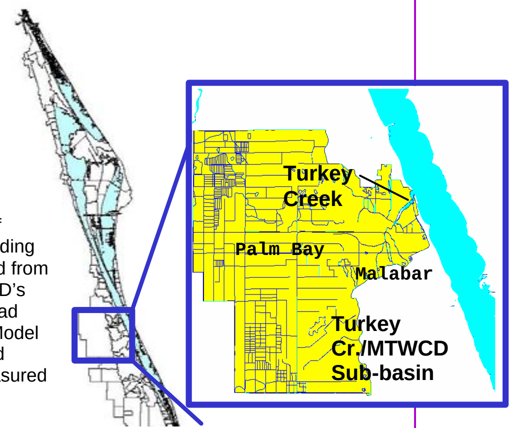
[11] Although it is not typically thought of as a suspended solids reduction strategy, the dredging of Crane Creek's lower reach in 1998 was intended to re-create, to some extent, the creek's sediment trapping capability. That capability serves to reduce the suspended solids loading to the IRL. This strategy could be defined as a BMP if the creek "trap" is periodically dredged. For more information please refer to the section in this chapter entitled *Non-point Source Strategy – Muck*.

[12] Crane Creek's 50% reduction target meets the 1943 loading rates for TN, but not for TP and TSS. A higher, 75% reduction target for TSS should be pursued. More stringent targets may not be economically achievable considering the high level of development in the sub-basin. The PLR Model will help evaluate whether the "50% or 75%" targets can satisfy the seagrass restoration goal for the area.

Turkey Creek/MTWCD. The Turkey Creek/MTWCD sub-basin represents a classic example of an *inter-basin diversion* project, i.e., a drainage development project that diverts drainage from one basin to another. Turkey Creek's drainage area was expanded 10 miles beyond its natural western boundary taking in about 98 sq mi of the Upper St. Johns River Basin (USJRB) floodplain and marshes. This expansion began in the 1920s and continued well into the 1960s under the authority and management of the Melbourne-Tillman Water Control District (MTWCD). As a result, the Turkey Creek watershed was effectively enlarged seven-fold!



Estimates of pollutant loading were derived from the SJRWMD's Pollutant Load Screening Model and checked against measured loading.

TurkeyCr/ MTWCD	*TN lb/ac/yr*	*TP lb/ac/yr*	*TSS lb/ac/yr*
Est.1995 loading	6.2	0.5	80
"allowable" loading target*	1.9	0.2	32

*provisional, meets c.1943 levels

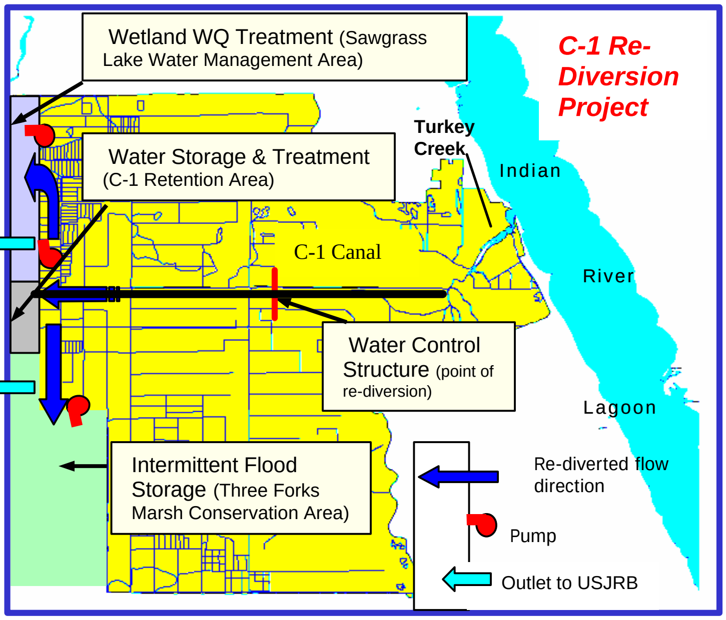
Over 90% of the annual volume of fresh water and 68% to 80% of the annual loadings of nutrient (N and P) and suspended solids that are discharged through Turkey Creek are contributed by the MTWCD's primary canal, C-1 (Trefry and Feng, 1991; SJRWMD unpublished PLSM[13] data, 1994). These unnaturally large volumes of fresh water and pollutant loads released from C-1 are impacting salinity and water quality and, in turn, the seagrasses within a 10 to 20 sq mi area of the adjacent Lagoon. Additionally, large releases of drainage water impacted the economically significant hard clam fishery in the 1980s and 1990s. Storm events frequently triggered C-1 discharges in excess of 500 million gallons/day for several consecutive days. Discharges at that magnitude and duration, occurring year after year, contributed to the decline in the hard clam fishery (*Mercenaria mercenaria*) because of the clam's sensitivity to prolonged drops in salinities[14].

Therefore, to significantly reduce Turkey Creek's impact on the IRL, tighter restrictions on discharge from C-1 canal are necessary. Freshwater, nutrient, and suspended solids reduction targets are established for C-1 as well as for other, lesser inflows to Turkey Creek. The targets and the plans to achieve them have taken years to develop through diagnostic investigations, evaluations of water management alternatives and costs, and analyses of secondary benefits and impacts (e.g., water supply, groundwater, and recreation). Of course, the SJRWMD has not acted alone. The MTWCD, U.S. Army Corps of Engineers (USACE) and the municipalities of Palm Bay and Malabar are actively engaged with SJRWMD in planning and implementation activities.

[13] PLSM is the Pollution Load Screening Model developed by SJRWMD (Adamus and Bergman, 1993). PLSM results were used in conjunction with results from Trefry and Feng (1991) to provide Turkey Cr. sub-basin loading estimates.

[14] For example, salinity below 20 parts per thousand for several days duration is potentially injurious or lethal to hard clam larvae (Davis, 1958; Chanley, 1958).

The primary strategy in this sub-basin is the C-1 *re*-diversion project, which is jointly funded and conducted by the SJRWMD, MTWCD, and USACE. Other important strategies – the water management plans of Palm Bay and Malabar, and the muck removal project in the creek's lower reach[15] -- are intended to work in tandem with the C-1 re-diversion project to achieve the overall PLRGs for Turkey Creek. The purpose of the re-diversion project is to re-divert as much of the MTWCD's C-1 drainage to the west (see map to the left). As currently planned, the re-diverted water will enter a storage/treatment cell (C-1 Retention Area: 1,280 acres) at the western terminus of C-1. From there, water will be pumped to the north end of a created wetland system (Sawgrass Lake Water Management Area: approximately 2,500 acres) and be allowed to gravity-flow southward through the system for water quality treatment. The treated water can then be released in a controlled manner to the USJRB. Flood waters can be further controlled by directing C-1 drainage southwest to the Three Forks Marsh Conservation Area in addition to the C-1 Retention Area and Sawgrass Lake WMA. The completion date set by the USACE for project construction is 2006.



The C-1 re-diversion project is currently designed to meet freshwater discharge and salinity targets and to achieve the majority of the targeted reductions in nutrient and suspended solids loads from the creek to the IRL. Targets limiting C-1 storm discharges are expressed as maximum discharges that would be allowed but not be exceeded under certain storm conditions. For example, under the current C-1 re-diversion design, C-1 discharges greater than 452 million gallons/day (700 ft^3/s) would occur no more frequently than once every 5 years. Discharges below those levels will certainly help meet the salinity targets. Presently, under average annual rainfall conditions, discharges up to or above 650 million gallons/day (1000 ft^3/s) usually occur at least once every year! In other words, the C-1 re-diversion project should go far toward meeting a desirable salinity regime in the portion of the Lagoon affected by Turkey Creek discharges.

With regard to annual nutrient and TSS loadings, an ambitious "up-to-80%" reduction target is established. Actually, any reduction above 60% would be a remarkable achievement. The water management opportunities to effect such a significant reduction are present in this sub-basin, probably more than in the other developed IRL sub-basins. Substantial reductions in pollutant loads (50% or more) would be accomplished by the C-1 re-diversion project and its planned reductions in C-1 storm discharges (above) and

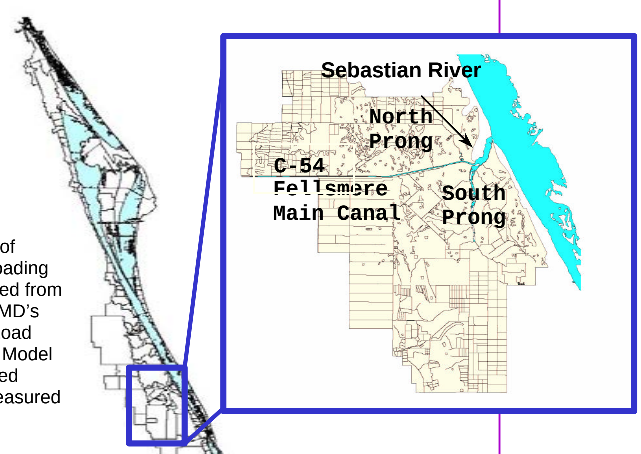
[15] Dredging of Turkey Creek's lower reach, completed in 2001, is intended to re-create the creek's sediment trapping capability. That capability serves to reduce the suspended solids loading to the IRL. For more information please refer to the section in this chapter entitled *Non-point Source Strategy – Muck*.

base flows[16]. The balance of the targeted reductions can be handled under stormwater programs managed by Palm Bay and Malabar and a canal side-slope erosion control program managed by MTWCD. Both municipalities are presently working on plans for that purpose as well as for improved flood control.

These municipal water management plans identify projects that would improve neighborhood drainage, reduce flood risk, and provide the drainage quality treatment required to meet PLRGs. Several of these projects in Palm Bay are constructed; many more are being planned in Palm Bay, as they are in Malabar. It's possible that some of the larger projects, requiring sizeable parcels of land, can be utilized as parks for recreation and for environmental education (these projects are called "stormwater parks"). Constructed projects in Palm Bay and Malabar are listed above in Table 5-3.

Erosion of canal side-banks is probably a major source of the suspended solids delivered to the creek and into the IRL. Therefore, a comprehensive erosion control program, with special emphasis on canals, will become a major initiative carried out by the MTWCD and the municipalities (please refer to section entitled *Next 5 years*).

Sebastian River. The Sebastian River sub-basin is the largest drainage area in the Central IRL, approximately 172 sq mi., and the second largest in the entire IRL basin, behind the St. Lucie River. The magnitude of Sebastian River's annual loading (c. 1995 - 1999) of nutrient and TSS (~300,000 to 650,000 lb/yr TN, ~33,000 to 100,000 lb/yr TP, and 3 to 7 million lb/yr TSS) easily exceeds that of either Crane or Turkey Creeks. Since 1943, Sebastian's largest increases in annual loadings are in phosphorus followed by suspended solids (>100% and >40%, respectively). These loading increases are due to inter-basin diversions of drainage and land development (agricultural and urban).



Estimates of pollutant loading were derived from the SJRWMD's Pollutant Load Screening Model and checked against measured loading.

Sebastian River	***TN*** *lb/ac/yr*	***TP*** *lb/ac/yr*	***TSS*** *lb/ac/yr*
Est.1995 loading	5.9	0.93	83
"allowable" loading target*	5.2	0.4	<50

*provisional, meets c. 1943 levels

[16] Base flows may be thought of as non-storm flows. For this project, a base flow is statistically defined as a monthly or seasonal average flow.

The South Prong and Fellsmere Main Canal contribute most (roughly 60%) of Sebastian's annual average discharge[17] and pollutant loading to the Lagoon. North Prong's flow constitutes 20-25% of Sebastian's annual discharge. C-54's contribution makes up most of the remainder, but its annual discharge volume has been substantially reduced over the last 7 years.

The diminished flows from C-54 are due to the work completed in the Upper St. Johns River Basin project (SJRWMD/USACE), enabling greater volumes of flood water to be stored in the project's constructed reservoirs and restored marshes rather than be released through C-54 to "tide". Consequently, the South Prong, Fellsmere Canal, and North Prong drainage areas are receiving more water management attention for the sake of the Sebastian River and IRL estuaries.

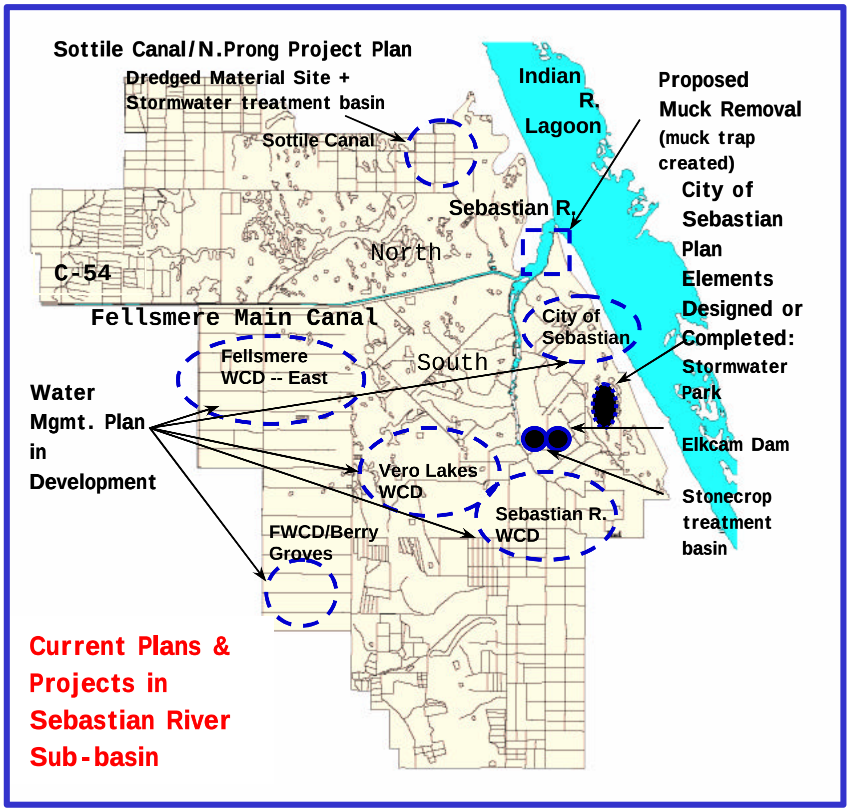
Several planning projects are underway in the South Prong, Fellsmere, and North Prong drainage areas to meet multiple water resource objectives – primarily salinity maintenance, and nutrient and solids reductions (i.e., PLRGs), followed by improved flood control, irrigation water supply, and groundwater protection. The plans are specific to the City of Sebastian (South Prong), Sebastian River WCD (South Prong), Vero Lakes Estates and Vero Lakes WCD (South Prong), Fellsmere WCD – East (Fellsmere Canal), and the Sottile Canal/North Prong drainage.

Discharge and water quality criteria are being established by the SJRWMD for guiding the development of each plan, from the conceptual level to the construction design level. Abiding by such criteria will help ensure that all plans, when implemented together, will meet the basin-wide salinity targets and PLRGs for the Sebastian/IRL system. Salinity targets (seasonal minimum and/or maximum) are recommended for the upper, middle, and lower reaches of Sebastian River and for the adjacent IRL. Concomitant with the salinity targets, discharge criteria will then be developed for each of the major drainage canals (e.g., Fellsmere, C-54, Lateral C canal of Sebastian River WCD, etc.).

Provisional pollutant reductions or "allowable" loadings (lb/ac/yr) for each planning project area are also recommended. They will be verified and possibly revised during the final PLRG process. Taken together, the pollutant reductions assigned to each planning area are intended to meet the basin-wide, provisional "allowable" loading rates (c. 1943) for TN, TP, and TSS: 5.2 lb/ac/yr, 0.44 lb/ac/yr, and <50 lb/ac/yr, respectively. Meeting those "allowable" loading rates would mean a basin-wide reduction of *build-out* loads (c. 2010 – 2020) by 25% TN, 44% TP, and 60% TSS.

In general, there are measures that can be shared in common by all plans to meet the basin-wide discharge criteria and PLRGs. For example, an erosion control program should be spelled out in each plan with an emphasis on canal bank stabilization. The widening and re-sloping of canals to provide additional drainage storage and erosion control should be considered. Erosion control and turbidity standards could be strengthened in construction/development ordinances and in WCD rules. The WCDs could impose drainage standards on new development to limit volume and peak discharge rates. The replacement of the "bottom-release" radial gate structures with "top-over" structures (e.g., vertical slide gates) is recommended for all WCDs and for C-54/S-157 to further reduce sediment scour and transport.

[17] For the period 1990 – 1999, Sebastian River annually discharged about 55 billion gallons (± 10 billion gallons). By comparison, Turkey Creek's annual discharge was roughly 30 to 40 billion gallons.



Each plan will also include management elements specific to its area and its resource issues (see map to the right). The City of Sebastian (7,185-acre area) is well into its surface water master planning to meet both pollutant reduction (e.g., up to 65% reduction of 1995 TSS loading) and flood control criteria. Certain master plan elements are already constructed and operational – the treatment pond that serves the Stonecrop drainage area (838 acres) and the improvement of the water control structure or dam on the Elkcam Canal.

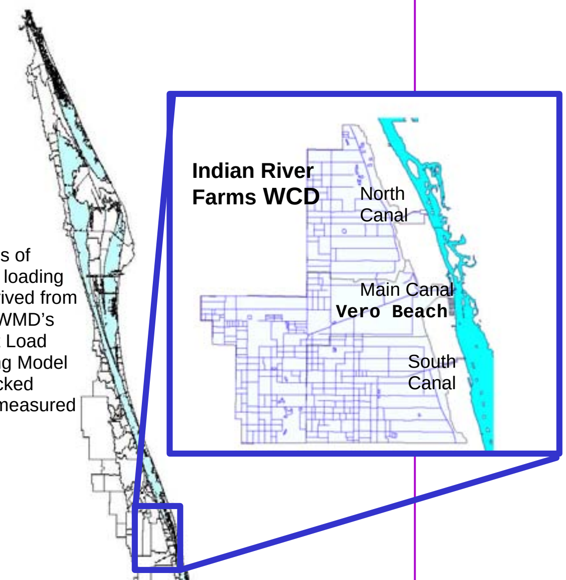
The SJRWMD is designing a 150-acre stormwater park to treat drainage within the southern portion of the City of Sebastian. The treatment area in the park is a 60-acre wet detention/dry retention facility intended to serve a 1,300-acre residential area. Re-creational amenities will also be designed into the park. The City will be responsible for operation and maintenance of the park facility and will provide partial reimbursement to the SJRWMD for land acquisition costs.

Conceptual planning is in progress for Sebastian River WCD, Vero Lakes WCD, and Fellsmere WCD. Management strategies and arrangements for cost-share and technical collaboration are being discussed between the SJRWMD, WCDs, and USACE. Management strategies include those common measures described above (e.g., erosion control program), and more costly initiatives like storage/treatment reservoirs and additional water control structures. Other benefits may be gained by implementing such strategies: increased stability in irrigation water supply and less dependence on groundwater for irrigation. Decreased withdrawal of groundwater also helps to reduce the intrusion of salt water into the aquifer.

In the North Prong drainage area, the SJRWMD recently purchased 496 acres of land that straddles the lower portion of Sottile Canal. A sizeable portion of the land will be set aside to sufficiently treat the drainage from the projected build-out (e.g., Barefoot Bay and other developments). About one-third of more of the land will be used to manage dredged material as part of the Sebastian River muck removal project. Dredging the lower to middle reaches of Sebastian River will remove a majority of the organic-enriched, oxygen-depleting muck and will also re-create deeper areas along the river bottom to trap sediment and eroded soils (please read the following section *Non-point Source Strategy – Muck* for more details).

Indian River Farms WCD. Interlaced with hundreds of miles of canals and ditches, this 80 sq mi water control district drains about a 50/50 mix of citrus agriculture and urban growth within and surrounding Vero Beach. The Indian River Farms WCD (IRFWCD) is an example of a large, efficient *intra*-basin[18] drainage project whose 35 billion gallons/yr discharge to the IRL rivals that of Turkey Creek. Discharge from IRFWCD is delivered by three primary canals – North, Main, and South Canals – affecting approximately 12 miles or more of one of the more narrow segments of the Lagoon. As previously described, this Vero Beach segment exhibits some of the worst water quality and seagrass resource conditions in the IRL system (along with the Cocoa-Melbourne segment). This segment's color, TSS, and TP levels are generally some of the highest recorded among all IRL segments (for more details, please read this chapter's section on **Seagrass and Water Quality**: *Water Quality Assessment*). What really sets the IRFWCD apart from the other Lagoon sub-basins is its heavy loading of TP, nearly 70,000 lb/yr. This TP loading is even higher than the loading from the Turkey Creek/MTWCD sub-basin, which is about 1.5 times the size of the IRFWCD!

Estimates of pollutant loading were derived from the SJRWMD's Pollutant Load Screening Model and checked against measured loading.



IRFWCD	*TN lb/ac/yr*	*TP lb/ac/yr*	*TSS lb/ac/yr*
Est.1995 loading	7.6	1.3	121
"allowable" loading target*	3.8	0.65	<50

*The "50%" planning target meets c. 1943 levels; however a 60% reduction in TSS is preferred to meet "allowable" loading of <50 lb/ac/yr.

A planning team composed of representatives from the SJRWMD, Indian River County, IRFWCD, Vero Beach, the county extension service of IFAS[19], and consultants was organized in early 2001 to deal with "upland solutions" to these problems. At the time of this writing, water management objectives and various management concepts were being developed. With respect to color and TSS, drainage volume reduction and erosion control measures are being considered. Some measures may include those mentioned above relative to other sub-basin/WCD plans (e.g., erosion control program including canal side-slope stabilization, water control structure retro-fits, etc.).

[18] A small western portion of the WCD (~10 sq mi) lies outside the Ten-Mile Ridge or historical IRL basin.

[19] Institute of Food and Agricultural Sciences (IFAS) of the University of Florida provides expert assistance in the fields of agriculture, soils, horticulture, etc. to all counties throughout the state.

Nutrient management is also quite important. An appreciable decrease in drainage volume (annual and wet season) can effect sizeable reductions in nutrient loads; nonetheless, home and farm fertilization practices should also be evaluated. For example, the amount and type of phosphorus application on citrus groves can be investigated with an aim toward recommending fertilization practices that can reduce runoff phosphorus concentrations without compromising crop production or cost[20].

Developing a comprehensive IRFWCD water management plan is proving to be an immense challenge. The plan must balance competing needs -- the restoration needs of the Lagoon and the drainage needs of a developing community. Furthermore, this plan may incorporate a water supply element. Construction plans for an electrical power plant in Vero Beach are being prepared. The plant's need for cooling water could be primarily satisfied by taking water from the IRFWCD canals. Withdrawals of canal water to satisfy this demand could help reduce drainage to the IRL. Even though the feasibility of this water supply option is not known yet, an opportunity like this is compelling because of its potential to be mutually beneficial to various water resource interests.

As the planning team nears consensus on a conceptual plan, other agencies such as USACE, FDEP, Florida Department of Agriculture and Consumer Services, and possibly the National Resources and Conservation Service will certainly be drawn in to review and comment on the plan, and hopefully participate. Cost-share funding from as many entities as possible will be critical to the success of the project. In 2000, the state legislature jump-started the project when it appropriated seed monies (~$4 million) toward the planning effort and for the eventual construction of some of the to-be-designed structural solutions.

Non-point Source Strategy – Muck. The 1989/90 IRL muck sediment survey revealed that only 10% of the Lagoon bottom area, from Ponce de Leon Inlet to St. Lucie Inlet, is covered with muck (Trefry et al. 1990). That is the good news. However, its distribution is the bad news. Most of the muck, over 65% of the cumulative area of muck, is deposited in the Central IRL (which is only 27% of the total length of the IRL system). It's a recent phenomenon too; nearly all the muck in the IRL has been deposited in just the last 40 years (Trefry et al., 1990).

Lagoon muck mostly consists of upland soils, clays and silts, with a lesser but generous amount of organic material. These eroded soils and organic debris are washed into drains, ditches, canals, and creeks and end up primarily in tributary creek mouths, the Intracoastal Waterway, causeway borrow pits in the Lagoon bottom, and other dredged or natural holes (Figure 5-11). As mentioned in previous chapters, muck sediment is a concern because of its deleterious effects on water quality and seagrasses. Muck can easily be re-suspended, increasing turbidity in the water and limiting light to seagrasses. Muck releases significant loads of nitrogen to the water[21], contributing to algae growth, which exacerbates turbidity levels. And, muck has a high oxygen demand, contributing to oxygen depletion in the water column.

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[20] A study is underway now to demonstrate the benefits of fertigation and to investigate alternative, slow-release, fertilizer media that can help reduce phosphorus-laden runoff from citrus groves. This study is being conducted by the IFAS, Indian River Research and Education Center, Ft. Pierce.

[21] For example, in the Central IRL, the N loading from muck sediment (~4 million lb/yr N) is twice that of surface water N loading (derived from Trefry et al.,1992 ; Reddy et al., 1999; SJRWMD unpublished data).

The strategy to deal with muck is two-fold: muck removal coupled with upland source control. This strategy is being pursued within areas where muck is believed to be an important source of nitrogen and/or turbidity. Both the North and Central IRL contain candidate sites for muck removal but the Central IRL certainly contains a greater number of large and extensive muck deposits. Therefore, most of the effort and funding spent by the SJRWMD, the state, and local cooperators have been and will continue to be directed toward the Central IRL.

The Intracoastal Waterway (ICW) is a prime candidate for muck removal. The ICW channel, because of its 12 to 15 ft maintenance depth, functions as a sump for the fine-grain muck sediment. A significant volume (>70%) of the muck that reaches the Lagoon proper ends up in the ICW channel. The USACE and the Florida Inland Navigation District (FIND) are responsible for maintenance dredging the ICW and for managing ICW dredge material disposal sites, respectively. These two agencies are committed to accelerating the ICW dredge schedule contingent upon an equal commitment by Congress to appropriate sufficient funds to support the schedule. In 1996, the USACE and FIND proposed an accelerated 10-year dredge plan, called the “Environmental Dredging Program,” for the Mosquito Lagoon and the North and Central IRL. Part of that plan is presently underway for the ICW reach that extends from south Mosquito Lagoon through North IRL to Titusville. The dredge schedule for the ICW reaches south of Titusville and into the Central IRL has been postponed because the necessary federal appropriations have not been forthcoming.

In addition to the ICW, other potential sites for muck removal in the Lagoon proper include the lesser navigation channels and turning basins, causeway borrow pits and other dredged holes. The SJRWMD identified six major areas in the North and Central IRL that contain numerous and/or extensive muck-filled sites. Three of the areas are located in the Titusville and Cocoa vicinities of the North IRL. The remaining, more muck-laden areas are located in the Central IRL: the South Tropical Trail area south of Rockledge, a 10-mile zone between the S.R. 518 (Eau Gallie) causeway and Turkey Creek, and the Vero Beach area. No dredge work is scheduled yet within these areas, but planning discussions with prospective cooperators (USACE, FIND, cities, counties) are taking place.

Tributary creeks, collectively, is a third category of muck removal areas. The SJRWMD and several cooperators are actively engaged in muck dredge planning or construction in several of the tributaries in the Central IRL: Eau Gallie River, Crane Creek, Turkey Creek, and Sebastian River. Thousands of metric tons of muck (upland soils and organic matter) are conveyed through these tributaries yearly. For decades, the lower reaches of these creeks have served as traps, retaining a large amount of this material and saving the IRL from the full burden. The creek “traps” have been quickly filling in (e.g., muck depths exceed 10 ft in Crane Creek and 15 ft in Turkey Creek), and muck migration rates to the IRL may increase as a consequence.

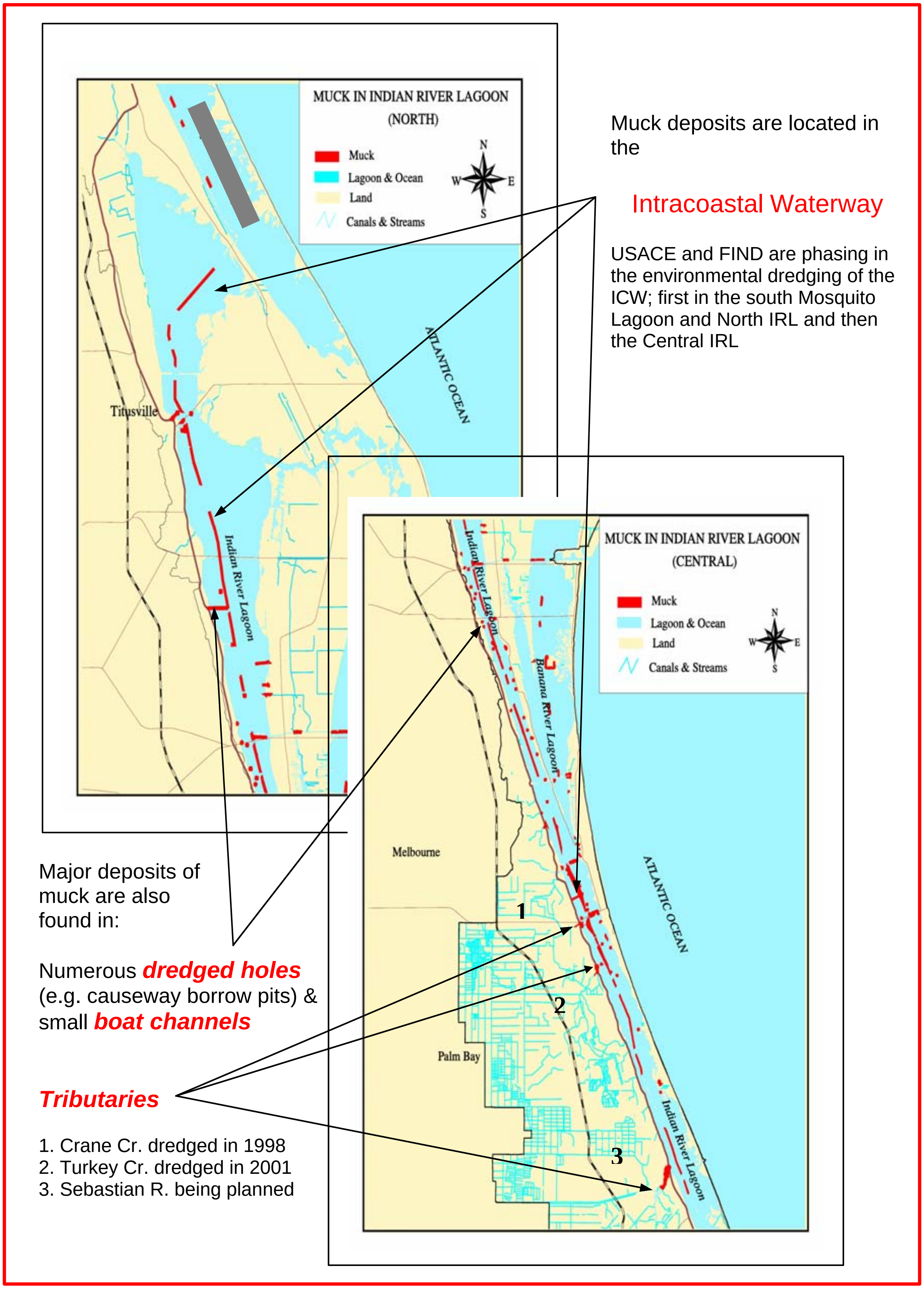

Figure 5-11. Muck sediment distribution in the North and Central IRL. Compared to the other IRL sub-lagoon areas, the Central IRL contains the largest percentage of muck by depositional area (>65%) and possibly by volume.

Management actions involve controlling the upland sources of muck sediment prior to, or in concert with, cleaning out and restoring the storage capacity of the creek "traps."

The lower reach of Crane Creek was dredged in1998 (~95,000 cu yd) and a larger muck removal project was completed in Turkey Creek in May 2001 (~380,000 cu yd). Detailed plans and permits are being prepared for a muck removal project in Sebastian River, and a conceptual dredge and disposal plan was developed for Eau Gallie River.

A post-dredge evaluation of Crane Creek is presently underway to determine whether the dredge operation satisfied environmental objectives or expectations of a muck removal project. This is a 3-year investigation, and full results will be reported in 2003. A similar investigation is being planned for Turkey Creek, but funding support for the project is uncertain. Even though it is still early in the Crane Creek investigation, data on post-dredge sedimentation rates do indicate the importance of implementing effective erosion or source controls prior to or concurrent with tributary muck removal. Periodic maintenance dredging of the creek "trap" should also be considered.

Disposal of dredged muck material is another challenge. Fortunately, nearly all the muck deposits surveyed are not considered contaminated or hazardous[22]. In fact, given that it's composed of upland soil enriched with nutritive organic material, muck should be regarded a beneficial resource to be used, not discarded as spoil. An investigation has shown a positive response of Bermuda grass and other landscape plants grown in IRL muck (BCI, 1996; BCI, 2000). It has been demonstrated that muck has potential as a topsoil amendment for nurseries, golf courses, roadway medians, and other green spaces. Melbourne-Tillman Water Control District (MTWCD) accepted truckloads of muck from Turkey Creek and spread it along canal banks and right-of-ways to encourage grass growth as a means to control side-bank erosion. Also, several agencies[23] have taken advantage of the dredged sand and shell, a by-product of the muck dredging, at their various public project sites as landscaping and fill material.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). During the initial 5 years of the SWIM program, the SJRWMD contracted with Volusia, Brevard, and Indian River counties to conduct inspections of septic tanks or OSDS (on-site disposal systems) in areas that were known to have documented failures, and to survey areas served by OSDS to determine their potential to contaminate surface waters (as mandated by Chapter 90-262, Laws of Florida, a.k.a. IRL Act). The inspections lead to corrections of OSDS, and the counties completed the basin-wide surveys of OSDS areas (Brevard County – White and Wiggins, 1995; Indian River County – Indian River County Public Health Unit, 1992; Volusia County – Bielby, 1993).

The surveys concluded that the IRL basin is generally not suitable for OSDS, particularly at densities of two or more units per acre. OSDS may be acceptable in relatively small areas in the basin; for example, in the sand ridge areas or in areas with good soil infiltration capacities that are sufficiently distant from surface waters. The surveys further delineated OSDS areas that pose a surface water contamination threat (as a result of poor soil permeability, shallow water table, high OSDS unit density, or other

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[22] It's suspected that muck deposits within Port Canaveral and Manatee Pocket (in the St. Lucie R. watershed) may be regarded as contaminated with respect to certain metals or organic compounds, but appropriate analyses have not been performed to confirm this.

[23] Melbourne Tillman Water Control District, Brevard County, Town of Malabar, and the City of Palm Bay.

factors). Some of the potential problem areas identified in the North and Central IRL include Port St. John, Palm Bay, southern Brevard County, Sebastian (especially Sebastian Highlands residential area), and southeastern Indian River County.

Some of these same areas were the subject of further investigations in an effort to determine the role of OSDS in the enrichment of groundwater nitrogen levels and loading to the IRL. The investigators concluded that "…virtually all of the effluent from these OSDS … end up in the lagoon" (Horsley and Witten, Inc., 2000). In the same study, it was found that OSDS effluent elevates water table concentrations of nitrogen to approximately 15 times above background levels. Given these findings, it is quite conceivable that OSDS areas may have a localized impact on water quality in certain segments in the IRL basin (e.g., IR6 – 11, IR13, Sebastian River, and IR20; refer to Figure 5-1 for location of segments).

A reduction in OSDS use in Brevard and Indian River counties is strongly encouraged by the SWIM initiative; not only for the sake of the IRL system, but also for the protection of groundwater quality and the reduction of public health risks associated with the potential release of pathogens to either ground or surface waters. Some local governments such as the City of Palm Bay and Indian River County are gradually eliminating OSDS use in favor of centralized wastewater treatment service.

The primary obstacles in resolving the OSDS problem are (1) lack of public funds to expand centralized wastewater treatment plant (WWTP) service, and (2) rules or policies that allow new OSDS installations in areas that are not well suited for OSDS. OSDS often offer the least expensive and most expedient means of treating domestic wastewater. It's difficult for local governments and citizens to bear most of the cost of connecting homes to a WWTP. A homeowner may be expected to pay thousands of dollars in fees to connect to a WWTP and for the proper abandonment of their OSDS units. Furthermore, there is no substantial financial support offered by federal or state agencies. It is unlikely this problem will be fully or rapidly remedied unless there is a significant financial commitment by the state and/or federal government to support the necessary infrastructure construction and home "hook-ups."

Point Source Strategy – Domestic Wastewater Treatment Plants. In the North and Central IRL, the cities and counties have achieved remarkable reductions in pollutant loading from domestic wastewater treatment plants (WWTPs). Consequently, domestic WWTPs appear to be a very minor source of pollution thanks to local government action in response to the IRL Act (formerly named the IRL "No Discharge" Act in the 1994 SWIM Plan; Chapter 90-262, Laws of Florida). WWTP loadings of nitrogen and phosphorus have decreased by well over an order of magnitude since 1986 (SJRWMD and SFWMD, 1987). Today, WWTP contributions of TN (30,375 lb/yr), TP (3,550 lb/yr), and TSS (3,941 lb/yr) represent 0.2 to 1.4% of the total surface water loading of these constituents to the North and Central IRL (Figures 5-8 and 5-9).

The Central IRL continues to stand out as contributing the highest WWTP loadings among the major sub-lagoons (up to 22% of the total for Mosquito, Banana, and the entire Indian River proper), which is certainly a reflection of the high and increasing levels of residential development in south Brevard and Indian River counties. Even so, WWTP loadings of TP, TN, and TSS in the Central IRL pale in comparison to their non-point loadings (Figure 5-9).

Monitoring, Modeling, and Applied Studies. Aided by volunteers from several agencies, the SJRWMD has maintained and improved the seagrass and water quality monitoring networks in the North and Central IRL (see network description in Chapter 2, pp. 15-16). The SJRWMD refined the monitoring networks to strengthen empirical relationships among water quality, light, and the depth coverage of seagrass (Sigua et al., 1996); and will periodically assess the need for further refinements. SJRWMD's analyses and reporting of monitoring data is largely restricted to seagrass coverage and those major optical pollutants germane to the seagrass-light limitation problem.

Data collected during 1997 through 1999 from both the water quality and seagrass monitoring networks were invaluable in the calibration of the Pollutant Load Reduction (PLR) Model. The PLR Model will be applied toward the development of *final* PLRGs[24]. In the meantime, *provisional* PLRGs, expressed as allowable loading rates based on 1943 land use, have been developed[25] for the segments in the North and Central IRL (Tables 5-4 and 5-5). Provisional PLRGs are considered conservative planning targets that can be used in watershed planning and non-point source treatment design. Provisional PLRGs could be adopted as final but the PLR Model will be used to help ascertain whether these provisional targets are reasonable or too stringent or impractical (and thus be revised).

Over the last 4 years, other models were developed that quantify the salinity response to a full range of freshwater discharges from the Turkey Creek/MTWCD and Sebastian River systems (Sucsy and Morris, 1998; Sucsy et al., 1997). These models enhance the District's capability to evaluate different water management alternatives for their effects on salinity zones within those estuarine systems. For example, the Turkey Creek salinity model confirmed an earlier study that set maximum discharge criteria for MTWCD's C-1 canal (Steward and Higman, 1989); and enabled the establishment of minimum discharge criteria to protect the creek's freshwater habitats. These models are used to assess salinity gradient changes that may occur due to the deepening of stream bottoms as a consequence of muck removal. Freshwater discharge criteria can then be re-evaluated to ensure compliance with salinity targets.

Fine-tuning hydrologic, salinity, and water quality models is and has been emphasized over the last 2 years as recent data are collected or environmental processes are better understood and quantified. This refinement is intended to produce more accurate appraisals of freshwater and pollutant load impacts and; therefore, more credible, defensible PLRGs and freshwater discharge criteria. Numerical models will also be utilized to evaluate the various management options to achieve PLRGs. Thus, it's imperative to have models that are calibrated and verified. Schedules for completion and application of the PLR Model and other sub-basin models are described in the foregoing section, *The Next 5 Years*.

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[24] PLRGs are pollutant load reduction goals, which are numeric targets established for the reduction of anthropogenic loads of pollutants that pose a stress on seagrasses.

[25] Provisional PLRGs were developed using an inference method that relies on a simple, mass-balance algorithm known as the Pollutant Load Screening Model (Adamus and Bergman, 1995). This model incorporates land uses, soil types, rainfall-runoff coefficients, and regional average pollutant concentrations to calculate annual pollutant loads.

Table 5-4. Provisional "allowable" loading rates for TN, TP, and TSS in North Indian River Lagoon based on estimated 1943 land use loading rates [calculated from Pollutant Load Screening Model (Adamus & Bergman, 1995) modified for the IRL Basin]

North IRL Segments *(from north to south)**	***TN*** *lb/ac/yr (total lb/yr)*	***TP*** *lb/ac/yr (total lb/yr)*	***TSS*** *lb/ac/yr (total lb/yr)*
IR1-3	2.6 (138,500)	0.30 (15,800)	38 (2,054,000)
IR4	4.3 (11,000)	0.68 (1,725)	72 (183,000)
IR5	3.0 (101,500)	0.24 (8,100)	43 (1,440,000)
IR6-7	3.9 (83,300)	0.46 (10,000)	50 (1,076,000)
IR8	5.6 (14,100)	1.0 (2,500)	89 (235,000)

* Refer to Figures 5-1 and 5-2 for location of segments.

Table 5-5. Provisional "allowable" loading rates for TN, TP, and TSS in Central Indian River Lagoon based on estimated 1943 land use loading rates [calculated from Pollutant Load Screening Model (Adamus and Bergman, 1995) modified for the IRL Basin]

Central IRL Segments *(from north to south)**	***TN*** *lb/ac/yr (total lb/yr)*	***TP*** *lb/ac/yr (total lb/yr)*	***TSS*** *lb/ac/yr (total lb/yr)*
IR9-11	4.1 (79,250)	0.32 (6,200)	50 (972,000)
IR12**	1.9 - 4.9**	0.2 – 0.6**	32 - 63**
IR13A	4.8 (8,650)	0.42 (753)	55 (99,100)
IR13B	4.9 (81,900)	0.35 (5,840)	59 (991,500)
IR14	5.1 (397,700)	0.44 (34,140)	58 (4,519,000)
IR15	4.9 (17,400)	0.82 (2,900)	68 (241,200)
IR16-20	5.2 (346,600)	0.66 (43,940)	74 (4,887,000)
IR21	2.2 (5,320)	0.33 (818)	41 (101,500)

* Refer to Figures 5-1 and 5-2 for location of segments.

** Segment IR12 includes Crane Creek and Turkey Creek sub-basins, which constitute the majority of that segment's watershed. Reduction targets for those sub-basins were established by criteria other than calculation by the Pollutant Load Screening Model. The target ranges above encompass the Turkey and Crane Creek's targets and the estimated 1943 loading rates for other areas within segment IR12.

Drift macroalgae (especially *Gracillaria* spp.) and the attached macroalga *Caulerpa prolifera* comprise a component of the IRL system that plays a large role in nutrient dynamics and as a habitat resource. However, their distribution and abundance throughout the IRL, especially that of drift macroalgae, are not adequately documented. Like the Banana River Lagoon, some segments of the IRL contain large masses of drift macroalgae, functioning as a nutrient "sponge", thereby limiting the availability of nutrients to phytoplankton. Phytoplankton (i.e., chlorophyll *a*) can effectively compete with seagrass for available light in the water column; that is, phytoplankton can become an optical pollutant. Some researchers believe that high macroalgae densities are an early symptom of nutrient enrichment or eutrophication, which could transition to a more chronic symptom of high phytoplankton levels or algal blooms (Bricker et al., 1999).

On the other hand, drift macroalgae provide habitat value comparable to that of seagrass, although macroalgae is more ephemeral than seagrass. Densities of animals on drift macroalgae and seagrass are similar, and about 75% of the species are common to both plant types. The habitat function of drift macroalgae is considered an extension of the seagrass habitat – often extending viable habitat beyond the deep edge of the seagrasses (Virnstein and Howard, 1987). Considering that drift macroalgal biomass in the IRL can average three times seagrass biomass, and is considerably more than that in some segments (SJRWMD unpublished data), the potential significance of this habitat warrants investigation.

The dual role of macroalgae as habitat and mediator of nutrient loads raises many questions. Are the macroalgae densities in some IRL segments considered too high, and is that an indication that nutrient levels may already be excessive? If macroalgae densities decrease appreciably even though nutrient loadings do not, will phytoplankton or algal blooms become more frequent? If nutrient reduction efforts reduce macroalgae abundance or coverage, has the IRL lost important habitat? Answering these questions may require specific modeling and regular macroalgae monitoring/mapping as part of the routine status assessment of the IRL.

Within the IRL program, BMP[26] efficiency monitoring and research has typically received relatively low funding support only because the construction or installation of BMPs is the primary programmatic focus. Once BMPs are in place then evaluations of their treatment levels can be performed with respect to meeting certain pollutant removal efficiencies or other specific standards. It is not practical to evaluate every BMP; rather representative or major BMPs will be chosen for such evaluations. Currently, the following BMP/remedial projects are being evaluated: Palm Bay's Basin 7 and Sebastian's Stonecrop basin drainage treatment systems, and the muck removal projects in Crane and Turkey Creeks. Although muck removal would not typically be viewed as a BMP, the periodic maintenance dredging of the creek "traps" could be regarded as such.

Land Acquisition. The acquisition of lands and buffer shorelines is a key strategy in the protection and restoration of wetlands and seagrasses in the North and Central IRL. This strategy is pursued largely through the IRL *Blueway* program. The *Blueway*

[26] **B**est **M**anagement **P**ractice. Refers to any structural solution or non-structural practice that controls, reduces or prevents pollution without substantive modification to existing land uses or drainage systems.

program, its scope and progress, is described in the section on Coastal Wetlands found in this and the other chapters.

In addition to acquiring lands that comprise critical habitats or habitat buffers, other lands are sought for constructing and operating surface water storage/treatment systems and dredged material (muck) management areas. Open lands, if sized correctly and appropriately located in the drainage basin, are the type of sites acquired for such purposes. The SJRWMD has been quite successful in its aggressive campaign to purchase lands within Turkey Creek/MTWCD, Sebastian River, and in other sub-basins that are required to proceed with water management, muck removal, or buffer preserve projects (Table 5-6). For example, since 1994 approximately 2,300 acres within the western portion of MTWCD were purchased for the C-1 re-diversion project and nearly 15,000 acres of the Sebastian River Buffer Preserve were jointly purchased by the SJRWMD and FDEP.

The acquisition campaign continues, but the financial challenge is becoming more difficult. State funds dedicated to land acquisition are dwindling. The SJRWMD will not be able to acquire lands on its own for much longer, thus making funding partnerships a practical necessity. In fact, SJRWMD always has preferred *joint* land purchases for water management projects. Typically, the acquisition partner is a local jurisdiction responsible for operating and maintaining the facility after its construction. Moreover, lands appropriate for large-scale, sub-basin projects are becoming increasingly limited and costly, especially in the Central IRL. Consequently, the determining land requirements for such projects (e.g., Crane Creek, Sebastian River, IRFWCD), and negotiating with the seller are on a "fast track."

Table 5-6. SJRWMD land acquisitions in North and Central IRL for buffer protection and water quality management purposes

Acquisitions – Parcel Name & Project Purpose	Acres
Corrigan (District/FDEP joint purchase) part of the ~23,000-acre Sebastian R. Buffer Preserve	6,894
Mary A (District/FDEP joint purchase) part of the Sebastian R. Buffer Preserve	1,482
Egan (District/FDEP) part of the Sebastian R. Buffer Preserve	1,167
Carson Platt (District/Indian R. County/FDEP) part of Sebastian R. Buffer Preserve	5,361
Curtis a.k.a. Ais Lookout Point (District, DOT, FCT) used to treat U.S. 1 drainage, Palm Bay	4.29
Platt, P. and T. (District) C-1 Re-diversion Project	210
Farm Credit of C. FL (District) C-1 Re-diversion Project	160
Tsamoutales (District) C-1 Re-diversion Project	19.25
G. Billie (District) C-1 Re-diversion project	10
Lapidus (District) C-1 Re-diversion project	10
Willard Palmer (District) C-1 Re-diversion project	205
Judge Platt (District) C-1 Re-diversion project	1,080
Carlyle Platt (District) C-1 Re-diversion project	585
Pine Island, Merritt Island (District/Brevard) Stormwater management & wetland preserve	769
Pine Island out-parcel (District/Brevard) Stormwater management & wetland preserve	98
Adams (District) drainage treatment facility for City of Sebastian	150
Wheeler Groves (District) Sebastian R. dredge material mgmt &/or stormwater treatment	286
Met Life (District) intended for Sebastian R. dredge material mgmt. and stormwater treatment	210
Inlet Groves (District/Brevard) wetland/upland preservation and restoration	290
Total acreage acquired to date (April 2002)	**18,990**

Coordination with Other Agency Plans. Non-point source pollution is the major problem in the North and Central IRL. The Central IRL, more than any of the other sub-lagoons in the SJRWMD, is in critical need of water quality remediation (via non-point source controls). This fact is fully recognized by the local governments, WCDs, and other agencies that manage land and water resources in Brevard and Indian River counties. Many of these agencies are coordinating their surface water planning with the SJRWMD to ensure consistency with regional strategies and policies regarding PLRGs, discharge criteria, and water quality in general. Most notably, the list of cooperating agencies include Titusville, Rockledge, Indialantic, Melbourne, Melbourne Beach, Palm Bay, Malabar, Sebastian, Vero Beach, Brevard and Indian River Counties, Melbourne-Tillman WCD, Sebastian R. WCD, Fellsmere WCD, Indian River Farms WCD, Florida Inland Navigation District (re: muck removal), FDEP Aquatic and Buffer Preserves, EPA, and NASA.

A few of the cities listed above have completed master plans and should be well-positioned to procure cooperative funding from the SJRWMD (including IRLNEP and its EPA funding source) and the FDEP/EPA Section 319 non-point source reduction grant program. Brevard and Indian River Counties are working with the SJRWMD and several other agencies (cities, aquatic preserves, WCDs, etc.) to comprehensively tackle various water quality and quantity issues in N. Merritt Island, Crane Creek, Sebastian River, and Indian River Farms WCD sub-basins.

NASA is consulting with SJRWMD on a full range of mitigation measures to offset future development impacts in the North IRL basin. These measures are intended to improve estuarine water quality (e.g., runoff containment/treatment) and wetland functions (e.g., impoundment reconnections, breaching, etc.). In addition, in 2001, SJRWMD and NASA established a formal arrangement to collaborate on a broad range of monitoring and data base management activities. Through this arrangement, NASA can dedicate specific resources to acquiring and managing a variety of environmental data (e.g., seagrass coverage, water and air quality data, meteorological data, etc.). This “centralization” of IRL data should benefit all public agencies managing natural resources in the IRL basin.

USACE and the SJRWMD recently drafted a scope of work for the IRL-North Feasibility Study. The study will address restoration alternatives in both the North and Central IRL. However, the Central IRL is the focus area with respect to evaluating surface water management and non-point source control projects alternatives such as muck dredging, watershed erosion control programs, surface water management BMPs, and possible causeway modifications to improve flushing and water quality.

The Next 5 Years

Strategies for Pollutant Load Reduction

Non-point Source Strategy – Surface Water Drainage. Volume reduction and treatment of surface water drainage will be key to the success of seagrass recovery in the IRL. This strategy is particularly the case in the Central IRL where regional planning efforts are underway and large capital expenditures are anticipated. Toward that end, the completing and implementing master surface water management plans are the main

5-year objectives common to the following priority sub-basins (and their local jurisdictional sponsors):

- **Crane Creek sub-basin** (can include the neighboring Eau Gallie River sub-basin; Brevard County, Melbourne, West Melbourne)
- **Turkey Creek sub-basin** (Melbourne-Tillman WCD, Palm Bay, Malabar)
- **Sebastian River sub-basin** (Sebastian, Sebastian R. WCD, Fellsmere WCD, Roseland, Indian River County)
- **Indian River Farms WCD** (including Vero Beach and Indian River County)

The SJRWMD supports these planning efforts with cost-share funding, with technical and planning staff participation, and by actively pursuing grant funds. The SJRWMD will continue such support through the implementation phase of these projects. By the end of the next 5 years, all the master plans listed above should be well into implementation. It is the SJRWMD's and local sponsors' mutual intent to develop the plans based on a set of PLRGs for total suspended solids, nitrogen, and phosphorus. Provisional PLRGs will be used on an interim basis and could ultimately serve as the final PLRGs for some sub-basins. The provisional PLRGs assigned to these sub-basins are conservative (based on estimated c. 1943 loading rates) and are used as planning targets in lieu of or until final PLRGs are established. Provisional PLRGs, or "allowable" loading rates, for these sub-basins can be reviewed in the preceding section under *Sub-basin Water Management Plans (Central IRL).*

Non-point Source Strategy – Muck. The Central IRL is the focus area for muck removal projects just as it is for the large, regional surface water management programs described above.

The SJRWMD will be working to accelerate the USACE's schedule to maintenance dredge the Intracoastal Waterway (ICW) from the Haulover Canal-Titusville reach southward through Brevard County and into Indian River County. Other major deposits of muck, lying outside the ICW channel (e.g., lesser navigational channels, causeway borrow areas, other dredge holes), could also be dredged during the ICW maintenance dredge operation. The funding and logistics for such an expanded operation will be a matter of discussion with the USACE in 2002/03.

Meanwhile, the SJRWMD and its consultants are completing a plan to dredge muck from the lower reach of Sebastian River and could develop a similar plan for Eau Gallie River within the next 3 to 5 years (possibly, with USACE assistance). It is difficult to establish a start-date on the dredge project in Sebastian River because the planning is not completed nor has the project been permitted. Based on current progress and funding commitments, the dredging in Sebastian River could begin in the River's lower reach in late 2003 immediately following a pre-dredge environmental survey. With respect to Eau Gallie River, it may be several years (2005 at the earliest) before a dredge operation could commence.

Post-dredge evaluations may be completed for Crane Creek and Turkey Creek by 2003 and 2005, respectively. These evaluations seek to improve the engineering and operational efficacy of future dredge projects and to reveal what can truly be environmentally achieved. It is clear that soil erosion and sediment control measures are lacking in watersheds where enormous accumulations of muck and sand have occurred. In fact, preliminary data on Crane Creek, where no erosion control program is currently in place, suggests fairly rapid infilling of newly dredged areas within months following dredge operations. Whether this recent deposition is largely bed-load material from non-dredged areas or newly eroded material washing into the creek is difficult to identify at this time (likely it's both, but more of the former so far). Nonetheless, this rapid infilling does point out the importance of implementing controls to prevent or minimize erosion and sediment transport.

Consideration should be given to developing a long-range plan, covering the next 15 to 20 years, for the removal of major muck deposits at all priority sites throughout the IRL basin (10 major sites, including southern Banana River Lagoon). The plan would include the method and results of the site prioritization, an estimated permit and dredge schedule for each project site along with general budget information, and a source control strategy that would be implemented prior to or contemporaneous with muck removal.

Non-point Source Strategy – Septic Tanks (a.k.a. OSDS). Local policy and ordinances restricting OSDS installations coupled with state and/or federal funding incentives could effectively resolve this non-point source problem. OSDS areas that are deemed a potential problem are located in southern Brevard County, the South Prong sub-basin of the Sebastian River, and southeastern Indian River County. Although there has been no definitive link established between OSDS and nutrient enrichment or bacteriological contamination of the IRL, studies have revealed that the *potential* for such cause and effect certainly exists, particularly in localized, high-density OSDS areas (Ayres Associates, 1993; Horsley and Witten, Inc., 2000). To promote protection of the IRL resources and the surficial aquifer, and to further reduce health risks associated with pathogen release, a change from OSDS use to centralized or regional wastewater collection and treatment is encouraged. Additionally, state and/or federal programs could improve financial support for local government projects providing central sewer to OSDS areas.

Recently a cost/benefit analysis of various alternatives for wastewater treatment and disposal was conducted for the IRLNEP. A cost/benefit model was developed and a variety of wastewater treatment/disposal alternatives were analyzed (ranging from OSDS to regional wastewater facilities). Using actual cost data from the IRL region, it was concluded that large-scale centralization of wastewater treatment (e.g., large WWTPS that serve regional areas) provides better treatment at a lower cost that OSDS or small-scale facilities (a.k.a. "package plants") (Horsley and Witten, Inc., 2001). It is anticipated that local governments will be able to use this analysis to estimate the costs and benefits of providing centralized sewer to both new development and OSDS areas.

Point Source Strategy – Domestic Wastewater Treatment Plants. Domestic WWTPs appear to be a very minor source of pollution thanks to local government action in response to the IRL Act (Chapter 90-262, Laws of Florida). However, the Act does allow WWTPs to discharge during wet weather. Therefore, the next step is to employ practical and environmentally sound solutions that will enable further reductions in wet weather effluent discharges to the IRL system.

Industrial WWTPs are permitted and monitored by FDEP (see Appendix B.2 for list of facilities) and are found to pose no apparent threat to the IRL (M. Paulic, personal communication, 10/17/02, based on a statement from FDEP's Central District office). However, reverse osmosis (RO) water treatment plants were a target of investigation and debate a few years ago because of concerns about the quality of their effluent discharge to the IRL (VanHems, 1999). Even though RO effluent is considered a brine discharge, it may be fresher than most reaches of the IRL. This and other potential contaminant concerns have placed RO plants under regulatory scrutiny by the SJRWMD pursuant to its authority to issue water supply permits (a.k.a. consumptive use permits). The SJRWMD is hopeful that this scrutiny may, in effect, induce further improvements in RO effluent treatment technology.

Monitoring, Modeling, and Applied Studies. The SJRWMD and its partner agencies will continue the seagrass and water quality monitoring networks described in Chapter 2 (pp. 2-15 and 2-16). The SJRWMD will continue to seek improvements to the monitoring networks with respect to operational efficiency and informational veracity. Analyses and reporting of monitoring data will key in on salinity trends and those major optical pollutants that may be significant in the North and Central IRL: TSS, color, and phytoplankton (as indicated by chlorophyll *a* concentrations).

The dual role of drift macroalgae (e.g., *Gracillaria* spp.) and attached macroalga (*Caulerpa prolifera*) as a habitat resource and as a mediator of nutrient loads may be quite important in the North IRL and in the northern reach of the Central IRL where flushing is relatively sluggish. This resource should be further explored with respect to its abundance distribution (spatially and seasonally) and nutrient management potential.

It's been over 10 years since the Lagoon-wide muck and toxic substances survey was conducted (Trefry et al. 1990; Trefry and Trocine, 1993; Windsor and Surma, 1993). This survey should be repeated to provide a more current assessment of these aspects of environmental pollution. Furthermore, site-specific surveys of muck distribution, volume, and characteristics (physical and chemical) will be conducted as planning requirements for any future muck dredge operations. Presently, such operations are being planned for the lower reach of Sebastian River and may be planned for Eau Gallie River. Post-dredge surveys will be completed for Crane and Turkey Creeks over the next 4 to 5 years. Post-dredge analysis should help in the far-range development of the muck management program.

By 2003, the PLR Model should be verified and ready to be applied toward the development of final PLRGs in the IRL. In the meantime, provisional pollutant load reduction targets can be used in stormwater treatment designs (see Tables 5-4 and 5-5). These provisional targets are intended to be conservative and, thus, be used to design municipal or regional stormwater treatment systems that should be able to meet the final PLRGs. The SJRWMD will use the PLR Model to "test" the adequacy of the provisional targets. If they are determined to be too stringent, the targets may need to be relaxed or re-set at levels that are more economically achievable but can still meet the water quality/light requirements for seagrass restoration.

Land Acquisition. Land acquisition serves as both a resource protection strategy and as a prerequisite for water quality restoration since lands are needed to construct surface water treatment basins. Thousands of acres will be needed, mostly in the Central IRL, for surface water storage and treatment. Much of this land has been purchased for the C-1 re-diversion project in the Turkey Creek sub-basin and for the stormwater master plan of the City of Sebastian. Hundreds of additional acres will need to be acquired to satisfy similar project objectives elsewhere in Crane Creek, Turkey Creek (Malabar and Palm Bay), Sebastian River, and the Indian River Farms WCD sub-basins. Because of the magnitude and importance of non-point source control in the Central IRL, more effort will be spent toward acquiring land there over the next 5 years than in the other sub-lagoons in the SJRWMD, except the South IRL and St. Lucie River sub-basin[27].

For information on wetland acquisition and other lands for the sake of habitat restoration or preservation, refer to the Coastal Wetlands section below (and in the other chapters).

Coordination with Other Agency Plans. The SJRWMD is engaged with a few federal agencies in the planning of management initiatives that will build upon the current projects in the North and Central IRL. The lead federal agencies and management initiatives are:

U.S. Army Corps of Engineers (USACE) – IRL- North Feasibility Study. This study covers both the North and Central IRL. Its purpose is to develop strong justifications for large expenditures of federal and local cost-share monies in support of major restoration activities such as wetland restoration, muck dredging projects, watershed erosion control programs and other surface water management BMPs, and possible causeway modifications to improve flushing and water quality.

U.S. Fish and Wildlife Service/Merritt Island National Wildlife Refuge (USFWS/MINWR) – MINWR Comprehensive Conservation Plan. Because this plan will affect management, land use, and public use activities in the MINWR for 15 years or more before it is re-visited, it is important for the SJRWMD and IRLNEP to be involved in its development. This plan can have a major, positive impact on the water quality, seagrasses, and fisheries in the open estuary of the North IRL and the southern reach of Mosquito Lagoon (as well as on the wetlands on Merritt Island).

NASA – Space Act Agreement with the SJRWMD. This agreement enables NASA funding and participation in a range of monitoring, data management, and information dissemination activities that will ultimately benefit all resource management agencies and the general public. Additionally, NASA's mitigation plan for proposed development in and near Cape Canaveral is anticipated to be final soon. The SJRWMD will review this plan with an eye toward incorporation of water quality improvement measures as well as wetland restoration projects.

Equally as important as the federal initiatives described above are those municipal and county plans aimed at reductions and treatment of surface water drainage. It is hoped that local governments, especially those that have management authority in the priority sub-basins of the Central IRL (Crane and Turkey Creeks, Sebastian River, and the Indian River Farms WCD/Vero Beach), will complete their plans within a year or two and that this is followed by aggressive implementation of projects over the next 5 years and beyond. Toward that end, the SJRWMD can assist local governments with technical guidance, direct funding support, and by applying for other sources of funds.

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[27] Major land areas (tens of thousands of acres) needed for storage and treatment of surface waters were identified in the South IRL and St. Lucie River sub-basin by the SFWMD and USACE during the feasibility study of the South IRL (refer to chapters 6 and 7 for details on that program).

Table 5-7. The 5-Year Plan List of Seagrass and Water Quality Projects for the North and Central IRL

- **Continue monitoring in the North and Central IRL as part of the Lagoon-wide monitoring networks***
  - **Water Quality Monitoring (NASA, SJRWMD, Indian River County)**
  - **Seagrass Mapping and Field Monitoring**
  - **Meteorological Monitoring**
  - **Hydrodynamic Monitoring**
- **Initiate regular monitoring of drift macroalgae and investigate its habitat and nutrient management value**
- **Develop final PLRGs by end of 2004**
- **Implement non-point, surface water projects aimed at reduction of nutrient, TSS, and freshwater inputs (in cooperation with Brevard County, Indian River County, Titusville, Cocoa, Rockledge, Melbourne, Indialantic, Palm Bay, Malabar, Sebastian, Roseland, Vero Beach, and the Water Control Districts)**
- **Recommend inclusion of large-scale regional stormwater projects within the Capital Improvement elements of the comprehensive growth plans of Brevard and Indian River counties**
- **Conduct the 5-year *IRL-North Feasibility Study* (USACE and SJRWMD)**
- **Conduct the Sebastian River muck removal project**
- **Develop 10-year plan for removal/management of muck from other priority areas**
- **Conduct re-survey of IRL for toxic substances (with emphasis on muck deposition areas)**
- **Continue periodic inventory of domestic WWTPs**
- **Continue to support actions by the counties in any further remediation of septic tank areas**
- **Pursue acquisition of lands identified under the *Blueway* program**

* **Descriptions of monitoring networks are found in Chapter 2, and listed in Table 2-4.**

Coastal Wetlands

Substantial progress has been made over the last 10 years in reconnecting impounded wetlands in the North and Central IRL. Over 16,400 acres of the 23,086 acres of total impounded wetlands in the North and Central IRL have been reconnected since 1991 (Figure 5-12 and 5-13). However, in just the last three years, the SJRWMD has been dealing with mitigation, management, and ownership issues that have stalled reconnection efforts on the remaining impoundments.

In the North IRL, mitigation planning is the immediate issue, specifically in the Merritt Island National Wildlife Refuge (MINWR), that has temporarily halted further reconnection efforts. Over 50% of the Lagoon's wetlands exist in the MINWR as do most of the remaining isolated impoundments. NASA is the landowner and is in the midst of developing a regulatory mitigation plan for MINWR in response to its projected expansion of facilities. This expansion will cause some environmental impacts, which is the reason for the mitigation plan. NASA and the SJRWMD are working together to identify appropriate mitigation projects by NASA, and impoundment reconnections would

Figure 5-12. North Indian River Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.

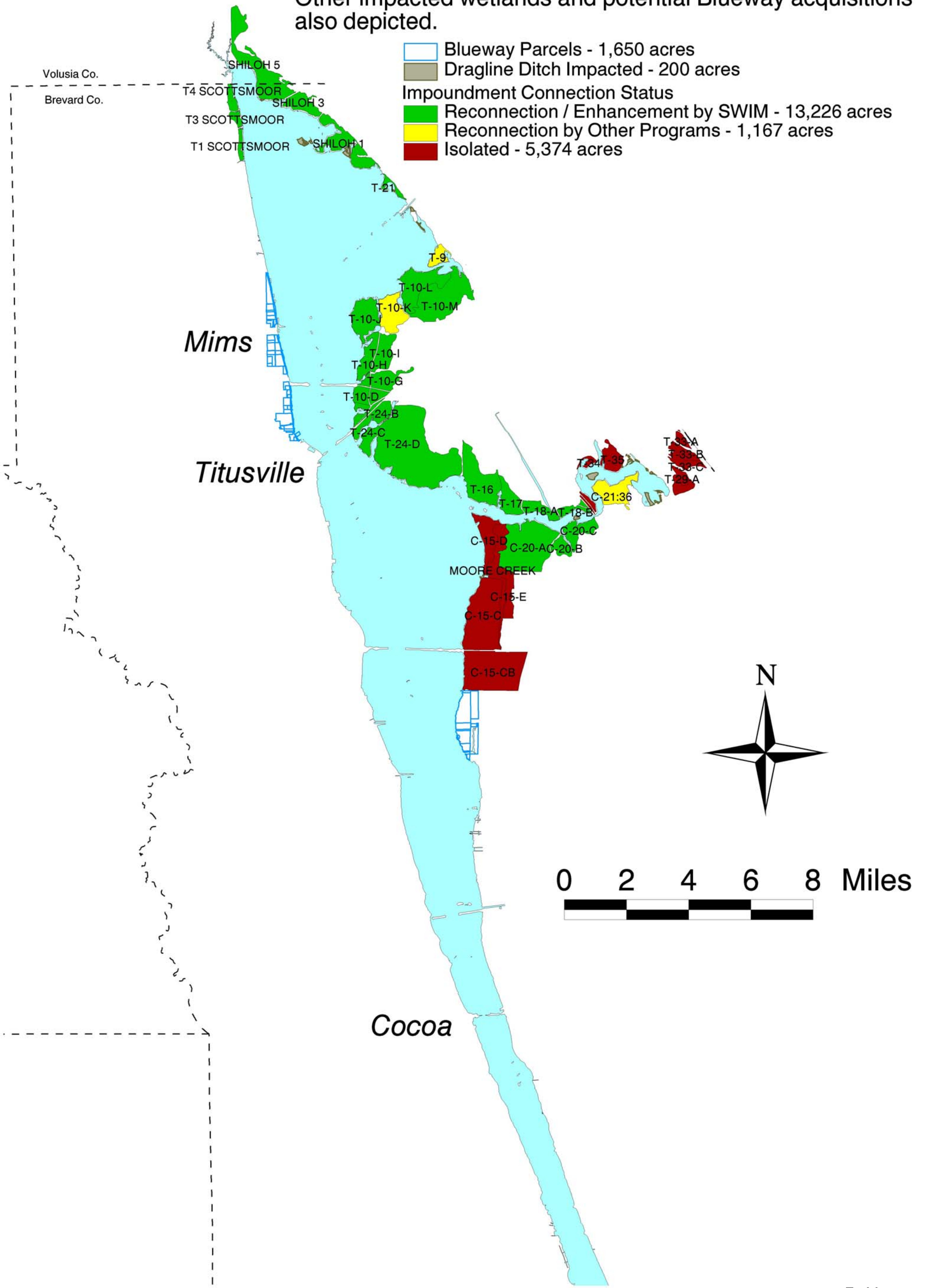
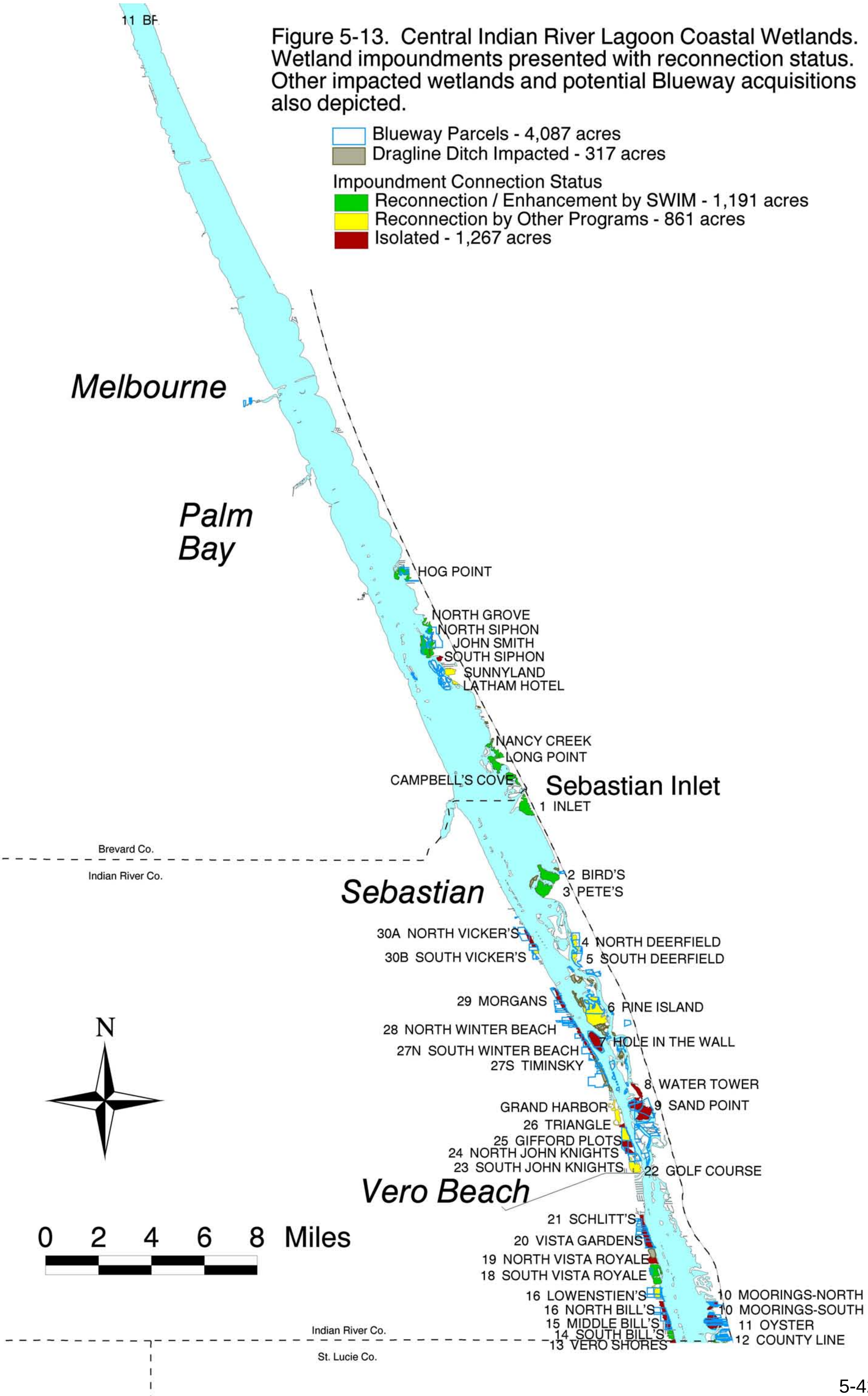


Figure 5-13. Central Indian River Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.



certainly be included. But, any reconnections that pre-date the completion and approval of the mitigation plan may not be counted as mitigation. Therefore, NASA has halted all MINWR reconnections, or wetland rehabilitation in general, until the plan is approved.

A longer term and, perhaps, more far-reaching issue is wetland management within the MINWR. Current management policies and practices regarding reconnected and isolated impoundments in the MINWR are in conflict with the restoration objectives of SWIM and IRLNEP. To help settle this management conflict, the SJRWMD is coordinating a multi-year study of the ecological response of MINWR wetlands to different management alternatives commonly applied throughout the IRL. The results of this study will help formulate recommendations for management that would best serve the restoration and wildlife goals of the agency stakeholders. Implementing such recommendations should assure that those impoundments that are and will be reconnected are managed to achieve the highest possible functional and biological diversity and connectivity to the uplands and open estuary.

In the Central IRL, private ownership is a major issue. As early as 1990, when the SJRWMD became proactively involved with coastal wetland rehabilitation, it was known that the rate of progress in reconnections could be stymied following the reconnection of all publicly available impoundments. The reason is private ownership. Without an owner's consent or public acquisition, a privately owned impoundment cannot be reconnected. Over the last 3 years, neither consent nor acquisition has successfully transpired regarding any of the remaining 1,267 acres of privately owned and isolated impoundments in the Central IRL (Figure 5-13). Therefore, acquiring and reconnecting these wetlands are the main objectives of this program in the Central IRL over the next several years (see further discussion in *The Next 5 Years*, below). More information about progress and challenges regarding the rehabilitation and management of coastal wetlands in the North and Central IRL projects are provided below.

Projects and Progress To Date

Please refer to the Coastal Wetlands section in Chapter 2 for a description of the general background, purpose and scope of the projects. The information provided below is strictly progress information related to the North and Central IRL.

Rehabilitation of Impounded Wetlands. The North IRL contains over 20,000 acres of herbaceous salt marsh wetlands. Over 19,750 acres of marsh are impounded; the remaining acreage is primarily the un-impounded area around the mouth of Turnbull Creek (Figure 5-12).

All of the impounded acreage outside the MINWR in the North IRL was reconnected prior to 1994 (e.g., Scottsmoor impoundments) and most of the MINWR impoundment reconnections were done since 1994. In fact, most of the impounded marshes in the North IRL are in the MINWR. The MINWR is on land owned by NASA but managed by USFWS. In the MINWR, over 14,100 acres of impoundments have been reconnected or fully restored (i.e., impoundment dikes completely removed). The fully restored impoundments are T-10-K and T-9 (~670 acres combined). From a SWIM program perspective, restoration is generally preferred since it provides greater ecological benefits than reconnection alone and does not require active management.

The isolated impoundments that remain in the MINWR (5,374 acres) are along Banana Creek or south of Banana Creek on the western shore of Merritt Island (Figure 5-12). Not all of these impoundments can be targeted for reconnection; for example, those that are immediately adjacent to NASA's Shuttle Launch facilities are excluded from consideration. But, efforts to reconnect the other targeted impoundments have temporarily ceased until NASA is assured that it will be credited for all future reconnections in the MINWR as mitigation of environmental impacts caused by its future development activities. This assurance can be given when NASA delivers a mitigation plan that is acceptable to the SJRWMD and the USACE. The SJRWMD is hopeful that NASA's mitigation plan can be completed and approved soon (perhaps by the time this plan update is published). Perhaps upon plan approval, the 2,000 acres of targeted impoundments can be immediately reconnected.

In the Central IRL, there are approximately 4,000 acres of coastal wetlands. Over 3,300 acres of these mostly mangrove-dominated wetlands are impounded. The impounded area reconnected to date stands at 2,052 acres; much of that acreage was reconnected prior to 1994. Slightly over 1,260 acres of wetlands remains isolated and nearly all are privately owned. Progress toward reconnecting these isolated impoundments will depend on the success of public acquisition. Acquisition of these wetlands was made a priority of the SJRWMD through the IRL *Blueway* program. To date, no firm purchase contracts have been executed, although a few could be imminent. The public purchase of one or a few of these impoundments in the development-intense Central IRL or Banana River Lagoon would help establish the market value of these lands, promoting additional public acquisitions.

In summary, nearly 14,400 acres of impounded wetlands in the North IRL were reconnected or completely breached; another 2,052 acres were similarly rehabilitated in the Central IRL.

Wetlands Management Research Initiative. The Wetlands Management Research Initiative, currently underway in the MINWR, is a logical response to an interagency debate about what policies and practices constitute appropriate management of reconnected impoundments. The rationale for the Wetlands Initiative is covered in some detail in Chapter 2 (in **Coastal Wetlands** and same sub-section heading). Wetland management alternatives, those in practice and those proposed, seem to be as varied as the wetland resources they seek to enhance. Consequently, the basic question that the Initiative is attempting to answer is "Which alternative or mix of alternatives is best with respect to serving both the USFWS mandates imposed on the MINWR wetlands and the variety of other wetland resource goals viewed as equally important by agencies of the state and IRLNEP?" Based on the Initiative study, recommendations for management will be developed for consideration by the USFWS for application at the MINWR. The general intent of the recommendations is to establish new guidelines that would reflect continued adherence to USFWS management mandates while seriously addressing other state and federal restoration objectives in the management of MINWR wetlands.

The Wetlands Initiative study is about halfway into its 3-year schedule as of December 2001. It is being generously funded by EPA ($550,000 at least), and is matched by SJRWMD, FDEP Bureau of Survey and Mapping, USGS, USFWS, and a host of other entities engaged in the research. More detail about the Wetlands Initiative can be obtained by accessing the project web site: http://dugong.ksc.nasa.gov/wi/.

Although the Initiative study and its recommendations will be directly applicable to the impounded herbaceous marshes of the North IRL and Mosquito Lagoon, there are anticipated management implications regarding mangrove-dominated impoundments in the Central and South IRL.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. The North IRL has approximately 200 acres of dragline-impacted marsh. Nearly all of the dragline impacts are on public lands. Restoration of dragline-impacted marshes in the North IRL will likely be a cooperative endeavor by SJRWMD, NASA, and USFWS/MINWR.

In the Central IRL, there are 317 acres of dragline-impacted wetlands. Most of these wetlands are in Indian River County and are privately owned. A detailed plan of restoration of these dragline-impacted wetlands will be developed in the near future (see also Chapter 2 for discussion of the Lagoon-wide plan to restore these degraded wetlands). Because private ownership is an issue here as it is with the remaining isolated impoundments, land acquisition will certainly dictate the plan's implementation schedule for the Central IRL.

Creation of Shoreline Vegetative Habitats. The project dealing with red mangrove (*Rhizophora mangle*) plantings does not cover the North IRL because this area is the species' northern limit in range. Plantings of red mangrove may not survive the colder winters here as they would the milder winters in Central and South IRL.

Mangrove plantings have been conducted at 22 sites in the Central IRL since 1995. Some of these sites have been expanded by multiple, follow-up plantings. Plantings are monitored to evaluate success and the planting technique has been refined accordingly (refer to Chapter 2, same sub-section heading, for details on the planting techniques).

Land Acquisition – *Blueway* Program. Most of the wetlands in the North IRL are in public ownership, and therefore, land acquisition is not as major an issue as it is in the Central IRL. Nonetheless, there are 1,650 acres of wetlands and adjacent uplands in the North IRL included in the IRL *Blueway* program (Figure 5-12). Approximately 870 acres of these lands, known as Pine Island, were purchased by SJRWMD and Brevard County.

Land acquisition is of greater strategic importance to the wetland restoration effort in the Central IRL than in the North. Over 4,000 acres of wetlands and adjacent uplands in the Central IRL were included in the *Blueway* program (Figure 5-13). Recently, a parcel of land, Inlet Groves, consisting of about 290 acres on the south Brevard barrier island, and abutting other publicly owned wetlands, were purchased. Unfortunately, progress on other potential acquisitions has been slow generally due to budgetary constraints and sellers' high asking prices.

In 1999, SJRWMD entered into a contract with The Nature Conservancy (TNC) to provide "land agent" assistance by contacting owners, conducting appraisals and even negotiating acquisition contracts with the sellers under the guidance of the SJRWMD. This collaboration between the TNC and SJRWMD was intended to expedite the acquisition process and it has, but just to the point of negotiating seller asking prices. The SJRWMD hopes that a spate of successful negotiations and parcel acquisitions will occur in 2002/03, and will continue at a high rate over the coming years.

The Next 5 Years

Rehabilitation of Impounded Wetlands. The goal over the next 5 years is to reconnect or restore all the remaining targeted impoundments in the North IRL, all located in the MINWR – over 4,500 acres. The objectives for the next 2 years are to resolve the mitigation and management issues with NASA and USFWS/MINWR and to reconnect at least 2,000 acres of wetlands in the MINWR.

Continued progress in rehabilitating impounded wetlands in the Central IRL depends on acquiring privately owned wetlands. Acquisition is complex and time consuming; thus, realistic objectives are impossible to predict.

Wetlands Management Research Initiative. The same agencies that manage wetlands in the North IRL and Central IRL are directly involved in or are being made aware of the Wetlands Research Initiative: USFWS, Brevard Mosquito Control District, and Indian River Mosquito Control District. These agencies can readily apply the research findings to their respective management policies and programs that affect impounded wetlands. It is expected that they will participate in the development of final management recommendations following the conclusion of the research in 2003.

Rehabilitation of Other Impacted Wetlands – Dragline-Ditch Impacts. After development of a plan in 2003 to rehabilitate dragline-ditched wetlands, the SJRWMD will develop activity schedules and a prediction of per-annum progress within the North and Central IRL. The plan will scope out what can be practically achieved within fiscal year time frames and how many years it may take to complete this program. At this time, it is not possible to realistically determine how much “draglined” acreage can be rehabilitated in 5 years. It should be noted that progress in the North IRL is partly contingent on the SJRWMD and USACE approvals of NASA’s mitigation plan because rehabilitation of dragline-impacted wetlands is likely to be included. It is possible that the USACE may further facilitate the rehabilitation of these impacted wetlands by including this effort in the IRL-North Feasibility Study.

Creation of Shoreline Vegetative Habitats – Emphasis on Red Mangrove Plantings. No plantings are planned for the North IRL. In the Central IRL, approximately 10 planting events per year over the next 5 years is the goal set by the Environmental Learning Center in Indian River County, the lead organization in this program.

Land Acquisition – *Blueway* Program. The objective over the next 5 years is to acquire most, if not all, of the *Blueway* wetlands, especially the impounded wetlands. Continued funding of acquisition support services should be maintained to help achieve that objective. The SJRWMD hopes that a number of willing sellers will consider and sign acquisition agreements. If the appraised values are in close agreement with the sellers’ asking prices, then substantial progress is possible toward meeting the 5-year objective. Progress on acquisitions is certainly critical to further progress in reconnecting impounded wetlands in the Central IRL.

Table 5-8. The 5-Year Plan List of Coastal Wetland Projects for the North and Central IRL

- **Acquire privately owned impounded wetlands, a high priority under the *Blueway* program (~1,270 acres)**
- **Pursue acquisition of an additional 4,380 acres of targeted lands under the *Blueway* program**
- **Reconnect all remaining and available isolated impoundments; most are in MINWR (~4,500 acres) or are privately owned (~1,270 acres)**
- **Complete Wetlands Management Research Initiative; develop management recommendations**
- **Initiate plan to rehabilitate dragline-impacted wetlands (~400 acres) in the North and Central IRL**
- **Complete shoreline planting projects at ~10 sites/year over the next 5 years in the Central IRL**

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CHAPTER 6 - SOUTH INDIAN RIVER LAGOON

Seagrass and Water Quality

Seagrass Resource Assessment

The SFWMD's assessment of the South IRL seagrass resource is based on the same three measurement indices used in the Lagoon-wide assessment:

- Acres of seagrass coverage over time (net gain or loss)
- Maximum depth of the edge of seagrass beds, and
- Percent of sunlight that reaches the targeted depth of 1.7m

For more information on why and how these indices are used to assess seagrass resource status, refer to Chapter 2 pp. 2-3. Additional details, beyond the scope of this plan, on methods and results in the South Indian River Lagoon can be found at

ftp://ftp.sfwmd.gov/pub/rbennet/docs/irl_sav_report.pdf

Segment classifications based on the measurement indices described above are provided in Table 6-1. Major findings on the status of seagrass in the South IRL and are summarized below:

Table 6-1. General Classification[1] of South Indian River Lagoon Segments

South Indian River Lagoon	£ 20% of surface light @ 1.7 m	SDI £ 75 %[2]	Loss since 1940 ³ 50 %	Loss since 1940 ³ 75 %	Classification[2]
22	X	X			Fair
23	X				Good
24	X	X			Fair
25	X	X	X		Poor
26					Good

1. Classification is based on the following indices-related criteria: % surface light @ 1.7m, seagrass depth index or SDI (a measure of depth extent of seagrass relative to the target depth of 1.7 m; see Figure 6-1), and a percent loss of seagrass since 1940 (≥50 % and ≥ 75 %). Any segment receiving 3 or more marks is classified as poor, 2 marks fair, and 1 mark or less good
2. Based on 1992, 1994, 1996, and 1999 data.

- Segment 26 has better seagrass conditions than any of the other South IRL segments. This segment was ranked “good” (Table 6-1) and is the only South IRL segment that exceeded the specified light, depth, and acreage targets. Clear oceanic waters entering this segment from the Jupiter Inlet create such favorable” conditions for seagrass growth.
- Segment 23 also received a “good” ranking. Healthy seagrass beds are present within this segment. However, expansion of the beds throughout the segment to the 1.7 m depth target may be limited by periodic turbidity that reduces the light available for seagrass growth.
- Although Segment 22 received a “fair” rating it was very close to receiving a “good” rating (it missed the “good” rating by having an SDI of 74 % instead of 76 %). Recent mapping efforts and water quality data support continued improvement in segment 22. Seagrass acreage increased 29% from 1994 to 1999. From 1990 through 1999 water clarity improved due to decreases in chlorophyll a, TSS, and color and an increase in secchi disk depth.

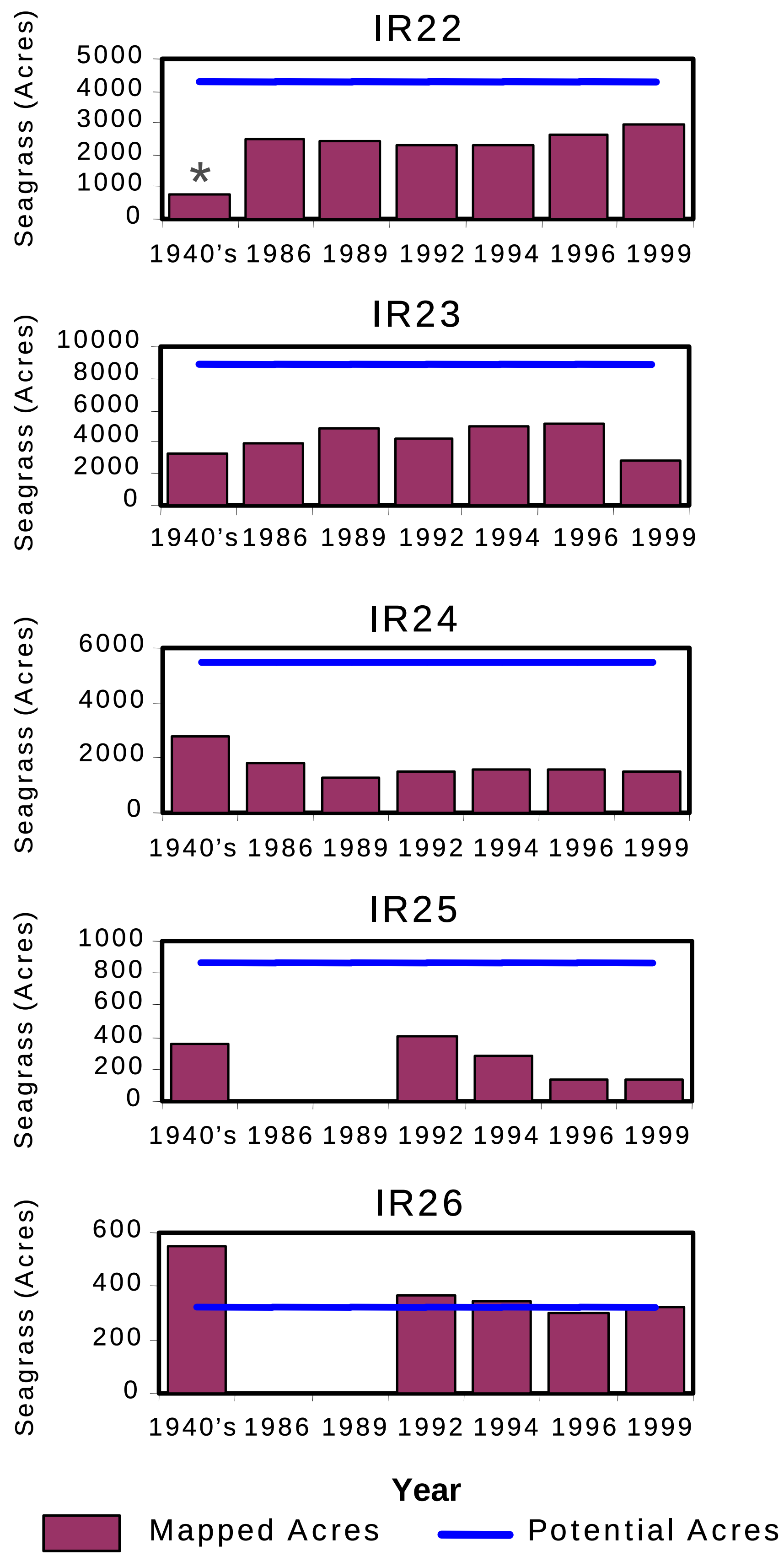


Figure 6-1 b. Acres of seagrass, by segment, in each year mapped. Note differing scales. Potential seagrass acres (the area < 1.7 m deep) are shown as a blue line.

* In IR22 seagrass acreage was 2,336 in 1958

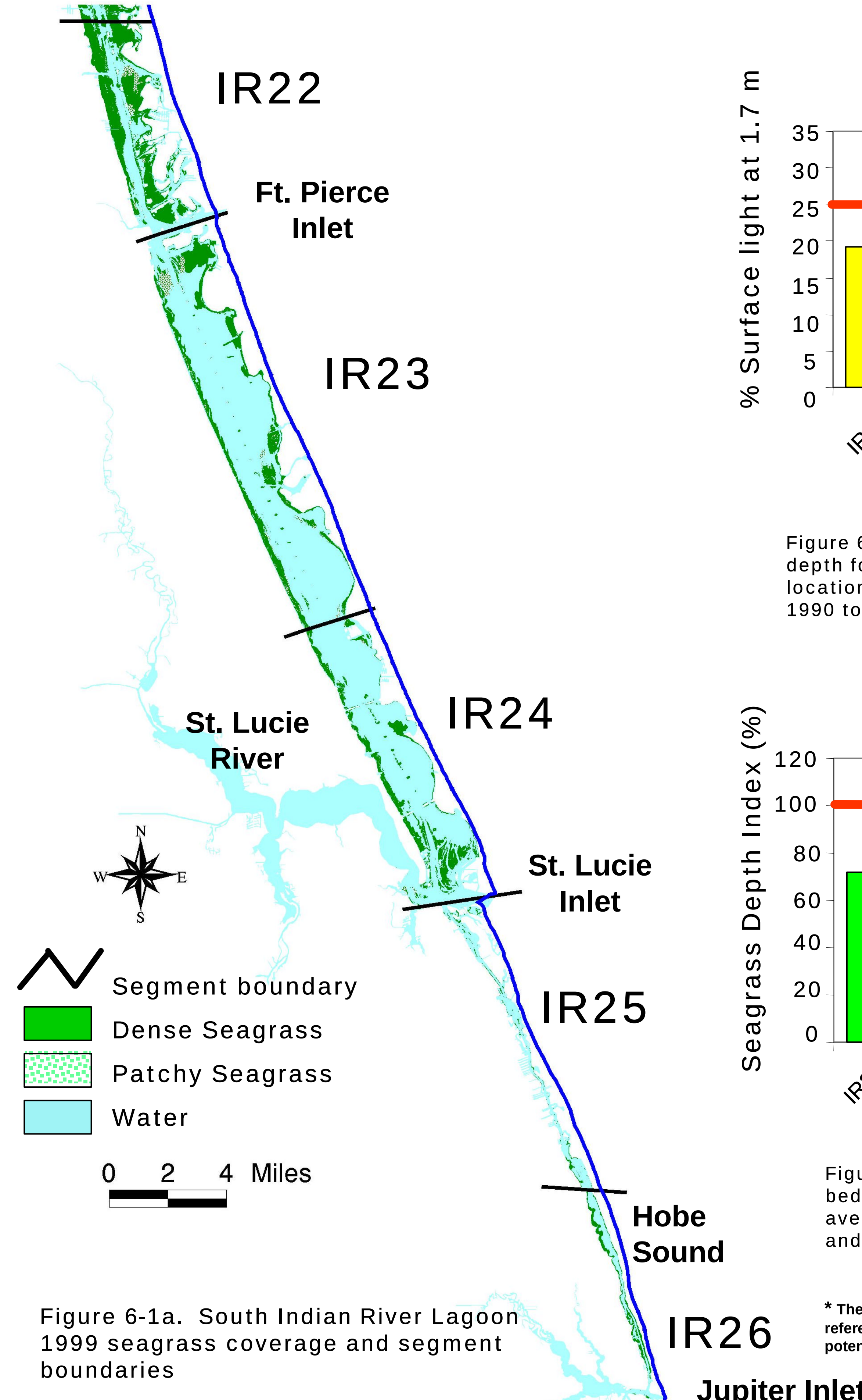


Figure 6-1a. South Indian River Lagoon 1999 seagrass coverage and segment boundaries

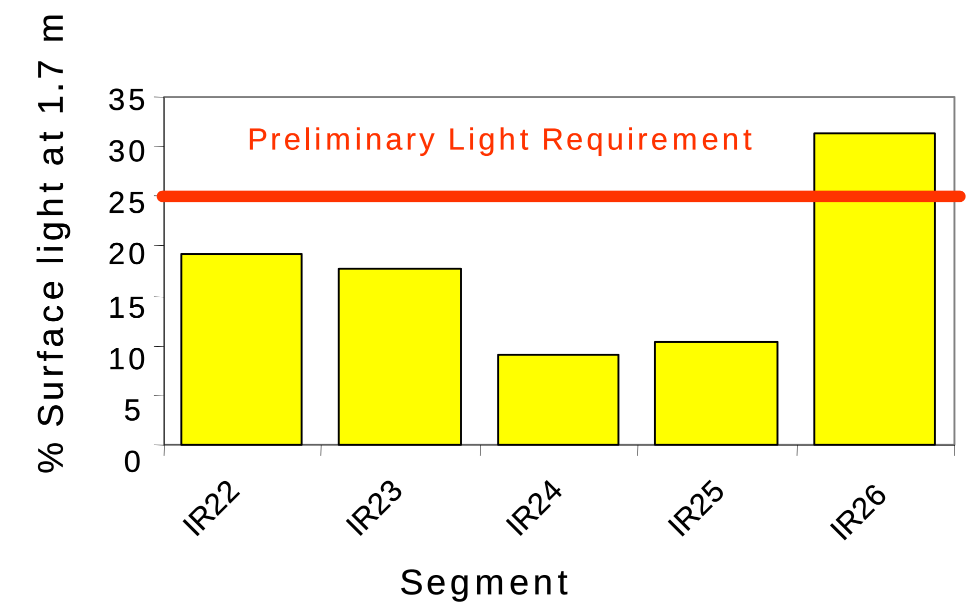


Figure 6-1c. Median percent surface light at the 1.7 m target depth for each segment, north to south (see map at left for location of segments). Based on monthly measurements from 1990 to 1999.

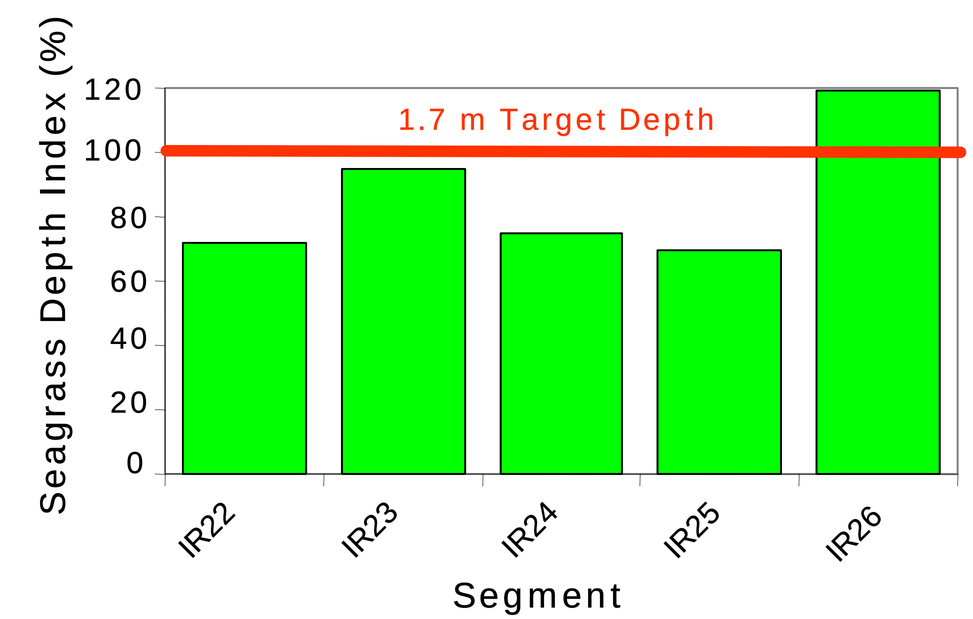


Figure 6-1d. Seagrass Depth Index = depth of edge of bed as a percent of the 1.7 m target depth*. Based on average seagrass deep edges mapped in 1992, 1994, and 1996.

* The Seagrass Depth Index (SDI) is based on potential coverage to 1.7 m referenced to the NGVD29 vertical datum. The SDI would be slightly less if potential coverage were referenced to mean water level (MWL).

- Segments 24 and 25, which receive freshwater discharges from the St. Lucie River, apparently support the least healthy seagrasses in the South IRL, with ratings of "fair" and "poor", respectively. Seagrass acreages in both of these segments were consistently well below the target acreages and light available for seagrass growth was low. A 67 % decrease in seagrass acreage occurred in Segment 25 from 1992 to 1999. This segment received the only "poor" rating in the South IRL.

Total seagrass acreage in the South IRL during 1940 was similar to the acreage mapped in 1999 (Table 6-2). Although overall seagrass resources in the South IRL have remained fairly stable over the last sixty yea, when the seagrass data is evaluated by segment, it is clear that considerable seagrass acreage changes have occurred. Seagrass acreage was less in 1999 than in the 1940s in all segments except Segment 22.

Table 6-2. South Indian River Lagoon Seagrass Distribution, 1986–1999, and Seagrass Target Acreages.

Lagoon Segment No.	Total Seagrass Acreage Per Mapping Year							Target Acreage[1]
	1940	1986	1989	1992	1994	1996	1999	
22	764	2471	2435	2310	2307	2649	2978	4303
23	3244	3916	4815	4273	5007	5187	2856	8833
24	2754	1806	1279	1513	1571	1589	1520	5469
25	358	Not Mapped	Not Mapped	413	281	136	134	870
26	548	Not Mapped	Not Mapped	365	341	303	320	324
TOTAL	7668	8193	8529	8874	9507	9864	7808	19799

1. Submerged bottom acreage less than 1.7 m deep.

In Segment 22, acreage increased dramatically (2000+ acres) from the 1940s to 1999. During the early 1940s, seagrasses in this segment were affected by inlet dredging and construction of the north causeway. Additionally, once the current Ft. Pierce Inlet was constructed, seagrassses began colonizing sediments in the delta of the old inlet (located approximately one mile north of the current inlet). Seagrasses in segment 22 appear to have recovered from the 1940s impacts and have expanded over the old inlet delta resulting in greater acreage now than in the 1940s (Woodward-Clyde Consultants, 1994).

A major decline in seagrass acreage from 1996 to 1999 was observed in segment 23. However, review of field notes and photographs associated with the 1996 and 1999 mapping efforts revealed that much of the apparent decline could be due to photointerpretation difficulties associated with distinguishing algae from seagrass signatures (Robbins and Conrad, 2001). Consequently, detailed groundtruthing efforts are warranted along the east shore of segment 23 for future mapping efforts.

During large discharges from the St. Lucie Estuary or from C-25/Ft. Pierce Farms canal, plumes of freshwater are pushed into the South IRL during incoming tides. Contaminants, and especially particle-borne contaminants, are then deposited into otherwise unaffected areas of the South IRL. Impacts to the seagrasses south of the confluence with the St. Lucie Estuary were documented in 1998 as a result of the large releases from Lake Okeechobee.

To better understand the water quality/seagrass link in the South IRL, modifications have been made to the South IRL water quality monitoring network. Beginning January 2000, water quality stations were co-located with many of the seagrass transects in the South IRL (Figure 6-2). The monitoring was increased from quarterly to seven times a year. Data collected at the seagrass transects will help refine the water quality targets presented in this plan.

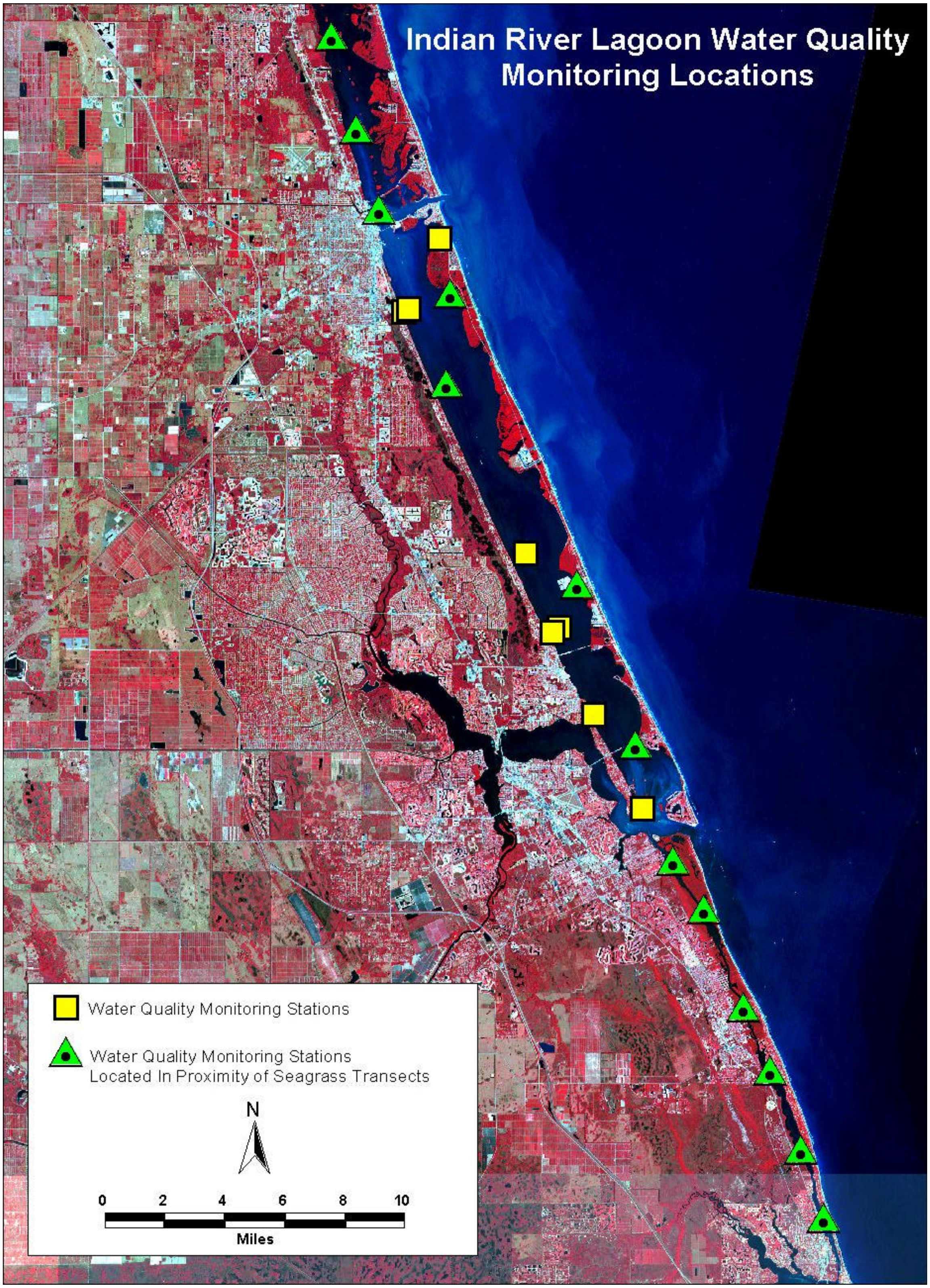


Figure 6-2. Revised Water Quality Monitoring and Seagrass Transect Sites

Water Quality Resource Assessment

The South IRL is less subject to the adverse disturbance of salinity than are areas where inlets are more removed from sources of freshwater (e.g., near Vero Beach or Melbourne; Woodward-Clyde, 1994a). Wet season reductions in South IRL salinity are usually confined to the areas adjacent to the C-25 canal near the Ft. Pierce Inlet, and the mouth of the St. Lucie River Estuary (SLE) near the St. Lucie Inlet (Woodward-Clyde, 1994b). The highest average salinity's, 29-33 ppt, are typically found in the Ft. Pierce, and Jupiter Inlet areas (Figure 6-3).

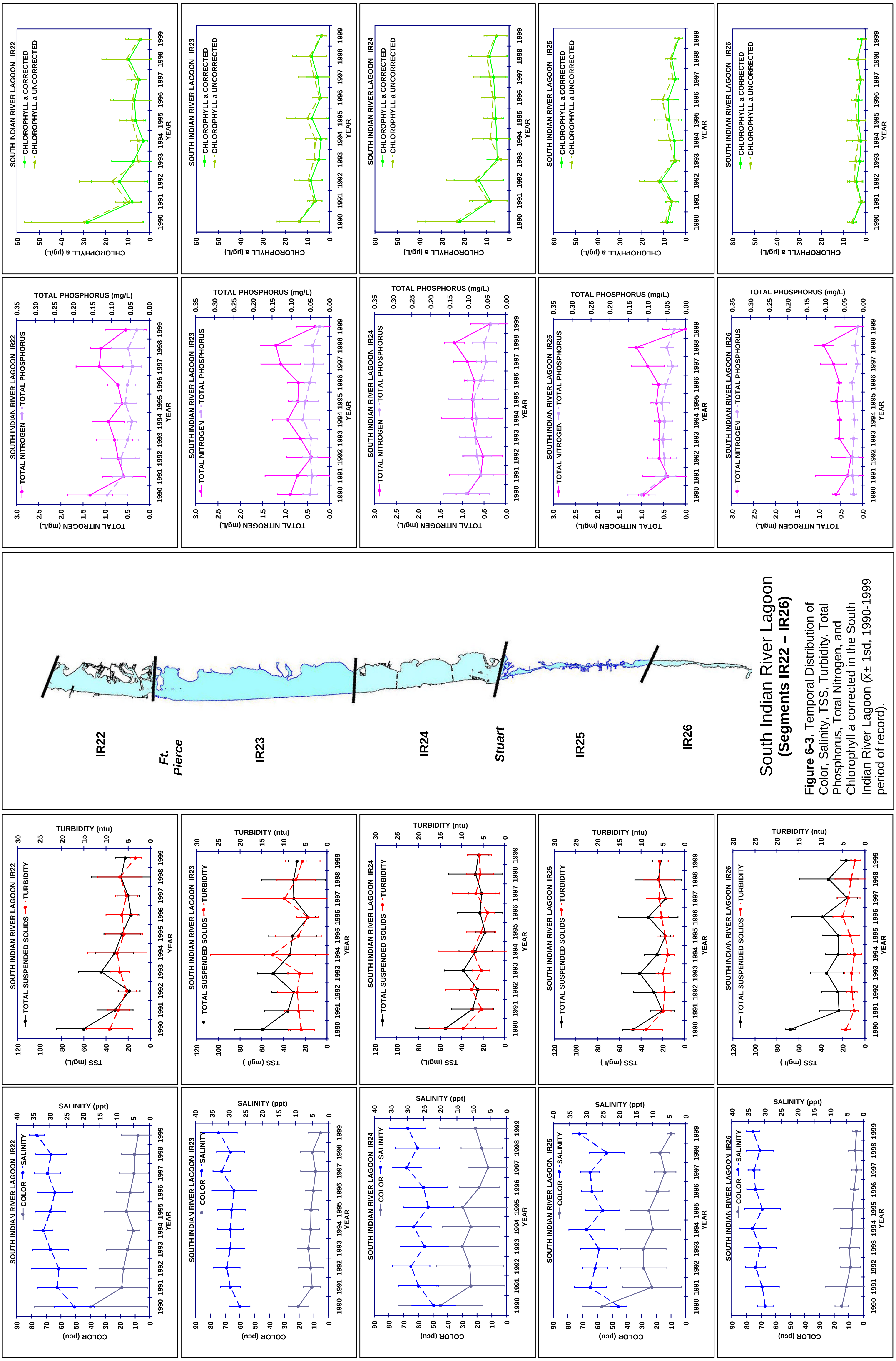
However, dramatic salinity changes in and adjacent to the South IRL were observed since the last SWIM Plan Update. In the winter and spring of 1998, freshwater releases from Lake Okeechobee through the S-80 structure on the St. Lucie Canal (C-44) began in December and steadily increased, with peak flows of 7000 cfs occurring between March 1 and April 20. These discharges from Lake Okeechobee, combined with local basin runoff, caused drastic decreases in salinity. The South IRL, normally averaging 30-ppt (part per thousand) salinity, decreased to 20 ppt during peak flows. The SLE, which normally averaged 24 ppt, decreased to 5 ppt during peak flows. The North Fork of the St. Lucie River, normally averaging 18 ppt, decreased to 0 ppt during peak flows. In 2000, the Lake Okeechobee Managed Recession Plan resulted in billions of gallons of freshwater being released to tide through the St. Lucie Canal.

Establishing a suitable salinity environment is a basic prerequisite to promote a healthy estuary. Accordingly, SFWMD restoration efforts are focusing on determining what freshwater inflows are needed to provide the salinity regimes needed to support healthy, sustainable estuarine communities. During the 1990s, despite the events noted above, 10-year average salinities were above 20 ppt and generally well within the optimum salinity range for seagrass growth.

Analyses to date, indicate that salinity, color, and turbidity are the primary factors in the South IRL that affect the amount of light reaching the Lagoon bottom. Color generally tends to track salinity levels in the South IRL, where tributaries or canals discharge relatively high colored waters and, concomitantly, salinities are reduced. Some of the lower color levels are in the South IRL, with Hobe Sound near Jupiter Inlet standing out with the lowest 10-year average: <10 pcu. Turbidity levels in South IRL frequently average above 6 ntu. The segment immediately south of Ft. Pierce Inlet experiences both the highest 10-year average and the highest turbidity levels: ~7 ± 7 ntu. Color and turbidity directly influence the penetration of light through the water column.

Light is a major factor controlling the depth distribution of seagrass in the South IRL. Preliminary results indicate that color and turbidity are the primary factors in the South IRL that affect the amount of light reaching the Lagoon bottom (Table 6-4; SFWMD), as measured by K_{par} (a measurement of photosynthetically active radiation). Most of the increased color and turbidity in the South IRL are being delivered with high flows of fresh water discharge, which in turn reduce the salinity in the Lagoon. Therefore, reducing freshwater flows to the South IRL will increase average salinities and reduce turbidity, color, and light attenuation.

The South IRL segments near the Ft. Pierce and St. Lucie inlets appear to be aggravated by high turbidities, TSS, and nutrients. The area of the South IRL near the mouth of the St. Lucie River experiences higher than typical levels in TSS, color, and nutrients (TP being the most obvious). Turbidity levels in the South IRL frequently average above 6 NTU. The segment immediately south of the Ft. Pierce Inlet experiences the highest, as well as, the largest fluctuating turbidities of ~7 ± 7 NTU. Some of the lower color level sin the IRL occur in the South IRL. Hobe Sound near Jupiter Inlet had the lowest 10-year average: <10 pcu.



South Indian River Lagoon
(Segments IR22 – IR26)

Figure 6-3. Temporal Distribution of Color, Salinity, TSS, Turbidity, Total Phosphorus, Total Nitrogen, and Chlorophyll *a* corrected in the South Indian River Lagoon ($\bar{x}$± 1sd, 1990-1999 period of record).

Summary of Assessments

Seagrasses

- Acreage and distribution change in seagrass meadows were assessed at two to three year intervals between 1986 and 1999 for the South IRL. Change in areal extent of seagrass coverage was evaluated through a map to map comparison of data interpreted from aerial photographs. The acreage changes for the entire project area were relatively stable over the mapping period. However, when data was reviewed by lagoon segment, acreage trends and distribution changes became more apparent. Acreage losses were documented in all segments except one. Segments closest to the influence of the St. Lucie River showed declines in seagrass cover and/or low percent cover of potential habitat. Segments removed from the river's influence had relatively stable or increasing seagrass coverage. The healthiest seagrasses were found in the southernmost segment, where coverage of potential habitat exceeded 90 % in all years.
- Temporal trends in seagrass acreage as well as significant distributional changes not associated with net changes in acreage occurred within thirteen key areas (Robbins, and Conrad, 2001) Seagrass mapping and monitoring efforts are focusing on understanding the causes of the acreage and distribution changes in these key areas.
- Less than 50 % of the South IRL potential seagrass habitat was covered by seagrass in any year, therefore there is great potential to increase seagrass acreage.
- The lowest coverage of potential habitat is near the St. Lucie River in segments 24 and 25. On-going efforts to reduce pollutant loadings to the St. Lucie River are expected to improve water quality in Segments 24 and 25 and potentially lead to increases in seagrass coverage in these segments.

A study is underway to document seasonal changes in seagrass and associated macro-algae in segments 24 and 25. Data collected will be used to better understand the natural seasonal variability of seagrass and macro-algae in the study area, and the response of the seagrass community to freshwater discharge.

Water Quality

Water quality targets were established for all the parameters listed in Table 6-3, based on water quality concentrations in healthy seagrass beds. The concept is to maintain the median values and not exceed the 25th or 75th percentile values on an average annual basis. Efforts to meet these water quality targets and to manage freshwater flows through the St. Lucie River Estuary for environmental enhancement should help stabilize or increase the seagrass edge of bed depth and, therefore, improve the overall health of the South IRL.

Estuaries are the receiving water body for a variety of watershed inputs. Therefore, estuarine restoration and management strategies must be linked to watershed management of surface water, groundwater, and atmospheric inputs in addition to the internal processes occurring in the receiving water body. (see http://www.sfwmd.gov/org/wrp/). The new Water Supply and Environmental (WSE) regulation schedule for Lake Okeechobee discharges should provide more flexibility for discretionary releases of water for environmental benefits. In addition, pulse releases are prescribed to lower lake stage with minimal impact to the South IRL. The current status of seagrass and water quality monitoring projects in the South IRL is summarized in Table 6-4. Many of the projects that were designed to assess the current status of seagrasses and water quality have been completed. Efforts to monitor changes and trends in over time are continuing (see Chapter 2).

Table 6-3. Water Quality Targets for the South Indian River Lagoon

Parameter	25^{th} Percentile	Median Value	75^{th} Percentile
Dissolved Oxygen (mg/l)	5.67	**6.09**	6.55
pH Units	7.8	**7.9**	8.0
Salinity (ppt)	28.3	**30.4**	33.2
Secchi Disk (m)	1.00	**1.44**	1.56
Chlorophyll a (mg/m^3)	1.9	**3.1**	5.3
Nitrite (mg/l)	0.002	**0.002**	0.002
Nitrate (mg/l)	0.006	**0.008**	0.008
Nitrite + Nitrate (mg/l)	0.002	**0.004**	0.008
Total Kjeldahl Nitrogen (mg/l)	0.339	**0.676**	0.997
Total Nitrogen (mg/l)	0.595	**0.692**	1.095
Orthophosphate (mg/l)	0.009	**0.023**	0.037
Total Phosphorus (mg/l)	0.025	**0.053**	0.070
Total Suspended Solids (mg/l)	14	**20**	28
Turbidity (NTU)	1.71	**2.84**	4.59
Volital Suspended Solids (mg/l)	5	**8**	11
Color Units	5	**8**	13
K_{par} (Photosynthetically Active Radiation)	-1.5	**-1.2**	-1.0

Table 6-4. Description and Status of Seagrass & Water Quality Projects

PROJECT NAME	DESCRIPTION	STATUS	LEAD AGENCY
Seasonal trends in sea-grass and macro-algae in SIRL	Document seasonal changes in seagrass and macro-algae in the South IRL near the mouth of the St. Lucie River	Continuing	SFWMD
Aerial Photographs	Annual aerial photographs to prepare SIRL seagrass maps. The SFWMD is the lead for the SIRL portion of the lagoon wide mapping and photography.	Continuing	SFWMD
Seagrass Mapping	Map seagrass lagoon-wide from aerial photos and ground truthing 1986 - 1999. The SFWMD is the lead for the SIRL portion of the lagoon wide mapping and photography.	Completed	SFWMD
Indian River Lagoon Seagrass Transects	Monitoring two times a year of 6 transects that were installed in September 1994 from Jupiter to St. Lucie Inlet	Continuing	SFWMD
IRL Seagrass Transects - additional monitoring	Monitoring a subset of the SIRL transects was done in May 1998 during Lake Okeechobee regulatory releases (a similar effort was also done in 2000)	Completed	SFWMD
1999 Seagrass Data Summary	Analyzed trends of seagrass mapping data from 1986-1999; summarized data for deep edges of transects; developed recommendations for future monitoring; Input data for Pollutant Load Reduction Goal (PLRG) development process	Completed	SFWMD
Indian River Lagoon Tidal Station Monitoring 1999	8 stations in the South Indian River Lagoon between Ft. Pierce Inlet and Pecks Lake	Continuing	SFWMD
Indian River Lagoon Water Quality Monitoring Network	Forty stations monitored quarterly: 1989 - 1999	Completed	SFWMD
Indian River Lagoon Water Quality Monitoring Network Revised 2000	21 stations monitored seven months/year. January 2000 to present.	Continuing	SFWMD
Water Quality Data Summary	Trend analysis and summary of water quality data; recommendations for future monitoring; Input data for PLRG development process	Completed	SFWMD
Indian River Lagoon Bathymetry 1998	Indian River Lagoon bathymetry completed as of 1998	Completed	SFWMD

Progress on Projects

Strategies for Pollutant Load Reduction

There has been, and continues to be, a variety of new and on-going activities in the South IRL Watershed. Many of these activities immediately contribute to the achievement of SWIM goals and objectives.

Pollution Load Reduction Goal (PLRG) Development

In the South IRL, a two-step approach is being taken to develop PLRG's. The first step was to develop concentration targets based on the establishment of healthy seagrass. Healthy seagrass beds were identified and statistical analysis was performed based on 10 years of water quality data from those locations. These numbers were then used to establish water quality targets for the South IRL Table 6-3. The next step will be to use these water quality target values, to develop Pollutant Load Reduction Goals (PLRGs) for the South IRL. Ultimately, the "in-lagoon" water quality target values will be used in conjunction with hydrodynamic/water quality and watershed modeling to evaluate pollutant load reductions needed in the watersheds to meet the targets. Water quality concentration targets will be reevaluated and possibly modified as additional data and modeling results become available.

A comparison of the South IRL water quality target values with the median wet season water quality from all forty South IRL water quality stations (July and October data from 1990 - 1999) is provided in Table 6-5. A high percentage of these values exceed the South IRL water quality targets. This suggests a need to improve water quality for the restoration and protection of seagrass resources in the South IRL.

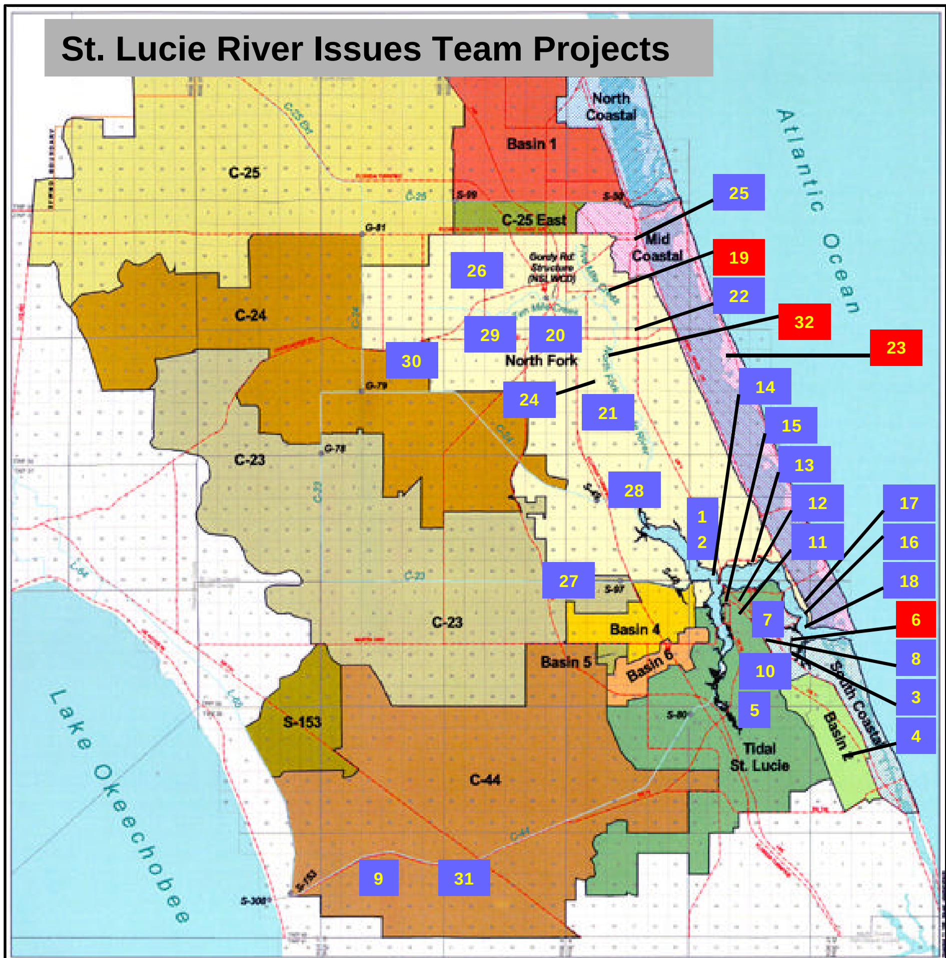
Table 6-5. Comparison of Water Quality Targets to Measured Values, 1990-1999

Parameter	Median Target Values	No. of Samples	No. of Exceedances From Target Values		Percent Exceedance from Target Values
			Dry Season	Wet Season	
Color units	**≤ 8**	**1216**	**340**	**450**	**65**
Turbidity (NTU)	**≤ 3**	**1310**	**599**	**434**	**79**
Salinity (ppt)	**≥ 30**	**1043**	**251**	**250**	**48**
$\mathbf{K_{par}}$ (Photosynthetically Active Radiation)	**≥ -1.2**	**600**	**138**	**143**	**47**
Chlorophyll ***a*** **(**mg/m$^{3)}$	≤ 3.1	1139	348	414	67
Total Phosphorus (mg/l)	≤ 0.053	1230	178	240	46
Orthophosphate (mg/l)	≤ 0.023	1154	133	250	34
Total Kjeldal Nitrogen (mg/l)	≤ 0.676	1302	289	310	46
Total Nitrogen (mg/l)	≤ 0.692	1124	236	329	50
Nitrite + Nitrate (mg/l)	≤ 0.004	1312	339	272	46
Dissolved Oxygen (mg/l)	≥ 6.09	1253	123	317	35
Volatile Suspended Solids (mg/l)	≤ 7.5	1312	319	330	50
Total Suspended Solids (mg/l)	≤ 20	1303	383	309	53

*Bold values indicate significant correlation to seagrass edge of bed depth

St. Lucie Issues Team Projects

Additional efforts in the South IRL have been funded by the state legislature for the projects nominated by the St. Lucie River Issues Team. This additional funding has greatly accelerated the implementation of many of these projects (Figure 6-4 and Table 6-6).



Habitat Restoration

Stormwater Quality Improvement

BASINWIDE PROJECTS

IFAS
- Citrus Pesticide BMP
- FY&N
- N, P, Heavy Metals in Runoff from Citrus & Vegetable Fields Phases 1, 2, 3
- Water Table Mgmt as a BMP in Citrus Groves Phases 1, 2, 3
- Agrochemical & Nutrient Loadings - Pastures, Golf Courses & Urban Areas in SLE Basin Phases 1, 2, 3
- Muck

NOAA/ NOS/NMFS
- Environmental Toxicity in SLE / IRL, Phases 1, 2, 3
- Fish Health Problems in the SLE

NRCS
- Citrus Irrigation - Microjet Conversion - 3 years

USGS
- Pesticide Reconnaissance within the SLE

USDA
- Watershed and Aquatic Research Assessing Key Environmental issues in the St. Lucie Estuary

Martin County Projects
1 - Palm Lake Park Phases 1, 2
2 - North River Shores
3 - SY&CC, North River, Normand St. Weirs
4 - Poinciana Gardens
5 - Fern Creek - Phases 1, 2
6 - Willoughby Creek
7 - Airport Ditch
8 - Golden Gate Retrofits - Phases 1, 2
9 - RUSS - Dupuis Restoration - 2 years
10 - Salerno Creek Retrofit

Countywide
- Vacuum Truck
- MSWCD Urban MIL - 2 years

City of Stuart
11 - Poppleton Creek - Phases 1, 2
12 - Frazier Creek - Phases 1, 2
13 - Haney Creek - Phases 1, 2
14 - Fork Road CRA
15 - Krueger Creek

Sewall's Point
16 - Mandalay/Marguerite
17 - Rio Vista Outfall Retention Area Retrofit
18 - Island Road Bafflebox (referred to NEP)

St. Lucie County Projects
19 - Platt's Creek Phases 1, 2
20 - NSLR Retrofits
21 - Hidden River Estates
22 - White City Canal F
23 - Mosquito Impoundment Restoration IX
24 - River Park Water Quality Improvements

Countywide
- SLCSWCD Urban MIL - 2 years

City of Ft. Pierce
25 - Moore's Creek

NSLSWCD
26 - NSLSWCD BMP Implementation

SFWMD
27 - C-23 Dredging
28 - C-24 Bank Stabilization - Phases 1, 2
29 - Ten Mile Creek - Phases 1, 2, 3
30 - PC38
31 - C-44 STA

St. Lucie Estuary/Indian River Lagoon
- Ag BMP Cost Share
- SLE Water Quality Monitoring
- IRL Water Quality Model - Phases 1, 3
- Oyster Restoration - Phases 1, 2

DEP - CAMA
32 - NFSLR Wetland Connection - Phases 1, 2

Figure 6-4. Location of St. Lucie Issues Team Projects, 1999-2001

Table 6-6. St. Lucie Issues Team 2002-2003 Rankings

Project Title	Sponsor
Pine-Riverdale Retrofit	City of Stuart
Water Quality Enhancement BMP	FPFWCD
Water Table Management as a BMP I/R Citrus	IFAS – IRREC
Water Quality Enhancement BMP	NSLRWCD
S. Sewall's Point Road Via Lucindia	Sewall's Point
Citrus Irrigation Conversion	USDA
Savannas Ecosystem Management Project	St. Lucie County
NFSLR Acquisition and Restoration	St. Lucie County
Cedar Pointe Water Quality Retrofit	Martin County
St. Lucie Estuary Watershed Citrus BMP – Water Quality Management	SFWMD
N, P, and Heavy Metals from Citrus Groves and Vegetable Fields	IFAS – IRREC
Coral Gardens Basin Water Quality Retrofit	Martin County
South Sewall's Point Road Mandalay	Sewall's Point
St. Lucie Fish health as Biological Performance Measure	NOAA
Golden Gate Phase 3 Water Quality Retrofit	Martin County
Rio SL WQ Improvements	Martin County
Environmental Toxicity in SLE/IRL	NOAA

Non-Point Source Strategies

Stormwater Discharge

Water quality impacts to the South IRL are dominated by stormwater runoff from urban and agricultural sources. Several strategies are being implemented in the South IRL watershed to better manage urban and agricultural runoff. Implementation of best management practices (BMPs) is on-going. Stormwater utilities are in place in each county. Counties, municipalities, and other agencies in the watershed have a variety of stormwater retrofit projects. Many of the SFWMD actions to ensure a more natural delivery and supply of good quality freshwater to estuaries occur in the watershed. These are currently being accomplished by instituting BMPs and construction of sub-regional storage and treatment facilities. Long-term solutions to excessive freshwater discharges to the South IRL will be addressed through CERP projects, specifically, The IRL-South Plan and the Lake Okeechobee Restoration Plan.

Best Management Practices

As outlined in the Florida Watershed Restoration Act (1999), Florida agriculture is encouraged to develop effective voluntary BMPs to help meet state water quality goals. The Indian River Citrus BMP Implementation Committee, a collaborative public/private group, guides the process for voluntary implementation of citrus BMPs in the watershed. Activities of the committee include identification of research and educational needs, work on rule development, and on-going support for implementation of science based BMPs. Aiding in this effort are various agencies and groups that are providing funding for technical projects and cost sharing for grower implementations (Figure 6-5). For additional details see http://www.irrec.ifas.ufl.edu/.

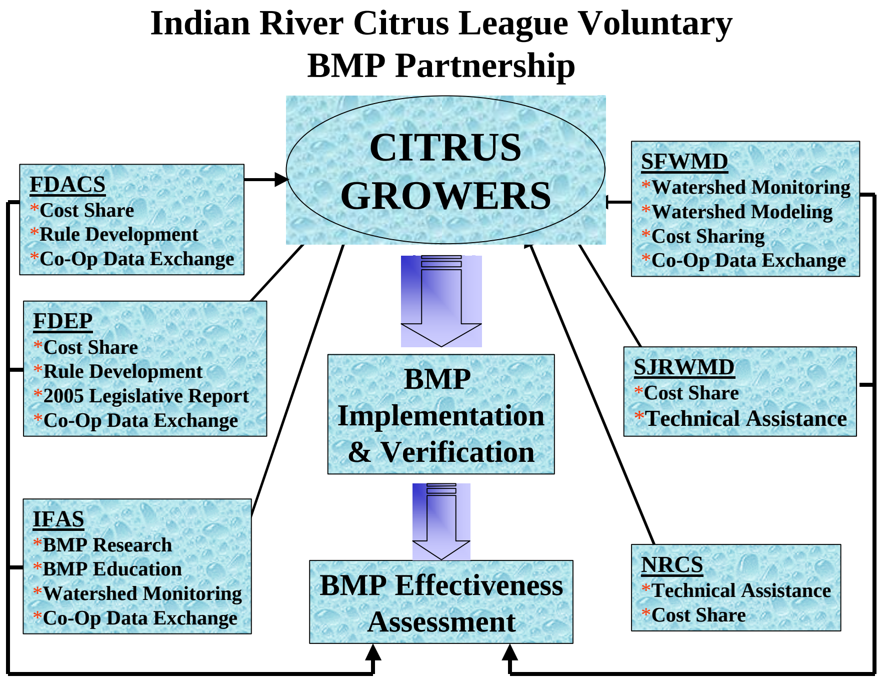


Figure 6-5. Agencies and groups provide funding for technical projects and cost sharing for growers to implement agricultural Best Management Practices (BMPs).

Muck

The Taylor Creek Sediment Removal project is projected to begin in 2003. This is a large project that will remove approximately 225,000 cubic yards of material.

Septic Tanks

Pollutant loads from on-site disposal systems (OSDS, a.k.a.,"septic tanks") or from inflows of groundwater contaminated by OSDS are considered by many to pose a potential threat to water quality in certain areas with close proximity to the lagoon and its tributaries. However, conclusive evidence is not available without site specific surface water/ groundwater monitoring. Progress has been made by local governments to identify priority areas and develop plans to convert OSDS to central sewer systems within the South IRL watershed. Ongoing groundwater monitoring studies that are underway by the SFWMD will provide data on both the quantity and quality of water entering the lagoon.

Project Descriptions and Status

A number of projects are underway to reduce pollutant loading from the South IRL Watershed. Many of these activities immediately contribute to the achievement of SWIM goals and objectives. The current status of pollutant load reduction projects in the South IRL is summarized in Table 6-7. One large retrofit project has been completed and the remaining efforts are continuing or underway.

Point Source Strategy – Domestic Wastewater Treatment Plants

In the South IRL, significant reductions in pollutant loading from domestic wastewater treatment plants (WWTPs) have been achieved since the mid-1980s. Consequently, domestic WWTPs appear to be a very minor source of pollution thanks to local government action in response to the IRL "No Discharge" Act (Chapter 90-262, Laws of Florida).

Table 6-7. Description and Status Pollutant Load Reduction Projects

PROJECT NAME	DESCRIPTION	STATUS	LEAD AGENCY
Non-point Source Strategy: Surface Water Drainage			
Salerno Creek Retrofit	Improve stormwater quality and flood protection in a 700 acre watershed, that discharges to SIRL. Construct a 23 acre wet detention lake discharge weir, and passive park along Salerno Creek.	In Progress	Martin County, Office of Water Quality
Sewalls Point Baffle Boxes	Install several baffle boxes to treat previously unimpeded stomwater discharges to the SIRL.	In Progress	Town of Sewalls Point
Moores Creek Retrofit	Improve stormwater runoff quality and existing level of flood protection in the 2,380 acre basin. Construct four water control structures, littoral shelves on canal banks and baffle boxes at major inflow points to the Creek.	In Progress	City of Ft. Pierce
Virginia Avenue Retrofit	Improve Stormwater Quality at Ft. Pierce discharge to SIRL	Complete	City of Ft. Pierce
Citrus BMP Implementation	Cost sharing implementations of BMPs for citrus systems in the St. Lucie Estuary and Indian River Lagoon watershed	In Progress	DACS, SFWMD, & Treasure Coast, Resource Conservation and Development Council, Ft. Pierce
Indian River Citrus BMP training for equipment operator and applicators	U of F, IFAS, and St. Lucie County Extension education and training in Martin, St. Lucie, and Okeechobee counties	Continuing	UF Extension, St. Lucie County
FL Yards and Neighborhoods (FY&N)	Educate and train for improved home, lawn and plant maintenance to improve water quality on site	In Progress	UF Extension, St. Lucie County
Manatee Creek Basin Water Quality Retrofit	The proposed water Quality retrofit improvements include an 11 acre detention area, creek improvements and installation of weirs for stormwater management. The project will reduce freshwater discharges, sediments and nutrient loading to Manatee Pocket and the SIRL.	In Progress	Martin County
Non-point Source Strategy: Muck			
Taylor Creek Dredging	Remove approx. 225,000 cubic yards of sediment. Currently in permitting phase.	In Progress	St. Lucie County

WWTP loadings of nitrogen and phosphorus have decreased by several orders of magnitude since 1986 (SJRWMD and SFWMD, 1987). Today, WWTP contributions of TN (~3,800 lb/yr), TP (~320 lb/yr), and TSS (~2,700 lb/yr) represent a miniscule fraction of the total surface water loading of these constituents to the South IRL. These small contributions primarily originate with just one WWTP at Ft. Pierce Inlet, which is operated by the Ft. Pierce Utility Authority.

Monitoring, Modeling and Applied Studies

Descriptions and status of Monitoring, Modeling, and Applied Studies projects are summarized in Table 6-8.

Monitoring

The objectives of South IRL Water Quality Monitoring are to: 1) develop a long term water quality data base to assess trends and support modeling; 2) evaluate ambient water quality in the South IRL; 3) establish a correlative link between water quality and the health of seagrass in the South IRL using the best available data; and 4) to use water quality at the healthiest seagrass sites to establish water quality targets for restoring seagrass in the South IRL.

In cooperation with Florida Department of Environmental Protection (FDEP), Bureau of Survey and Mapping (BSM) tide/salinity stations were installed in the St. Lucie Estuary in 1997. Tide (water surface elevation), currents (flow velocity), salinity, and temperature are recorded

Table 6-8. Description and Status of Monitoring, Modeling, & Applied Studies Projects.

PROJECT NAME	DESCRIPTION	STATUS	LEAD AGENCY
Water Table Management BMP	Use water table management as a BMP for reducing discharges from Indian River citrus groves	In Progress	UF, IFAS, IRREC, Ft. Pierce
St. Lucie Estuary Nutrient Loading Monitoring	Nutrient/sediment loading monitoring in C-23, C-24, C-25, and C-44 canals and Five and Ten Mile Creeks	On-Going	SFWMD
Ground Water/Surface Water Interaction Monitoring Network	15 monitoring wells at six sites to gather data on surface-groundwater interaction. Implemented 2002.	Continuing	SFWMD
Enhance Implementation of Citrus Pesticide BMPs in St. Lucie Estuary Watershed	Improve pesticide spray practices to reduce environmental contamination and improve efficacy. Assess precision spray application.	In Progress	UF, IFAS, IRREC, Ft. Pierce
St. Lucie River Watershed Assessment	Assessments of the C-25, C-23, C-44, and Tidal St. Lucie basins, and Basins 1, 4, 5, and 6	Completed	SFWMD
BMPs for citrus and vegetable crops to evaluate nutrient and metal loading	Characterization of nitrogen, phosphorus, and heavy metals in surface water runoff from citrus groves and vegetable fields in the IRL/SLE Watershed	In Progress	UF, IFAS, IRREC, Ft. Pierce
Estuary Water Quality Model	Currently in development anticipated completion data for all phases 2003.	In Progress	SFWMD
Environmental Toxicity in St. Lucie Estuary/Indian River Lagoon	NOAA study of adverse biological effects associated with chemical contamination	In Progress	NOAA
Martin County GIS	Geographic Information Systems (GIS) work to support a storm water management program	Completed	Martin County
BMPs for Citrus and vegetable Crops to Improve Surface Water Quality	Demonstrate effects and desirability of using newly developed best management practices for citrus and vegetable production in the IRL/SLE watershed	In Progress	UF, IFAS, IRREC, Ft. Pierce
Citrus herbicide BMP effects on the quality of off site discharges	Determine the influence of groundcover management on losses of herbicides to irrigation and drainage ditches in two different grove systems.	In Progress	UF, IFAS, IRREC, Ft. Pierce
Agrochemical and nutrient loadings and quality of runoff from golf, urban, pasture	Quantify nutrient and metal loadings from urban areas, golf courses, and pastures. Identify sites where pesticide losses in runoff maybe problem.	In Progress	UF, IFAS, IRREC, Ft. Pierce
Sediment Control BMP Evaluations for Indian River Citrus	Determine the ability of water furrow sediment traps to reduce phosphorus and copper losses in runoff. Compare sediment released from ditches where water levels are controlled by gates and riser boards	In Progress	UF, IFAS, IRREC, Ft. Pierce
Turbidity/Seagrass Study	Compare ecological characteristics and maximum growth of seagrasses at a location receiving colored water discharge and a location removed from the discharge near Ft. Pierce	Completed	SFWMD
Martin County Rain, Stage, Groundwater Stations	15 gauges at 12 sites rainfall, groundwater, stage data. Initiated January 2000.	Continuing	Martin County
Watershed Water Quality Model (WaSh)	Currently in development, anticipated completion data for all phases 2002.	In Progress	SFWMD
Upper East Coast (UEC) Water Supply Plan	Establish a framework for future water use decisions to provide adequate water supply for urban areas, agriculture, and the environment.	Completed	SFWMD

continuously at 15-minute intervals. Salinity and temperature are measured at two different depths to detect stratification in the water column. The data collection program was expanded in January 1999, when five more tide/salinity stations were installed in the South IRL between Ft. Pierce Inlet and Pecks Lake. The SFWMD has had on-going water quality sampling programs within the South IRL system. Since 1988 SFWMD conducted quarterly sampling for physical parameters, nutrients, photosynthetically active radiation (PAR), and chlorophyll, at 40 sites within the South IRL.

As previously noted, modifications have been made to the South IRL water quality-monitoring network to better understand the water quality/seagrass link in the South IRL (Figure 6-2). The SFWMD has used water quality data collected over ten years in the Indian River Lagoon at station C25S50 in the Belcher Canal (C-25) in order to conduct analyses for total phosphorus (TP), total nitrogen (TN), dissolved oxygen (DO), and turbidity. The SFWMD has also collected quarterly samples for pesticide and heavy metal analysis at the S-80 structure on C-44 and the S-99 structure on C-25. As part of an effort to evaluate potential toxic effects of contaminants on estuarine biota (macroinvertebrates), the FDEP has collected quarterly samples for nutrients, pesticide and heavy metals at the coastal structures in C-23, C-24, C-25, and C-44. The SFWMD and the FDEP water quality findings are in agreement: inflows to the South IRL and the St. Lucie Estuary contain excessive concentrations of nutrients, as well as, relatively frequent detections of pesticides and heavy metals. Pesticides at concentrations that exceed state water quality standards have been detected in all the monitored inflow sources other than the historic South Fork of the St. Lucie River.

To better understand the contribution of groundwater input to the St. Lucie Estuary & River and South IRL, a total of 15 monitor wells were recently installed at six sites (Figure 6-6).

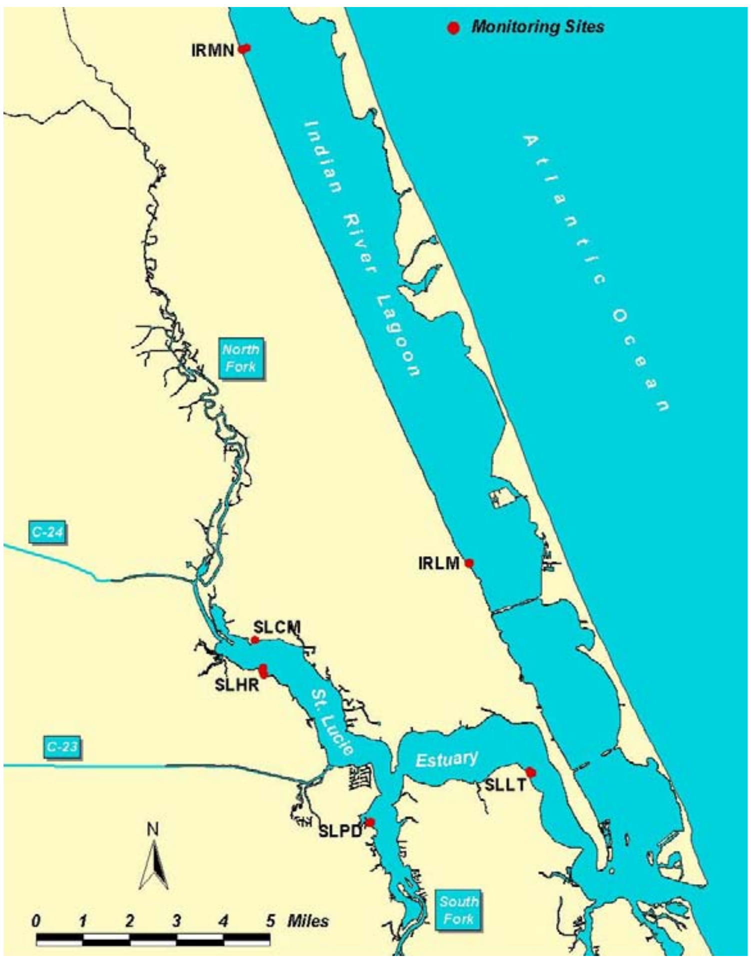


Figure 6-6. SLE/IRL Groundwater, Surface Water Interaction Studies - Location of Monitoring Stations.

Chemical characterization of groundwater and surface water is key to understanding the exchange and movement of the water (inflows and outflows), the spatial and temporal affects on the water, the aquifer, and solute movement to and from the aquifer and the surface water. Analysis of the field parameters, major ions, iron, manganese, Total Organic Carbon, Dissolved Organic Carbon, Total Dissolved Solids, and Total Suspended Solids, will allow evaluation of the water from different layers, the sampling or analytical inconsistencies, and the sampling problems. Analysis of the nitrogen and phosphorous parameters will address nutrient questions. Additional tests include Methyl Blue Activated Surfactants (MBAS), which measures surfactants (detergents) in water-- an indicator of possible input from septic systems.

Modeling

Under the SWIM Programs the SFWMD is mandated to develop Pollution Load Reduction Goals (PLRGs) in the South IRL. Development and application of computer models is a critical step in accomplishing this goal. In order to evaluate the effectiveness of pollutant reduction strategies, the modeling efforts will include predicting estuarine water quality parameters as a function of external inputs, internal hydrodynamics, relevant processes, and transformations occurring within the estuary. The reliability of a receiving water model depends on the accuracy of freshwater input data. A receiving water modeling project cannot succeed without dependable watershed input.

Hydrodynamic Modeling

Hydrodynamic modeling has been the primary tool in understanding changes within the South IRL and St. Lucie Estuary (Figure 6-7). It has been used to develop salinity-flow relationships under stable conditions and to study salinity shock within the estuary under storm-event conditions. A work plan for St. Lucie Estuary Modeling was developed in 1996. Plans for data collection and a bathymetric survey were developed in parallel. The tide/salinity-measurement network began in August 1997.

A 2-D salinity model was developed using the computer models RMA-2 and RMA-4, which were developed by Research Management Associates, Inc. under contract to the Army Corps of Engineers. The model was calibrated in 1998. The St. Lucie Estuary Hydrodynamics/ Salinity Model includes the North and South Forks of the St. Lucie River, the middle and lower St. Lucie Estuary, the St. Lucie Inlet, and the Indian River Lagoon between Nettles Island and Pecks Lake. The model computes tides (water surface elevation), two-dimensional velocity field and salinity distribution in the model domain. Since the main interest is the impact of watershed runoff on the overall salinity regime in the estuary, a 2-D depth averaged approach was considered sufficient.

The freshwater inflow in the salinity relationship includes both surface and subsurface (groundwater) input to the system. The model is two-dimensional; therefore it does not simulate the stratification in the water column. While depth averaged salinity is sufficient to describe the overall salinity regime on a macro scale, it does not reflect the salinity difference between surface layer and bottom layer when the system is stratified. For a more detailed look at water quality and biological study, it is necessary to consider the factor of stratification. Outputs generated by the St. Lucie hydrodynamics/salinity model have provided scientific support to the CERP IRL-South Plan and system operations. The model was also adapted and extended to predict salinities for the St. Lucie River Minimum Flows and Level (MFL) Study.

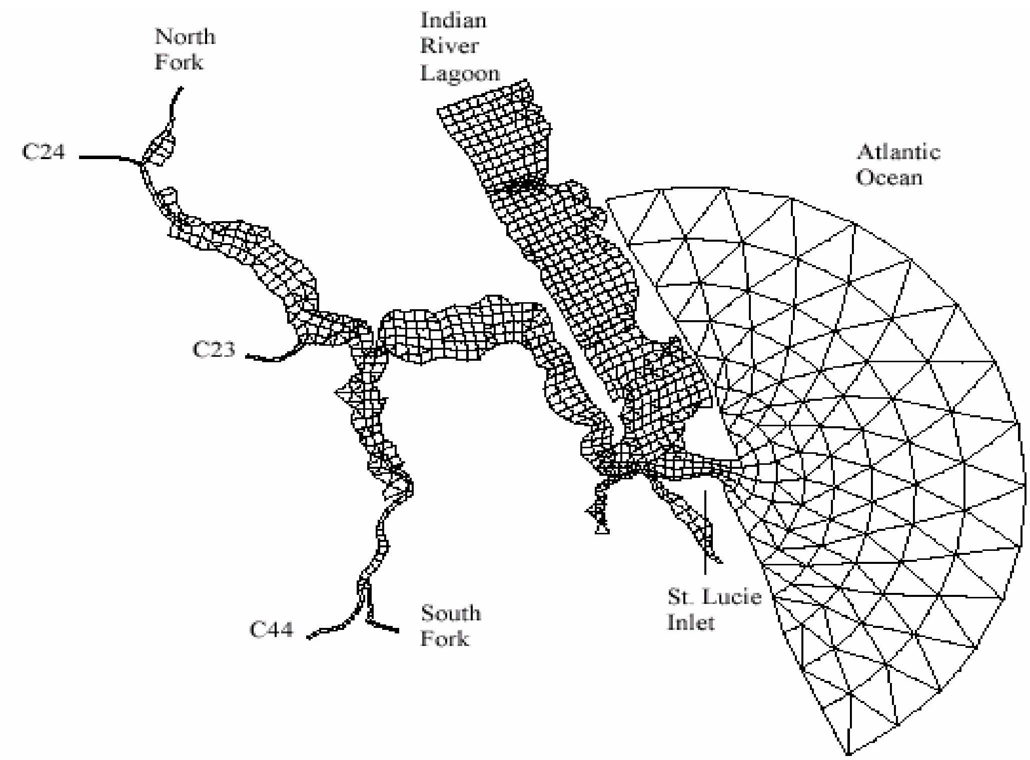


Figure 6-7. Boundary Domain of the St. Lucie Estuary Model

The Waterways Experiment Station (WES) of the USACE is converting the existing St. Lucie hydrodynamics/salinity model to a three dimensional version. The new version will be able to simulate salinity and temperature stratification and the formation and movement of a salt wedge. Both phenomena have been observed and recorded in the field. WES is also extending the model to cover the Indian River Lagoon between Fort Pierce and Jupiter Inlets (including the Loxahatchee River). Model development is anticipated to be completed by 2003.

Water Quality Modeling

The SFWMD initiated a project in 1999 to model watershed water quality. Under a contract with the SFWMD, URS Corporation developed a watershed hydrology and water quality model (WaSh) suitable for assessing some of the unique hydrologic issues in South Florida involving dense drainage canal systems, high water tables, and multiple irrigation sources and for evaluating watershed management options. The model has a cell-based representation of watershed surface where hydrology and water qualities are modeled with Hydrologic Systems Program Fortran (HSPF). The infiltrated water is routed to a groundwater model that represents the surficial aquifer of simulated watersheds. The runoff is routed to a drainage system model that has the capacity to simulate bi-directional flow, branches, and common flow structures. An Arcview Graphic User Interface (GUI) has also been developed to facilitate BMP implementation, land use changes, reservoir and stormwater treatment system operations that are key watershed management strategies in South Florida

The ultimate goal of the water quality modeling effort is to develop watershed management strategies to achieve PLRGs (Pollution Load Reduction Goals) for the South IRL watershed. To better meet this goal, the District initiated a 3 dimensional (3-D) estuary water quality modeling project for SLE/IRL in 2001. A 3-D water quality model, namely the Environmental Fluid Dynamic Code (EFDC), is being developed, calibrated, validated, and applied to simulate estuarine hydrodynamics, salinity stratification and distribution, bed erosion and sedimentation, and water quality behavior in the SLE using existing data. Curvilinear-orthogonal model grid cells are generated to represent the St. Lucie Estuary, the down stream of North Fork and South Fork, and the lower portion of the Indian River Lagoon (see Figure 6-8). The model grid has sufficiently high resolution to incorporate essential bathymetry while maintaining computational efficiency needed to perform long-term simulations. Model calibration and validation are being conducted in a step-by-step fashion following the sequence of hydrodynamic/salinity modeling, sediment modeling, and water quality modeling. Calibration and validation of the hydrodynamic/ salinity model, sediment model, and water quality model are scheduled to be complete in 2003. All of parameters listed in Table 6-5 could be addressed through the use of the Watershed and Estuary models. Basin loads can be calculated, as well as distribution within receiving water bodies Site specific allocation of parameters may not be possible without further understanding of receiving water body processes and dynamics. In order to evaluate the effectiveness of pollutant reduction strategies, the remaining modeling efforts shall include predicting estuarine water quality parameters as a function of external inputs, internal hydrodynamics, relevant processes, and transformations occurring in the estuary.

Figure 6-8. Grid Structure of the Environmental Fluid Dynamic Code Water Quality Model

Applied Studies

A variety of organizations have monitoring and research underway in the South IRL and it's watershed. The SFWMD, FDEP, Florida Department of Agriculture and Consumer Services (FDACS), Florida Fish and Wildlife Conservation Commission (FFWCC), Harbor Branch Oceanographic Institute (HBOI), Smithsonian Marine station, (National Oceanic and Atmospheric Administration (NOAA), United States Geological Survey (USGS), and others have on-going studies. In addition, partnership studies have been performed with several Non-Governmental Organizations (NGOs). The SFWMD has developed an Estuary Research Plan, (Coastal Ecosystems Division, August 2001), that outlines strategies for monitoring, modeling, and research. The Research Plan outlines projects that are intended to provide decision-makers with the scientific information necessary to attain management objectives. The research projects described are either ongoing or planned to begin within the next two or three years depending on the SFWMD priorities and availability of funds. The goals and objectives of the Research Plan have been defined to maintain the critical linkage between research and the requirements of water management and legislative mandate. Research strategies for the South IRL are summarized below and projects are listed in Table 6-9.

Table 6-9. Projects for Establishing Optimum Freshwater Inflows to the SIRL

Project Title	Reference
Indian River Lagoon Seagrass Mapping	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/irl_seagrass.html
South Indian River Lagoon Seagrass Transects	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/irl_seagrass_trans.html#top
Water Quality targets for the South IRL	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/irl_wq_targets.html
Laboratory Studies of the Salinity Tolerance of SAV	http://www.sfwmd.gov/or/wrp/wrp_ce/projects/gumbo_limbo_mesocosm.html
Laboratory Studies of the Salinity & Substrate Tolerance of Oysters	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/oyster_program.html
St. Lucie Estuary Hydrodynamic/Salinity Model	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_salinity_model.html
St. Lucie Estuary Water Quality Model	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_wq_model.html
Upper East Coast (UEC) Watershed Model	http://www.sfwmd.gov/org/wrp/wrp_ce/
UEC Citrus Best Management Practices (BMPs)	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/uec_bmp.html
IRL–South Project Management Plan Studies	http://www.sfwmd.gov/org/wrp/wrp_ce/
St. Lucie River Minimum Flows and Levels	http://www.sfwmd.gov/org/wsd/mfl/stlmfl/index.html
Fort Pierce Inlet Area Indian River Lagoon Hydrodynamics and Salinity Model	http://www.sfwmd.gov/org/wrp/wrp_ce/projects/irl_hydro_pres.html

Estuaries depend on freshwater input not only for their existence, but also because fresh water influences the biological structure (composition, abundance, and distribution of flora and fauna) and ecosystem function (physical, chemical, and biological processing of material). Despite years of effort, questions of how much fresh water and what water quality are required to maintain a naturally functioning estuary remain at the forefront of basic estuarine research.

One purpose of research efforts that are underway to determine freshwater inflows that are needed to protect and enhance key estuarine communities, is to provide information and performance criteria required to fulfill the mandates of SWIM, MFLs, PLRGs, and potential TMDLs. The Florida Watershed Restoration Act (1999) establishes FDEP as the lead agency for TMDL development. This Act requires the SFWMD to support and coordinate in the development of these pollution abatement goals. On-going research and analyses, by the SFWMD, for the development of pollution load reduction goals (PLRG) provides an opportunity for consistent input into the TMDL process. The schedule and process for TMDL development the northern portion of the Indian River Lagoon (TMDL Group 5) differs from the schedule and process used for the southern portion of the lagoon. The St. Lucie Estuary is in Group 2 and follows a more accelerated schedule that requires completion of the Verified List by 2003.

Additional detail on the TMDL process and the relationship to PLRG development can be found in the Appendix A of this Plan

Another application of these research efforts is to assess the impact of the CERP components and facilities, in order to help determine proper operational guidelines, which meet environmental goals as shown in Figure 6-9. Successful operation of new CERP infrastructure will be critical to achieving environmental restoration goals and targets.

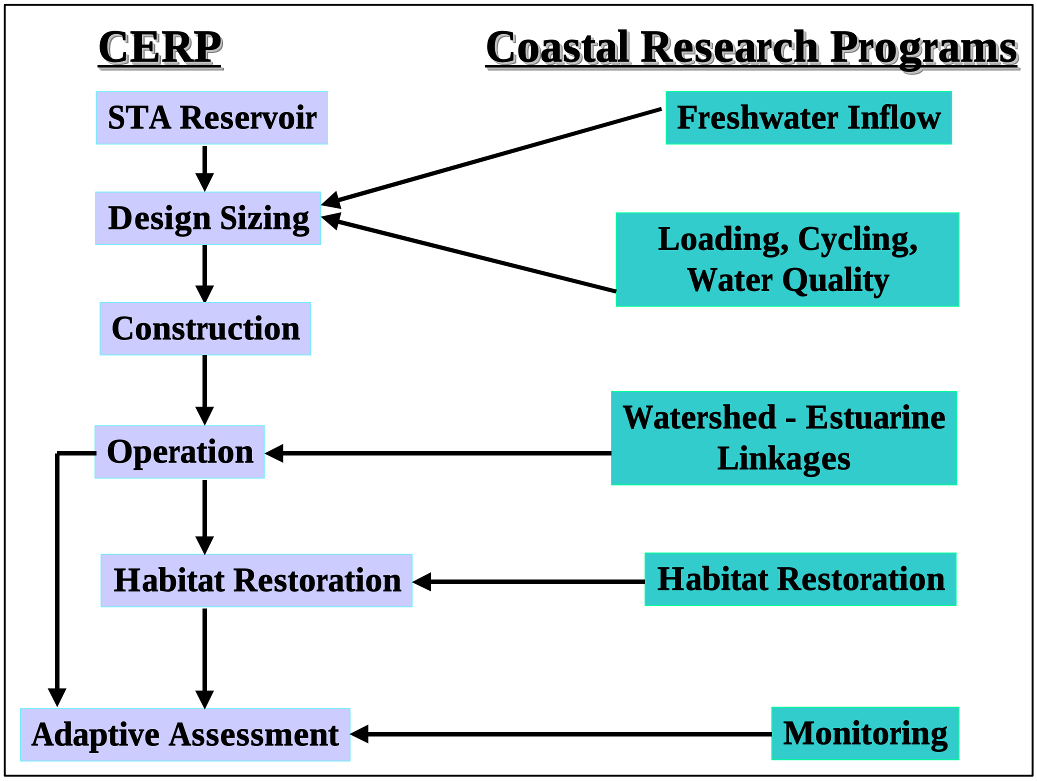


Figure 6-9. Coordination and Integration of Coastal Research and CERP.

Central to successful operation is the environmentally compatible delivery of freshwater to downstream estuarine and marine systems. Little information currently exists in the literature regarding how to best deliver freshwater to an estuary. Therefore, additional experimental and monitoring studies are required.

Land Acquisition.

Significant land acquisition has occurred in the South IRL watershed in recent years. Public acquisition of lands is important to protect or restore wetlands, tidal systems, and uplands, but it can also be quite effective in mitigating pollutant loads – present and future. The SFWMD has partnered with state, federal, and local governments to acquire properties for preservation, restoration, and stormwater treatment systems. Both Martin and St. Lucie Counties have held successful referendums to raise funds for public acquisition of environmentally sensitive lands.

Additional Information on Land Acquisition Projects is available from the following websites:

Martin County - Capital Projects Updates
http://www.martin.fl.us/GOVT/depts/adm/cie/status_reports/04.02.02.html

Martin County - Healthy Rivers
http://www.martin.fl.us/GOVT/depts/adm/rivers/
http://www.martin.fl.us/GOVT/depts/adm/rivers/onecent/March.2002.html

St. Lucie County - Environmental Lands Program
http://co.st-lucie.fl.us/esl/index.htm

Watershed Land Acquisition - Preservation/Restoration
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/maps/uec_plate2.pdf

The IRL - South Plan (USACOE and SFWMD) proposes to acquire approximately 116,000 acres, with almost 93,000 acres devoted to natural storage and water quality treatment areas. These areas will be restored by plugging existing drainage systems to retain rainfall onsite, while providing groundwater recharge, re-hydration of historic wetlands, enhancement of existing wetlands, and improved wetland and upland habitat for native wildlife, including, but not limited to, threatened and endangered species

The SFWMD and Martin County have partnered to purchase several large properties, i.e., Atlantic Ridge and Allapattah Ranch. In addition, the SFWMD and local governments have cost shared land acquisition for smaller stormwater improvement projects. For specific information on land acquisition associated with the IRL *Blueway* program, mosquito impoundments, coastal or barrier island habitat restoration, see the Coastal Wetlands Section.

Coordination with Other Agency Plans.

Various SFWMD work groups and the Martin/St. Lucie (MSL) Service Center have extensive coordination and regular communication with the IRL NEP, FDEP, FDACS, SJRWMD, as well as a number of Federal agencies, USACE, USGS, USFWS, etc. Likewise, the MSL Service Center works closely with the local governments and stormwater utilities in St. Lucie and Martin Counties. Updates and coordination associated with SWIM, the UEC Water Supply Plan, UEC BMPs, PLRGs and potential TMDLs, also require that the SFWMD work closely with various agencies. See Figures 6-4 and 6-5 as examples of projects with ongoing agency and stakeholder interaction. Coordination activities are summarized in Table 6-10.

The St. Lucie River Issues Team program provides additional opportunities for consistent coordination and communication through their annual evaluation of projects and quarterly progress reports and coordination. The FDEP Port St. Lucie Regional Office Director and the Director of the SFWMD Martin/St. Lucie Service Center meet on a regular basis and co-chair the St. Lucie River Issues Team. Recently, the University of Florida, IFAS, Indian River Research and Education Center coordinated a Research Forum which allowed the Indian River Citrus BMP Working Group and the St. Lucie Issues Team to present information on the status of current projects for agencies stakeholders and the public. It is anticipated that this will be on annual event to provide information and coordinate project planning and development in the South IRL/SLE Watershed. Finally, Development of the IRL - South Feasibility Study required extensive interaction among local, state and Federal agencies and the various stakeholders in the watershed, and this will continue as the project moves forward.

Table 6-10. Coordination with Other Agency Plans.

PROJECT NAME	DESCRIPTION	STATUS	LEAD AGENCY
Martin/St. Lucie Service Center (1995)	Service Center was established and opened in the fall of 1995 in Stuart to provide coordination and communication with the National Estuary program, local government planning efforts and local interests	Continuing	SFWMD
Draft IRL Feasibility Study & EIS	Awaiting final revisions before submission to Congress 2002	In Progress	SFWMD
IRL - South Project Management Plan (PMP)	Document under construction for submission to USACOE in 2002	In progress	SFWMD
Voluntary Agricultural and Urban Best Management Practices (BMPs)	Several on-going efforts are in progress to implement BMPs in the SIRL Watershed. Partner ships involve a variety of organizations.	Continuing	UF, IFAS, IRREC, Ft. Pierce/St. Lucie River Initiative, Stuart
St. Lucie River Issue Team	Continuing cooperative program involving local stormwater improvement projects, research and education, FDEP, SFWMD, local governments, federal agencies, Florida Universities, state agencies, NGO's, and the private sector.	Continuing	FDEP/SFWMD
2002 Indian River Citrus BMP/St. Lucie River Issue Team Research Forum	One day forum for agencies, researchers, and stake-holders interested in on-going research projects in the SIRL watershed. This may become an annual event.	Completed	UF, IFAS, IRREC, Ft. Pierce/St. Lucie Issues Team

Indian River Lagoon – South Feasibility Study

The Indian River Lagoon-South Feasibility Study identifies a recommended plan that, when implemented, will help restore, protect, enhance, and preserve the South Indian River Lagoon and the St. Lucie Estuary and River. The IRL-South Plan provides an opportunity to reverse the course of declining ecosystem health and restore a highly productive system. The reconnaissance and feasibility phases of the Restudy demonstrated that the Indian River Lagoon is an integral part of the Comprehensive Everglades Restoration Plan (CERP). The Indian River Lagoon – South Feasibility Study is a continuation of the Restudy, with a purpose to further develop the conceptual designs of CERP components within Martin and St. Lucie counties. Hydrologic modeling, environmental modeling, water quality analyses, and water supply studies were conducted to refine the information developed in CERP. The IRL–South Plan reduces the impacts from the watershed runoff while relying on the development of other CERP components which significantly reduce the number and frequency of high volume discharges from Lake Okeechobee through C-44 canal to the estuarine system. Acquisition of land is an important aspect of this plan as shown in Figure 6-10.

Major Features of the Recommended Plan

Above Ground Water Storage

Four above-ground water reservoirs will be constructed to provide 127,150 acre-feet of storage. Construction of these features includes water control structures, pumps, levees, canals and the acquisition of approximately 13,196 acres of land in Martin and St. Lucie counties. The reservoirs would have a maximum storage elevation of 8 feet for the C-25 reservoir, 10 feet for the C-44 reservoir and 12 feet for the C23/24 reservoirs. These facilities would be designed to:

1. Provide storage for watershed runoff from C-44, C-23, C-24; and C-25 canals;
2. Reduce extreme high peaks of watershed discharges into the receiving water bodies;
3. Provide reduction in phosphorus load (3%) and in nitrogen load (3%) to the St. Lucie River and Estuary and to the South Indian River Lagoon; and,
4. Provide water supply for agriculture to offset reliance on the Floridan Aquifer from 27 years in 30 to 10 years in 30.

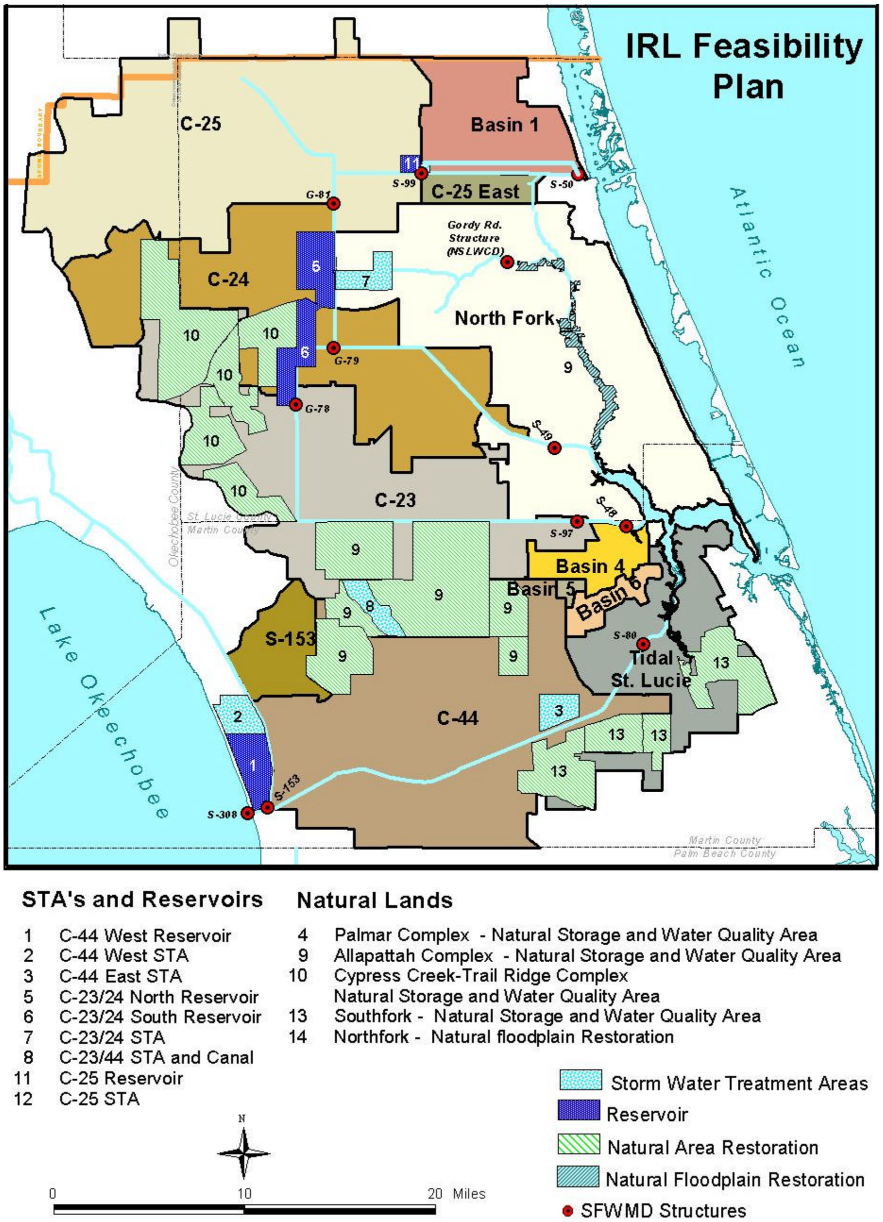


Figure 6-10. IRL South Plan Proposed Land Acquisition Components

Stormwater Treatment Areas

Five storm water treatment areas would be constructed to provide phosphorus reduction (18%) and nitrogen reduction (8%) to the St. Lucie River and Estuary and the South Indian River Lagoon. Construction of these features includes canals, levees, water control structures, pumps, and acquisition of 9,939 acres of land (7,639 acres of intense agriculture and 2,300 acres of highly impacted pastureland). Facilities would have a maximum water depth of 4 feet and a normal operating depth of 18 to 24 inches. and would be designed to provide water quality treatment to watershed flows captured prior to release to the St. Lucie River and Estuary, the South Indian River Lagoon and Lake Okeechobee.

Natural Storage and Water Quality Treatment Areas

Natural Storage and Water Quality Treatment Areas include the following: acquisition of 92,919 acres of upland/wetland mosaic, plugging of existing secondary drainage ditches to remove discharge into C&SF system canals, a total effective storage capacity of approximately 30,000 acre-feet, and phosphorus reduction (6%) and nitrogen reduction (4%) to the St. Lucie River and Estuary and South Indian River Lagoon. This is a multi-purpose feature designed to capture watershed flows prior to runoff into primary and secondary canal systems of the upper East Coast region. This is accomplished by plugging the existing drainage system of these

92,919 acres to retain rainfall onsite while providing groundwater recharge, re-hydration of historic wetlands, and enhancement of existing impacted wetlands.

Diversion of Existing Watershed Flows

An operational constraint of the recommended plan involves two different diversion goals: 1) Diversion of C-23 & C-24 discharges into the North Fork of the St. Lucie River as opposed to their current discharge points near the middle estuary; and, 2) Diversion of C-23 flows to the C-44 canal where they will be directed to either the South Fork of the St. Lucie River or Lake Okeechobee. About 105,000 acre-feet per year of canal flows are diverted due to this component. Approximately 64,000 acre-feet per year, which previously discharged through C-23 and C-24, will now discharge to the North Fork via Ten-Mile Creek. Approximately 41,000 acre-feet per year will discharge into Lake Okeechobee that previously discharged from C-23 and C-24 to the St. Lucie River and Estuary.

Muck Remediation and Artificial Habitat

Muck component to remove 5,500,000 cubic yards of muck from a total of four ‘hot spots’ located in the North Fork, South Fork, and Middle Estuary of the St. Lucie River. Removal of this muck provides approximately 1,200 acres of new suitable substrate for bottom organisms to recolonize. In addition, artificial habitat materials are being placed into the river and estuary in the general location of the muck remediation in an effort to speed up this process of oyster reef formation. An additional 90 acres of habitat will be created by use of oyster shell, artificial reef balls, and artificial submerged aquatic vegetation.

What the Plan Will Accomplish

Implementation of the Indian River Lagoon – South Plan will begin the recovery process of the St. Lucie River and Estuary and the South Indian River Lagoon. The Plan meets the following objectives: 1) Enhances ecological values by improvements to the estuarine health of the St. Lucie River and Estuary and the South Indian River Lagoon through a reduction of damaging discharges to the receiving water bodies, retention of water in the natural system, water quality treatment of captured water, and restoration of historic natural wetland-upland mosaic systems thereby preserving, protecting, increasing the spatial extent and enhancing wetlands areas outside the Everglades; and 2) Enhance economic values and social well being by increasing water supply, maintaining flood control, and improving economic opportunities through restoration of the natural resource by reducing the existing unacceptable level of flocculent ooze and muck in the estuarine system and by significantly reducing the source of that ooze and muck.

How the Plan Will Be Implemented

A draft of the overall implementation schedule for this project is provided in Table 6-11. A Project Management Plan (PMP) for the recommended plan is currently under development and

Table 6-11. Draft Implementation Schedule for IRL-S, from 15 June 2002 to 23 December 2010 (Subject to COE & SFWMD Approval v.5, 18 Mar 2002)

Project/Component	Duration	Start	Finish
Indian River Lagoon South (overall)		15-Jun-02	23-Dec-10
Project Management Plan (PMP) Development	**212 days**	**9-Oct-01**	**31-Jul-02**
C-44 Basin Components			
C-44 West Reservoir & STA			
Real Estate Acquisition	780 days	15-Jun-02	27-May-05
Preconstruction Engineering and Design	780 days	15-Jun-02	27-May-05
Construction (phased)	780 days	1-Nov-04	26-Oct-07
C-44 East STA			
Real Estate Acquisition	780 days	1-Jan-03	27-Dec-05
Preconstruction Engineering and Design	780 days	1-Jan-03	27-Dec-05
Construction	720 days	28-Dec-05	30-Sep-08
PMP Development	**212 days**	**9-Oct-01**	**31-Jul-02**
C-23/24/ Basin Components			
C-23/24 North Reservoir			
Real Estate Acquisition	780 days	15-Jun-02	27-May-05
Preconstruction Engineering and Design	780 days	15-Jun-02	27-May-05
Construction	780 days	30-May-05	23-May-08
C-23/24 South Reservoir			
Real Estate Acquisition	780 days	15-Jun-02	27-May-05
Preconstruction Engineering and Design	780 days	15-Jun-02	27-May-05
Construction	780 days	30-May-05	23-May-08
C-23/24 STA			
Real Estate Acquisition	780 days	15-Jun-02	27-May-05
PED	780 days	15-Jun-02	27-May-05
Construction	780 days	30-May-05	23-May-08
C-23/44 STA & Canal			
Real Estate Acquisition	780 days	1-Oct-03	26-Sep-06
Preconstruction Engineering and Design	780 days	1-Oct-03	26-Sep-06
Construction	780 days	27-Sep-06	22-Sep-09
PMP Development	**212 days**	**9-Oct-01**	**31-Jul-02**
C-25 North Fork & South Fork Basin Components			
C-25 Reservoir/ STA			
Real Estate Acquisition	780 days	1-Jul-04	27-Jun-07
Preconstruction Engineering and Design	910 days	1-Jul-04	26-Dec-07
Construction	780 days	27-Dec-07	22-Dec-10
Natural Storage Area & Water Quality			
Real Estate Acquisition - Allapattah	1040 days	15-Jun-02	26-May-06
Real Estate Acquisition PalMar	1040 days	1-Jan-03	26-Dec-06
Real Estate Acquisition Cypress Creek/Trail Ridge	1040 days	1-Jan-03	26-Dec-06
Preconstruction Engineering and Design	1040 days	1-Jan-03	26-Dec-06
Construction	1040 days	27-Dec-06	21-Dec-10
Muck Removal & Artificial Habitat			
Real Estate Acquisition	650 days	1-Jul-05	27-Dec-07
Preconstruction Engineering and Design	650 days	1-Jul-05	27-Dec-07
Construction	780 days	28-Dec-07	23-Dec-10
Natural Floodplain Restoration			
Real Estate Acquisition	390 days	1-Oct-03	29-Mar-05
Preconstruction Engineering and Design	650 days	1-Oct-03	28-Mar-06
Construction	520 days	29-Mar-06	25-Mar-08
PMP Development	**212 days**	**9-Oct-01**	**31-Jul-02**

will be available with the release of the final report. The plan will identify specific tasks to be accomplished during pre-construction engineering and design.

A follow-on Special Project Implementation Report (SPIR) will be completed to address the water reservations issues associated with the Indian River Lagoon – South Plan as required by the Water Resources Development Act of 2000 and Section 373.470, Florida Statutes.

A separate feasibility study effort is ongoing to investigate the northern portions of the Indian River Lagoon. That feasibility study will investigate water resource problems in Brevard, Volusia, and Indian River counties associated with the existing C&SF Project system. A multi-agency, interdisciplinary team has been formed to perform this study. The local sponsor is the St. Johns River Water Management District.

The Next Five Years

Seagrass and Water Quality

- Continue mapping every 2 years, collecting aerial photography each year, lagoon wide transects twice a year, and seagrass/algae monitoring near St. Lucie Inlet each month
- Continue in-lagoon water quality monitoring as modified in 2000.
- Incorporate all historic data, for future seagrass change analysis and targets.
- Refine and evaluate bathymetric coverage to rectified 2001 imagery.
- Continue to evaluate the water quality/seagrass link to support PLRG development.
- Continue to work with local partners help fund land acquisition and habitat restoration.
- Continue coordination and joint projects with the SJRWMD and IRLNEP.

Pollution Load Reduction Strategies

- Complete Moore's Creek Retrofit Project, and fully implement voluntary BMPs in the C-25/Ft. Pierce Farms Basin.
- Completion of Taylor Creek Muck Removal Project.
- Replacement of Indian River Drive stormwater outfall pipes in St. Lucie County.
- Continue to install baffle boxes in Sewalls Point and other sites that discharge stormwater directly to the lagoon.
- Initiation of the Manatee Creek Basin Retrofit Project in Martin County.
- Continue support for implementation of voluntary BMPs through the Indian River Citrus League, and the St. Lucie River Initiative.
- Employ sound solutions that further reduce WWTP discharges and wet weather effluent discharges from other sources.

Monitoring, Modeling and Applied Studies

- Add one additional lagoon tidal station in segment 24.
- Implement atmospheric deposition monitoring in lagoon sub-basins.
- Continue studies on Submerged Aquatic Vegetation (SAV) and other Valued Ecosystem Component (VEC) at the Gumbo-Limbo Mesocosm Laboratory.
- Continue studies on muck removal and disposal technology.
- Continue to support existing local government surface water monitoring projects in tributaries that discharge to the lagoon.
- Continue to support the annual Indian River Citrus BMP/St. Lucie River Issues Team Research Forum.
- Complete development, validation, and calibration of the Watershed Water Quality Model, WaSh, and the St. Lucie Estuary Water Quality Model.

- Continue refining South IRL water quality targets and have PLRG adopted by 2006.
- Implement a "State of the Watershed - 2004" conference that will provide benchmarks to evaluate success of non-point pollution abatement efforts and identify unmet needs.

Coordination with Other Planning Efforts

- Continue implementation of the IRL-South Plan
- Continue to communicate and coordinate with FDEP, other agencies, and stakeholders in PLRG establishment, and any future TMDL activities.
- Continue support and coordination with the St. River Issues Team.
- Continue support and coordination with local governments and other partners.

Coastal Wetlands

<u>Project Descriptions and Status</u>

The South IRL contains a variety of salt marsh wetlands, mangrove swamp, and tidal creeks. Approximately 5000 acres of impounded marshes were used for mosquito control. A SWIM priority is to reconnect these impounded areas to the South IRL. Incorporating operational changes and enhanced mosquito control management practices, such as, flow through strategies designed to increase circulation during summer mosquito control phases, have resulted in improved water quality and bio-diversity. Implementation of integrated pest management programs by mosquito control districts has also allowed for reductions in pesticide application rates in the coastal wetlands adjacent to the IRL. Another SWIM priority is shoreline habitat preservation and restoration. These two priorities are key elements of the SFWMD coastal wetlands program (see Figure 6-11). Major projects are listed in Table 6-12.

Table 6-12. Description and Status of Coastal Wetlands Projects

PROJECT NAME	DESCRIPTION	STATUS	LEAD AGENCY
Indian River Lagoon Mangrove Restoration	Cooperative multi-agency effort to reestablish mangroves and test various planting methods. (see http://www.elcweb.org/shoreline/index.html)	In progress	Environmental Learning Center (ELC) Vero Beach
Indian River Lagoon Wetland Restoration	Re-establish coastal marshes and wetlands in accordance with *Blueway* Plan.	Continuing	Martin and St. Lucie counties
Mosquito Impoundment Report	Progress report on mosquito impoundment activities	Completed	St. Lucie County Mosquito Control District
Mosquito Control Impoundment Reconnects	St. Lucie and Martin counties have plans to reconnect all mosquito impoundments	In progress	St. Lucie & Martin County Mosquito Control District
Mosquito Impoundment Restoration	Habitat restoration and exotic removal within recommended impoundments is well underway.	Continuing	St. Lucie & Martin County Mosquito Control
Indian Riverside Park Restoration	Exotic Removal and reconnection of tidal marsh to the IRL.	Completed	Martin County
1996-2001 Snook License Plate Projects	Multiple projects for stormwater retrofits, habitat restoration, exotic removal, environmental education.	In progress	Multiple agencies/ non-profit
2002-2003 Snook License Plate Projects	Projects covering habitat restoration, exotic removal.	In progress	Multi-agency and non-profits
TNC Blowing Rocks Shoreline Restoration	Long-term program for exotic removal and shoreline vegetation restoration.	In progress	Nature Conservancy @ Blowing Rocks, Martin Cty

Reconnection of mosquito impoundments has been relatively successful in the South IRL (see Figure 11). St. Lucie Mosquito Control District has an extensive impoundment retrofit program. Typical projects involve breaching dikes, installing culverts, installing pumps and other water control devices. Each of these projects also has a habitat restoration element that includes exotic vegetation removal and restoration of native vegetation. The St. Lucie County Mosquito Control District has also successfully implemented a Land Acquisition Preservation Program,

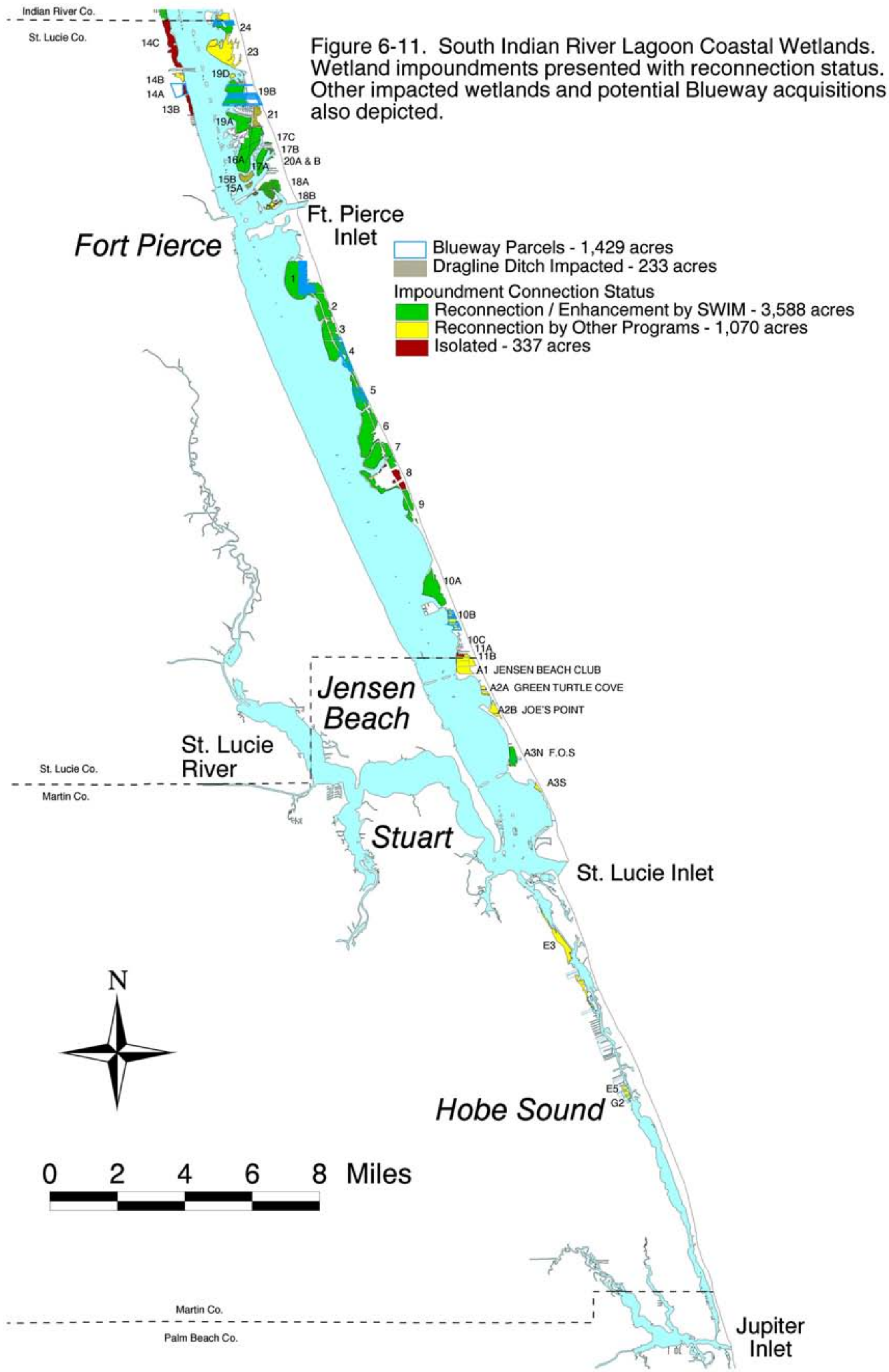


Figure 6-11. South Indian River Lagoon Coastal Wetlands. Wetland impoundments presented with reconnection status. Other impacted wetlands and potential Blueway acquisitions also depicted.

with over 55% of the coastal barrier island in St. Lucie County now under public ownership. The land acquisition/ mitigation/ donation program is a critical component of the Mosquito District's coastal impoundment management program. In 1999, St, Lucie County acquired 33 acres on the west shore of the lagoon that is currently undergoing habitat restoration.

Martin County Mosquito Control has an active program of mosquito impoundment rehabilitation. In 2001 Martin County Mosquito Control received a $50,000 grant from SFWMD (SWIM) to add more culverts and an electric pump station to the Florida Oceanographic Society Impoundment. This was a first step in a Martin County Conservation Area, restoration project involving almost 40 acres of estuarine habitat. In addition, about 500 acres of Hutchinson Island owned by Martin County. A wetland mitigation bank is also in the permitting process. Both counties have focused on improving water quality in impoundments, and the use of impoundments by wading birds, fishes, etc., to increase the productivity and biodiversity of the South IRL ecosystem. In addition, there has been progress on other shoreline habitat preservation and restoration efforts. In Palm Beach County work was completed to remove exotics and restore tidal creeks and ponds, mangrove swamp and hydric hammock habitat.

The Nature Conservancy (TNC) owns and manages the 73-acre coastal Blowing Rocks Preserve, located on southern Jupiter Island in Martin County. The preserve has over a mile of shoreline on the South IRL. Approximately 46 acres of mangrove swamp and adjoining uplands adjacent to the lagoon is slated for restoration or enhancement. The preserve has developed a 5-year restoration plan and has completed projects on some units. Future restoration and maintenance of segments will occur as funding becomes available.

Martin County recently opened Indian Riverside Park on the west side of the lagoon, and in addition to exotic removal a portion of the park now includes a restored tidal mangrove area. The Florida Inland Navigation District (FIND) also owns property a long the South IRL, which is designated primarily for spoil disposal but may also offer opportunities for shoreline restoration and water quality improvement. Other coastal habitat restoration and exotic removal projects involve FDEP at the Ft. Pierce Inlet State Park, St. Lucie Inlet Preserve State Park, Seabranch Preserve State Park, and efforts of the IRL Spoil Island Working Group. The Jupiter Inlet site in Palm Beach County also has habitat restoration potential.

The Hobe Sound National Wildlife Refuge consists of two separate tracts of land totaling over 1000 acres. The 735 acre Jupiter Island tract adjacent St. Lucie Inlet Preserve State Park, (4,834 acres) and the approximately 300 acre sand pine scrub mainland tract, to the south. The refuge is presently completing Comprehensive Conservation Plan (CCP). This plan will address the future need for visitor services and long term protection of the resources.

Mangrove restoration has been an ongoing cooperative effort. An experimental planting program has been underway for several years throughout the South IRL, using PVC pipe to stabilize mangrove seedlings (see http://www.elcweb.org/shoreline/index.html). Results indicate that sites must be carefully selected and seeds must be planted at proper water depths to ensure success.

Funding for coastal wetlands projects is a constant challenge, especially in regards to land acquisition. IRL license tag funds, St. Lucie Issues Team funds, and a variety of grants have been successfully used by local governments, state agencies to undertake projects. Future *Blueway* acquisitions have also been identified and some progress may occur over the next five years as state funding becomes available to allow the counties to move forward.

The Next Five Years

Rehabilitation of Impounded Wetlands

- Fully reconnect all mosquito impoundments in the South IRL.
- Use various funding sources to restore habitats in reconnected impoundments.
- Use of various funding sources to provide for research and monitoring of fisheries and wildlife utilization of restored mosquito impoundments.

Spoil Island Rehabilitation

- Continue coordination with FDEP and others to implement habitat restoration projects.

Shoreline Restoration

- Continue to support exotic removal and habitat restoration projects.
- Utilize a variety of funding sources to maximize shoreline restoration.

Preservation of Coastal Habitat - Land Acquisition

- Support *Blueways*, and other lagoon land acquisition, through cost shared funding.

Cooperative Mangrove Planting

- Continue to support encased planting method as appropriate, and explore other alternatives in high wave energy areas.

Web Site References for South IRL and St. Lucie Estuary

Environmental Learning Center - Shoreline Restoration
http://www.elcweb.org/shoreline/index.html

FDEP Sites - Aquatic Preserves

http://www.dep.state.fl.us/coastal/sites/indianriver/

FDEP Sites - Stormwater & TMDLs
http://www.dep.state.fl.us/water/tmdl/index.htm
http://www.dep.state.fl.us/water/stormwater/index.htm

FDEP Site - Water Quality
http://www.dep.state.fl.us/water/monitoring/index.htm

FDEP Site - Watersheds
http://www.dep.state.fl.us/water/watersheds/index.htm

FDEP Site - Surface Water
http://www.dep.state.fl.us/water/surfacewater/index.htm

FDEP Site - Water policy
http://www.dep.state.fl.us/water/waterpolicy/index.htm

Florida Oceanographic Society
http://www.fosusa.org/water.htm

Martin County - Overview
http://www.martin.fl.us/GOVT/depts/adm/annual_report_2001.pdf

Martin County - Capital Projects Updates
http://www.martin.fl.us/GOVT/depts/adm/cie/status_reports/04.02.02.html
http://www.martin.fl.us/GOVT/depts/adm/rivers/
http://www.martin.fl.us/GOVT/depts/adm/rivers/onecent/March.2002.html

Martin County - Stormwater
http://www.martin.fl.us/GOVT/docs.html

Port St. Lucie - Sewer System Master Plan
http://www.cityofpsl.com/CityHall/Water_sewer_expansion.htm

St. Lucie County - Stormwater
http://www.stlucieco.gov/engineering/stormwater/index.htm

Indian River Estates Subdivision Stormwater Project
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/savanna.html

St. Lucie County - Environmental Lands Program
http://co.st-lucie.fl.us/esl/index.htm

SJRWMD - IRLNEP
http://sjr.state.fl.us/programs/index.html

SFWMD - MSL Service Center - St. Lucie Issues Team
http://www.sfwmd.gov/org/exo/mslsc/slr/sle_issues_team.html
http://www.sfwmd.gov/org/exo/mslsc/wtrsp/index.html

SFWMD - MSL Service Center - Know The Flow
http://www.sfwmd.gov/org/reg/know_flow.html

SFWMD - UEC Water Supply Plan
http://www.sfwmd.gov/org/pld/proj/wsp/uecwsp.htm

SFWMD - Minimum Flows and Levels
http://www.sfwmd.gov/org/wsd/mfl/index.html
http://www.sfwmd.gov/org/wsd/mfl/stlmfl/index.html

SFWMD - IRL License Tag
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_lagoon/snook_tag.html

Variation in Primary Production and Benthic Nutrient Flux in the St. Lucie Estuary
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_benthic_flux.html

St. Lucie Estuary Water Quality Model
lhttp://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_wq_model.html

St. Lucie Estuary Hydrodynamics/Salinity Model
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_salinity_model.html

SFWMD - In House Projects Muck Removal
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/muck.html

SLE Oyster Bed Restoration
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/oyster_program.html

SFWMD - South Indian River Lagoon Seagrass Studies
ftp://ftp.sfwmd.gov/pub/rbennet/docs/irl_sav_report.pdf

Artificial Habitats - SAV
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/artificial.html

St. Lucie Water Quality Data Collection
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/sle_wq_data_col.html

N. Fork Wetland Reconnection
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/oxbow.html

North Fork Nursery Study
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/n_fork_nursery.html

Upper East Coast Citrus Best Management Practices (BMPs)
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/uec_bmp.html
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http://www.irrec.ifas.ufl.edu/Bomanpdf/Citrus%20BMP%20Related%20Activities.htm

Ten Mile Creek Water Preserve Area Project
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/tenmile_creek.html

SFWMD - IRL - South Plan
http://www.sfwmd.gov

Watershed Land Acquisition - Preservation/Restoration
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/maps/uec_plate2.pdf

Restoration of Historic Upland/Wetland Habitat
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/irl_rfs.html

Enhancement/Restoration/Creation of Wetlands
http://www.sfwmd.gov/org/wrp/wrp_ce/projects/wetland.html

USACOE/SFWMD - IRL Feasibility Study
http://www.evergladesplan.org/pm/studies/irl/index.shtml

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http://hort.ufl.edu/fyn/

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http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/2_wrp_ce_pubs.html

Technical Publications & Reports
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/2_wrp_ce_docs.html

Other Documents
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/2_wrp_ce_outreach.html

Other Sources of Information
http://www.sfwmd.gov/org/wrp/intro_coastal_eco.html
http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_info/2_wrp_ce_links.html
http://www.sfwmd.gov/org/wrp/2_wrp_related.html
http://www.sfwmd.gov/org/wrp/2_wrp_glossary.html

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CHAPTER 7. ST. LUCIE ESTUARY AND WATERSHED

Introduction

General Overview

The St. Lucie Estuary (SLE) is one of the largest brackish water bodies on the east coast of Florida and a primary tributary to the South Indian River Lagoon. The SLE is located along the Martin/St. Lucie County line on the East Coast of south central Florida. The inner SLE is comprised of the North Fork and South Fork of the St. Lucie River, and has a total surface area of about 6.4 square miles. The two forks converge to form a single middle estuary with a surface area of 4.7 square miles. The middle estuary extends east for approximately 5 miles until it meets the Indian River Lagoon (IRL), just before opening to the Atlantic Ocean at the St. Lucie Inlet (Figure 7-1).

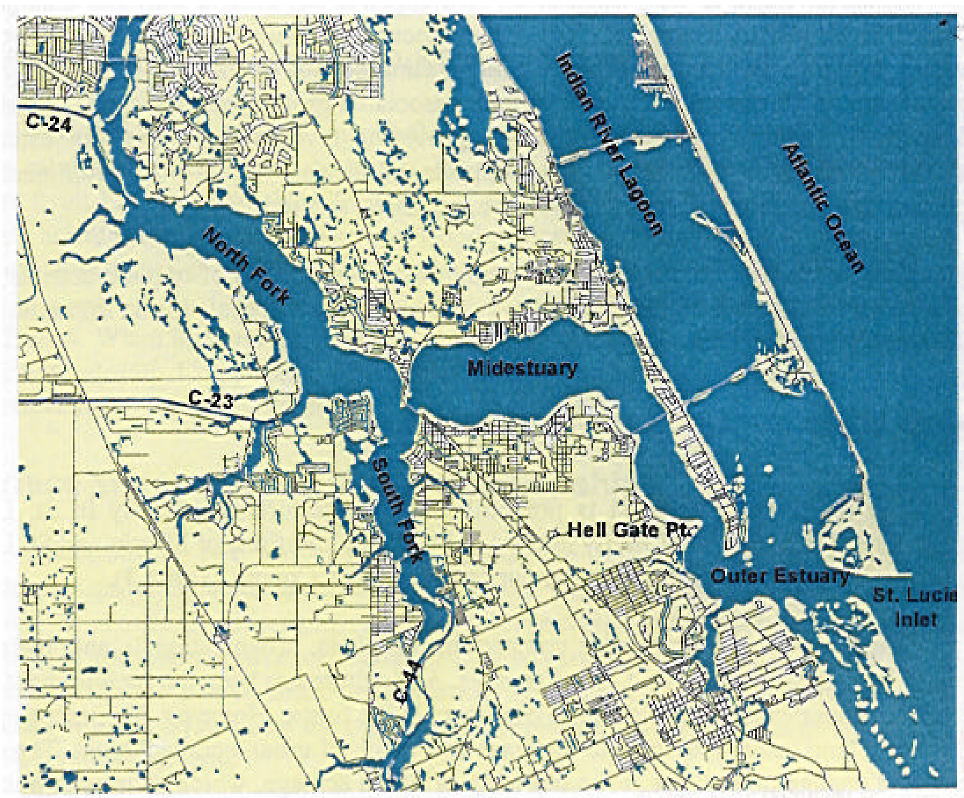


Figure 7-1. St. Lucie Estuary (SLE)

The SLE has been highly altered at both its landward and seaward ends. The system was essentially a freshwater river until 1892 when the St. Lucie Inlet was dug, providing direct ocean access and creating an estuary. The South Fork of the estuary was connected to Lake Okeechobee in 1924 by construction of the C-44. This canal provided a navigable connection to Lake Okeechobee and a route for discharge of excess Lake Okeechobee water to the South Fork of the Estuary. These discharges control high lake levels that jeopardize the integrity of the levee surrounding the Lake. To control water levels in Lake Okeechobee, periodic high-volume freshwater releases have been made to the estuary via C-44 that have varied in duration from days to months and have turned the entire estuary to fresh water.

C-44 Canal in Martin County

During the 1950's, the watershed was enlarged when the North Fork was connected to the C-23/C-24 system that drains much of St. Lucie County. Watershed runoff from the North Fork drainage basins flows quickly into major canals that transverse the coastal ridge (C-23, C-24) instead of being detained, evaporated, cleansed and attenuated by natural systems.

C-23 at S-48

The historic watershed has been extensively modified through regional flood control projects and various secondary drainage systems for agricultural and urban development. Five tributaries to the estuary provide drainage for a watershed that now encompasses 827 square miles. Ten Mile Creek, canal C-24 and canal C-23 empty into the North Fork, while the Old South Fork and the St. Lucie Canal (C-44) discharge into the South Fork. See Figure 7-2.

The SLE can potentially provide vital habitat for substantial populations of fish and invertebrates that have biological and economic importance. However, this ecosystem has been adversely impacted by a variety of watershed and shoreline modifications. Some of major environmental concerns within the SLE include adverse salinity fluctuations, accumulation of sediments and toxins, poor water quality, and loss of seagrass and shellfish resources.

C-24 at S-49

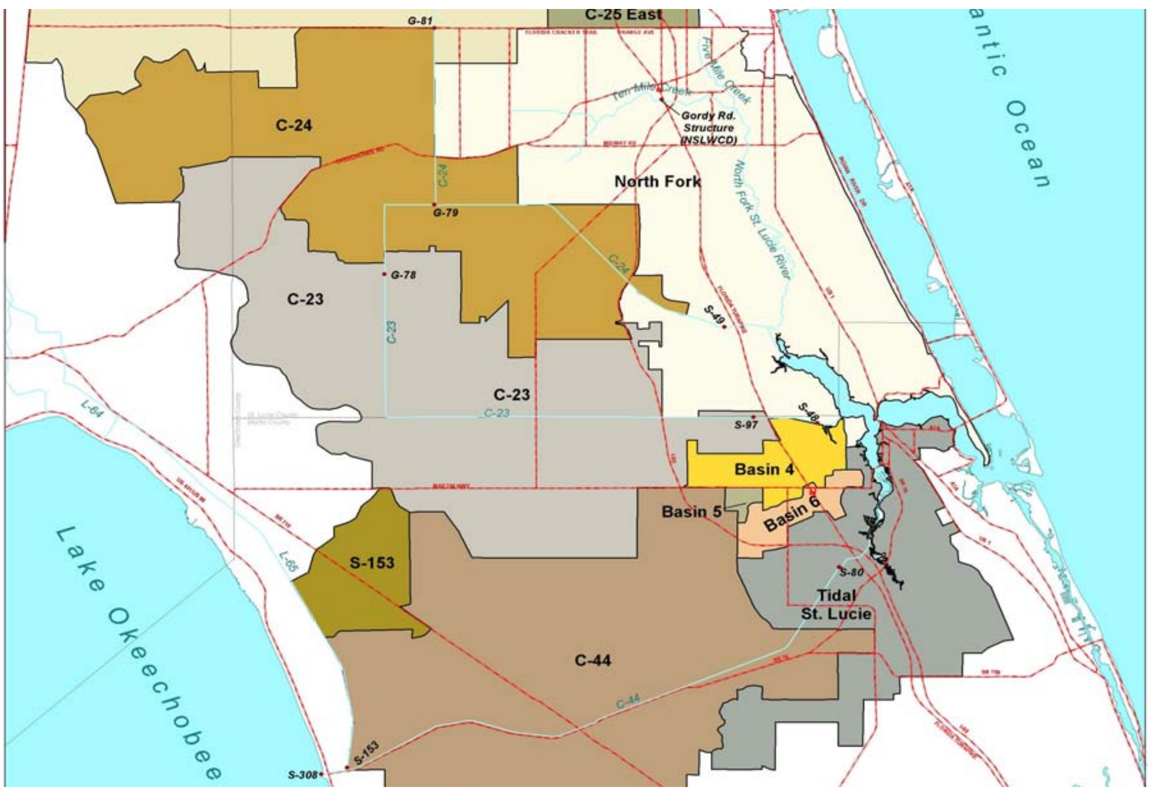


Figure 7-2. SLE Watershed and Basins Map

Excessive freshwater input, sediment loadings, and nutrient loadings associated with urban and agricultural activities can explain the occurrence of these unfavorable circumstances (Janicki *et al*. 1996); (Haunert and Konyha 2001). Runoff from the watershed contains substances from urban and agricultural practices including pesticides and excess suspended solids and nutrients. Therefore, the quality of water entering the estuary through the South Florida Water Management District system is degraded and the quantity, timing, and duration of inflows are substantially altered. However, it is the development of a network of secondary canals that drains urban and agricultural lands within the St. Lucie watershed that is most often responsible for changing the quantity and quality of freshwater flows to the estuary (Chamberlain, 1996).

In addition to the watershed modifications, the estuary shoreline and bottom sediments have been severely impacted. The natural shoreline vegetation once helped stabilize the substrate, filter storm water runoff, and provide quality habitat. Shorelines and inter-tidal areas of the estuary that were once populated by mangroves and other detritus producing vegetation now support very little vegetation. In many areas, seawalls and docks have replaced mangrove and seagrass. (see http://www.evergladesplan.org/pm/studies/irl/irl_impact_statement.shtml)

Estuaries in South Florida suffer from four main problems: (1) disruption of natural freshwater inflows; (2) alteration of natural timing of freshwater flows; (3) increasing input of nutrients and other materials of concern; and (4) loss of critical estuarine habitat and biological communities. (see http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_estuary/2_wrp_ce_estuary.html)

Estuaries are the receiving water body for a variety of watershed inputs. Therefore, estuarine restoration and management strategies must be linked to watershed management of surface water, groundwater, and atmospheric inputs in addition to the internal processes occurring in the receiving water body. (see http://www.sfwmd.gov/org/wrp/)

Freshwater Inflows and High Discharge Events

Local newspaper reports and anecdotal information from long time area residents, describe the SLE as very productive with good water clarity and a sandy bottom throughout much of its extent in the 1930's and 1940's. For many decades there has been concern in the local community over the deteriorating condition of the SLE and River. Due increased amounts of freshwater entering the SLE, muck ("ooze") has been accumulating faster than historic levels. These unconsolidated sediments are frequently resuspended by wave energy. Resuspension of these sediments releases nutrients to the water column, reduces light penetration, and depletes oxygen in overlying waters. In the winter and spring of 1998 freshwater releases from Lake Okeechobee through the S-80 structure on the St. Lucie Canal (C-44) began in December and steadily increased. Peak flows increased to a maximum of 10,000 cfs between March 1 and April 20, causing drastic decreases in salinity. Due to the combined effects of Lake Okeechobee discharges and local watershed runoff, The SLE, which normally averaged 24 ppt, decreased to 5 ppt during peak flows. Salinities in North Fork St. Lucie River, which normally average 18 ppt, decreased to 0 ppt during peak flows. Within weeks, fish - mostly mullet - appeared with small sores and lesions. The malady spread to more than 25 other species,

Although fish abnormalities have been reported in the SLE system in the past these fish lesions were widely publicized and became a recognized problem, demanding greater scientific study. Several monitoring and research projects were initiated to address this concern. FDEP established a hotline for the public to report diseased fish, and monitoring was initiated to describe the prevalence of fish abnormalities in the SLE and IRL. NOAA later initiated several ongoing projects to analyze fish health problems, characterize fish health and environmental conditions and identify the prevalence and potential causal factors in the St. Lucie system.

St. Lucie Inlet Freshwater Discharges

In April 2000, implementation of the Lake Okeechobee Recession Plan again resulted in billions of gallons of freshwater being released to the St. Lucie Estuary to provide environmental and water quality benefits to Lake Okeechobee. Although these releases may have provided significant benefits to Florida' largest lake, they once again resulted in damage to the St. Lucie Estuary and adjacent waters. The long term solution to these problems -- balancing the need to manage water in the regional water management system with the need to protect the estuary -- lies with developing alternative ways to store and distribute water in South Florida.

Regional Planning Efforts

Lake Okeechobee SWIM Plan

The June 21, 2002 DRAFT of the Lake Okeechobee SWIM Plan provides documentation that describes the operational criteria and major effects of these large discharge events and modifications to the natural system. Combined with other alterations in the watershed, such as increased drainage and changes in stormwater runoff characteristics (Doering, 1995), wet-season flows to the estuary have increased and dry-season inflow characteristics have been altered significantly. These changes have impacted habitats and organisms that depend on brackish or freshwater areas during their life cycle. High volume stormwater discharges produce rapid fluctuations of salinity as well as increased sedimentation. The increase in nutrient and sediment loading has contributed to the build-up of fine-grained, nutrient-rich muck in the estuary. The resultant change in aquatic communities in the estuary consists of more pollutant tolerant benthic organisms and decreases in seagrasses and oysters. All of the impacts described above have adversely affected the 'health' of the St. Lucie Estuary. However, salinity alterations are considered to be the major impact to the St. Lucie Estuary's biological communities. Salinity is considered to be the environmental factor that primarily controls the performance, abundance and distribution of estuarine organisms.

Lake Okeechobee Regulation Schedule

As the local sponsor of the Comprehensive Everglades Restoration Plan (CERP -- http://www.evergladesplan.org) and the Lake Okeechobee regulation schedule, the SFWMD must provide a balance between the competing objectives of flood protection, water supply, and protection of the lake's marsh zone and downstream estuaries. To maximize the extent to which this balance is achieved prior to completion of the CERP, a new regulation schedule for the lake was formally adopted by the United States Army Corps of Engineers (USACOE) in July 2000. This schedule, the Water Supply and Environment (WSE) schedule uses climate forecasting to determine the volumes of water to release from the lake under flood control circumstances, and has the potential to provide environmental benefits for the lake and downstream systems while not sacrificing water supply. SFWMD and other agency scientists are working with operations specialists to identify environmental "triggers" that can be used in the process of the WSE regulation schedule for determining amounts of water to release from the lake under flood control conditions. The extent of the benefits will depend in part on specific adaptive management protocols that are presently being developed by the District.

IRL Feasibility Study.

The CERP IRL Feasibility Study has created new opportunities for resolving SLE water quality problems, and provides the basis for long term habitat restoration. The feasibility study focuses on large-scale alternative surface water management options in the western portion of the SLE watershed. The objectives of the project are to: improve quality, quantity, timing, and flows to the IRL and the SLE; improve habitat quality of estuarine ecosystems; improve functional quality of watershed wetland ecosystems; reduce sediment loading and flocculent ooze in the estuaries; improve water supply; and provide recreational enhancements. See Chapter 6 for additional details. In conjunction with other CERP projects such as the Ten Mile Creek Water Preserve Area and restoration plans for Lake Okeechobee, it is anticipated that freshwater releases can be greatly reduced and the SLE can be managed to create salinity regimes and habitat conditions that will allow long-term restoration of the estuary.

Estuary Research Plan

The SFWMD estuary research plan identifies future information requirements to support Valued Ecosystem Components (VEC) strategies (USEPA, 1987). Foremost among these are: (1) a need for an enhanced modeling capability in the upper, low salinity zones of the estuary; (2) better biological data for the North Fork of the river and estuary, including seasonal use of the oligohaline zone and salinity needs of benthic, planktonic and nectonic species and communities; and, (3) additional information on oyster habitat sensitivities, reproductive cycles and substrate requirements in the SLE. In particular, technical criteria to support minimum flows in the St. Lucie Estuary (SFWMD, 2002), and the workload required to support the development for the CERP Indian River Lagoon (IRL) Feasibility Study have helped to establish and focus future data collection and modeling needs. Additional information on restoration plans and studies can be found in the Applied Studies section of this chapter.

For more information on SLE history, issues and plans, reference the 1994 Indian River Lagoon SWIM Plan. Other sources are The Citizens' Report to Congress, St. Lucie River Initiative; The Stuart News, November 8 – 11, 1998.

Also: http://www.sfwmd.gov/org/wrp/wrp_ce/2_wrp_ce_estuary/sle.html
http://www.sfwmd.gov/org/exo/mslsc/index.html

Oysters, Submerged Aquatic Vegetation (SAV) and Water Quality

Oysters and submerged aquatic vegetation have been selected as the key biological indicators for developing appropriate salinity ranges (and flow ranges) for the St. Lucie Estuary. The oyster species that occurs in the St. Lucie Estuary is the eastern oyster (*Crassostrea virginica)*. Three species of SAV have been selected as the most likely to be successful in the St. Lucie Estuary. These species are: shoal grass (*Halodule wrightii*); widgeon grass (*Ruppia maritima*); and wild celery (*Vallisneria americana*).

Establishing Suitable Salinity Conditions

Freshwater Inflow Requirements

Providing a suitable salinity environment is a fundamental prerequisite for establishing a 'healthy' estuarine system. Initial restoration efforts have thus focused on determining what freshwater inflows are needed to provide salinity regimes that will support healthy, sustainable estuarine communities. The conceptual approach for determining minimum and optimal freshwater inflows depends on four supporting components: the Valued Ecosystems Components (VEC) methodology, estimates of the salinity tolerance of estuaries biota, static and dynamic habitat overlap (Browder and Moore, 1981) and hydrodynamic/salinity modeling. (SFWMD, Coastal Ecosystems Division, Draft Research Plan for Estuaries, 2001). The process for determining the magnitude of minimum, maximum, and optimal flows is illustrated in Figure 7-3.

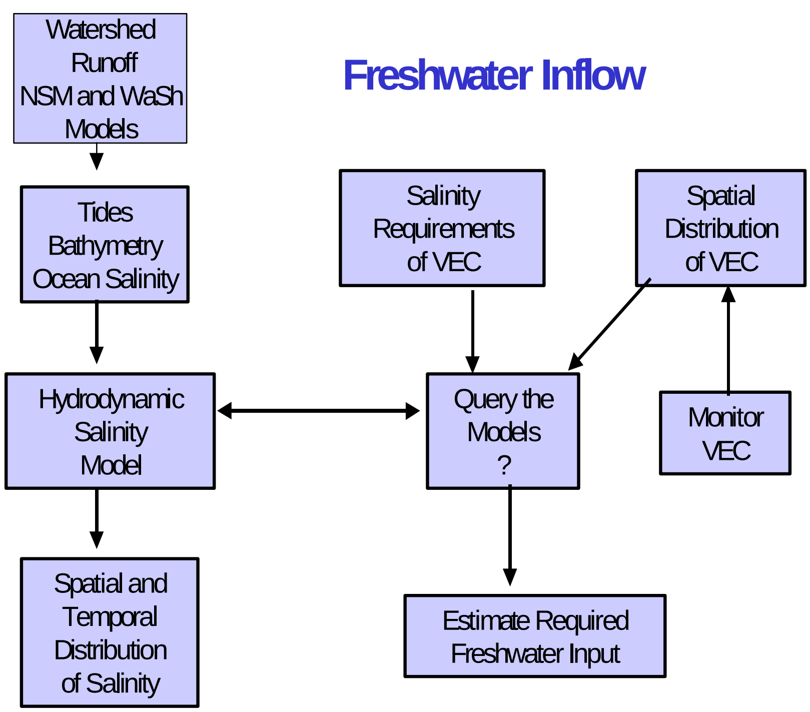


Figure 7-3. Requirements for Freshwater Inflow Management Conceptual Diagram

In addition to establishing limits on the quantity of water entering the estuary, the quality of water must also be considered. Suitable salinity conditions alone will not guarantee a 'healthy' estuarine system. It is also necessary to establish optimum loading ranges for nutrients and other critical materials. Estuarine water quality can determine the viability of estuarine biological communities (Dennison *et al.* 1993; Stevenson *et al.* 1993). Perhaps the most severe threat to estuarine water quality is eutrophication by nutrient inputs from wastewater treatment facilities, urban and agricultural runoff, and other sources (Gray 1982; 1992; Kennish 1992; Howarth *et al.* 2000). Eutrophication results in altered species composition, reductions in macrophytes and ultimately, anaerobic conditions and mass mortality. Harmful algal blooms, outbreaks of fish lesions, and other undesirable events have been associated with excess nutrient loading (Howarth *et al.* 2000). Salinity and water quality targets are identified based on the VEC requirements. Hydrodynamic and water quality models are used to estimate the freshwater inflows and nutrient loads that produce the appropriate temporal and spatial distribution of salinity and water quality to maintain VEC. Freshwater inflows and nutrient loads are estimated from watershed models.

Salinity Envelope Concept

Using the VEC approach, a favorable range of inflow and salinity was established for juvenile marine fish, shellfish, oysters and SAV. This favorable range is referred to as the “Salinity Envelope." The “Salinity Envelope” of 350 to 2000 cfs was established for the SLE based on previous research on fish and shellfish, as well as predicted monthly mean salinity from various inflows at designated areas. A family of curves for salinity in the SLE was obtained by providing a salinity model with constant inflows until a steady salinity gradient was obtained (Figure 7-4). Using the family of curves, preferred areas and salinity for oysters and SAV (the salinity envelop) can been seen. This provides a method to predict where ‘healthy’ populations of VEC would exist if the favorable range of flows and salinity were not violated beyond the frequency that is attributed to natural variation of flows from the watershed (Haunert and Konyha, 2001).

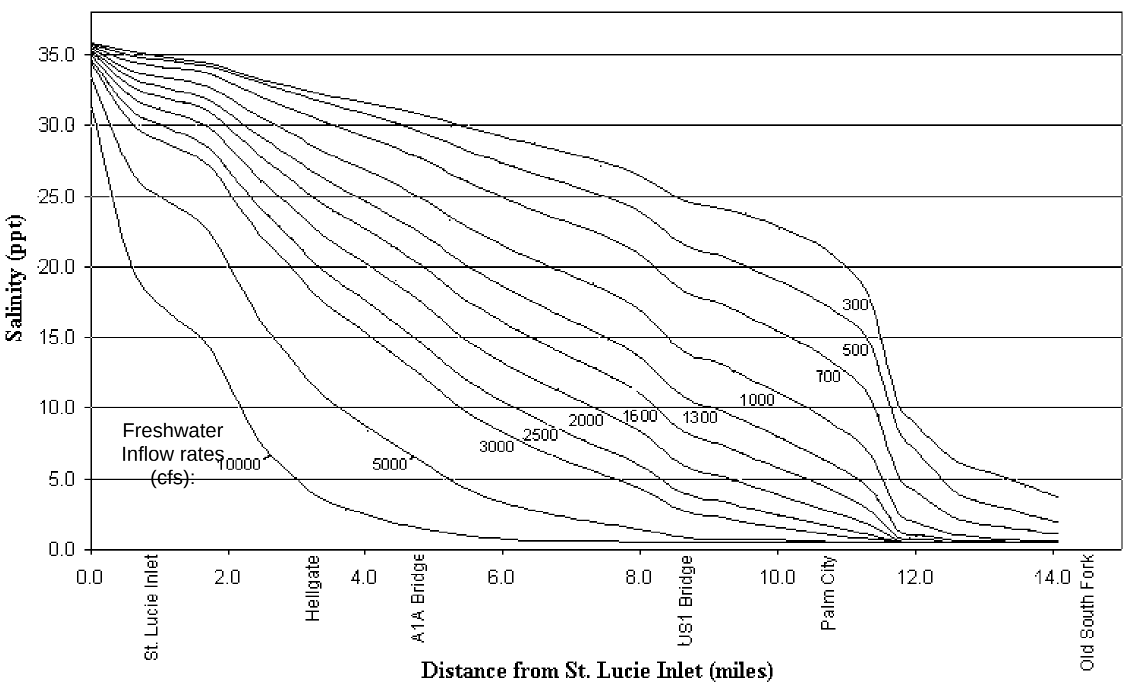


Figure 7-4. Effects of Various Freshwater Inflows on Salinity in the St. Lucie Estuary.

It is the long-term goal of the SFWMD is to develop coupled watershed-estuarine models that can be used to: (1) make estimates of historical runoff patterns that preceded human intervention; and (2) evaluate the effects of watershed alterations on receiving waters. Such alterations include changes in canal discharge or point of discharge, operation of storage facilities, impacts of filter marshes and best management practices (BMPs) on water quality, and operation of coastal structures. These management tools can be used to explore creative ways to meet minimum flows and levels (MFLs) and pollution load reduction goals (PLRGs), to test operational criteria for CERP infrastructure, to define environmentally sensitive operating procedures for existing water management schedules and to establish restoration goals. For additional detail on these four components and other material in support of these strategies for the SLE, refer to: SFWMD, Coastal Ecosystems Division, Draft Estuary Research Plan, 2001.

Oysters

Historic Distribution

Although numerous reports have mentioned oyster presence in the St. Lucie Estuary, very little specific information is available on oyster location, condition, or abundance. Woodward Clyde International-Americas (1998) used information from a literature review and interviews with people who had historical knowledge of the area to develop maps that represent generalized estimates of historical distributions of oysters in the St. Lucie Estuary (Figure 7-5). Oysters were probably never abundant in the lower estuary except along mangrove roots and feeder streams. Significant oyster beds have been reported in the middle estuary from at least the 1940s to present. Small beds have been reported in the South Fork, and scattered beds have been reported in the North Fork since about 1940.

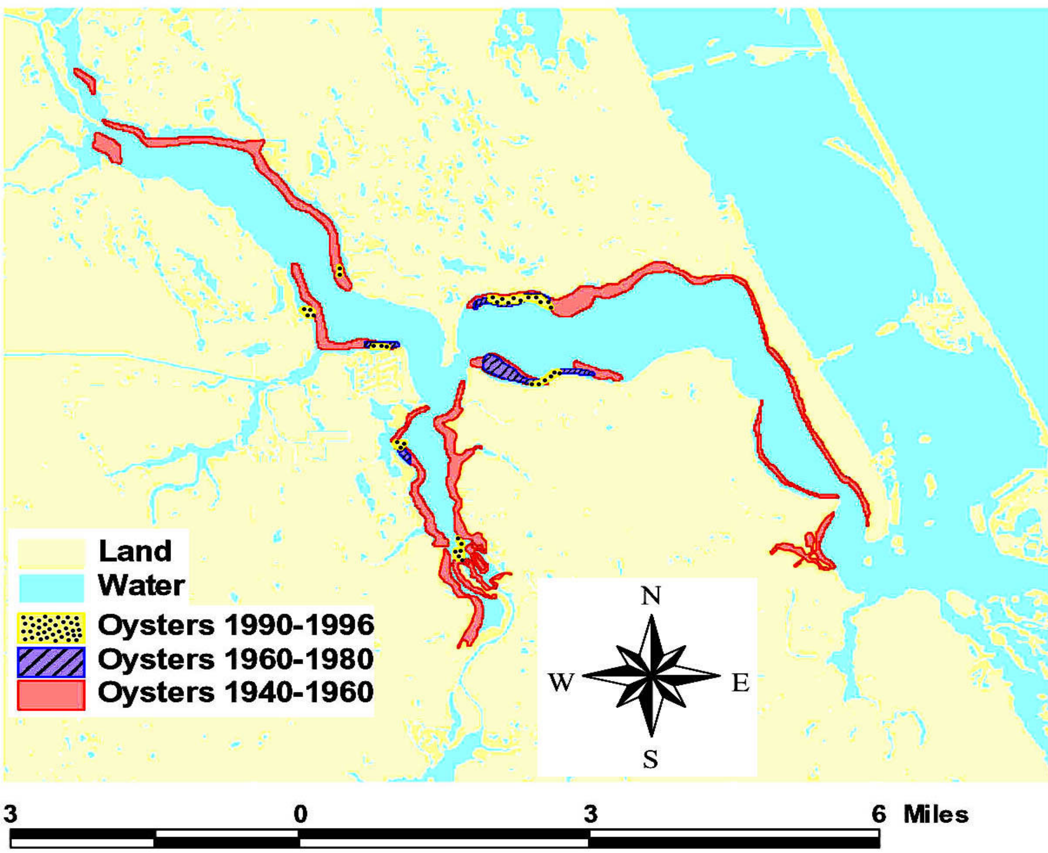


Figure 7-5. Historic Oyster Distribution

Current Distribution

The SLE no longer supports permanent or extensive populations of oysters and seagrasses (Chamberlain and Hayward 1996). Extended periods of salinity below 12 parts per thousand (ppt) can be fatal to oysters, or inhibit feeding, growth and spawning (Chesapeake Bay Program 1991). Increased freshwater inputs and sediment deposition from the SFWMD system, agricultural, and urban drainage canal systems have probably been a major factor in the decline of the oyster in the SLE. In concert with documented declines in seagrass abundance over the last 30 years, oysters have become virtually nonexistent (Janicki et al. 1996). A detailed field survey, GIS mapping of oysters and SAV in the SLE, was conducted in 1997. (URS Greiner Woodward-Clyde, 1999). At that time, 27 oyster beds covering only 208 acres were mapped, but less than 5% of the oysters in 24 of the beds were alive (Figure 7-6).

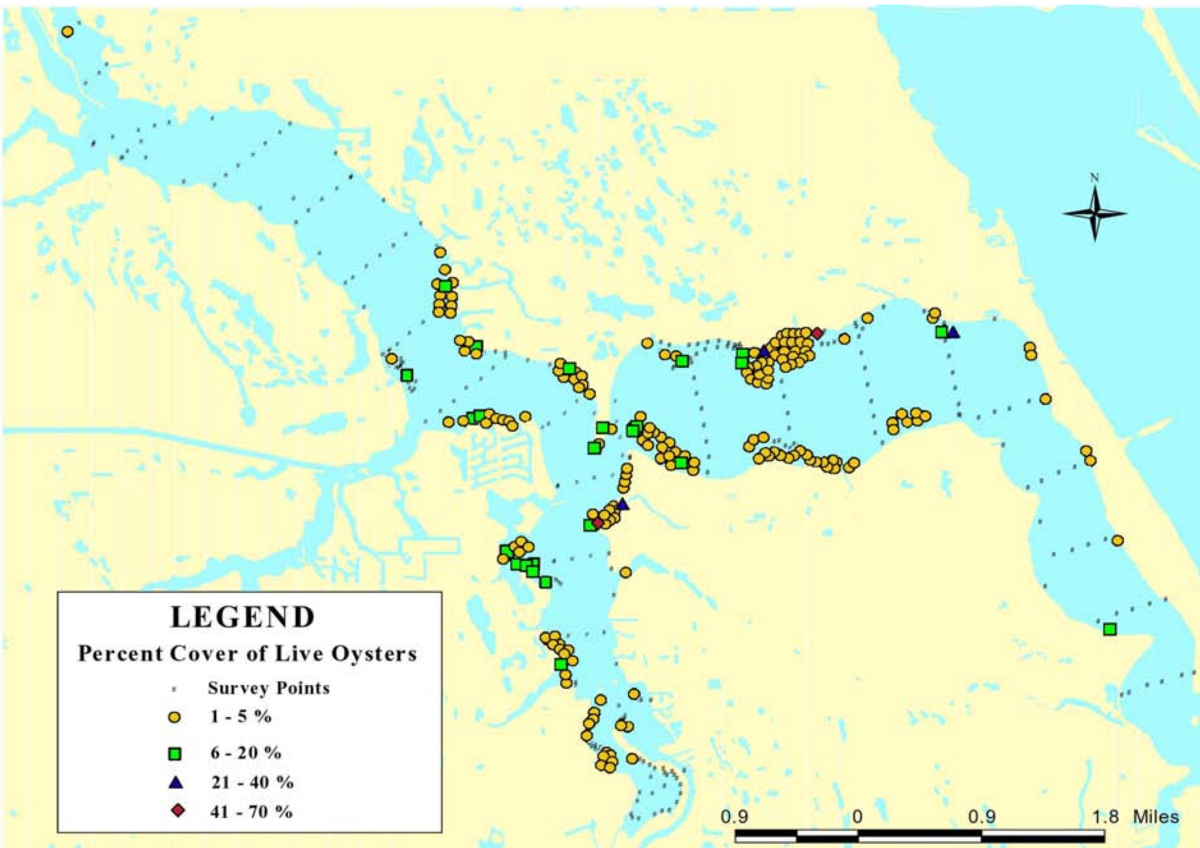


Figure 7-6. Range of the eastern oyster, *Crassostrea virginica,* in the SLE as of 1997.

Resource Assessment

The extent of potentially suitable substrate appears to be significantly greater than the current distribution of oysters in the SLE. The reported historical range of oysters occupies more of the potentially suitable substrate, but again does not include all possible areas. Thus oysters should have the potential to occur in much of the SLE, in a range much larger than they currently exist. For sustained natural production, the key consideration is appropriate substrate for setting of spat.

Substrate "firmness" is recognized as one of the core variables (V6) in the Habitat Suitability Index (HSI) model for the American oyster (Cake, 1983; Soniat and Brody, 1988). Sedimentation and turbidity factors also affect the ability of oysters to colonize different substrates, with the greatest ability to clear sediment from shell margins in coarse sand and the poorest ability in fine sand (Dunnington *et al*., 1970).

There has been considerable study of alternatives to natural oyster shell as "cultch" (setting substrate) (Butler, 1995; MacKenzie, 1989; Eckmayer, 1983; Chatry *et al*., 1986; Haven *et al*., 1987; Thayer *et al*., 1997). Crushed oyster shell and gravel additives, or mix of these, have been the most common substrates used for both clam and oyster beds. Oyster shell (uncrushed) is superior as cultch, due to the rugosity of the exterior surface of the right valve (Baker and Mann, 1994; Baker, 1997). By developing an irregular surface with gravel or shell on otherwise flat mud flats, settlement of larvae may be increased, and larvae and young spat may have additional protection from predators (Kraeuter and Castagna, 1977).

Based on the overall physiological tolerance range of adult oysters, virtually all of the SLE system appears to have suitable salinity levels. However, numerous other factors are involved in salinity tolerance in natural environments. Based on the 1997 field surveys, there appear to be very limited oyster resources downstream of the middle of the Middle Estuary at Rio. Most of the remaining estuary appears to fall within a salinity range in which at least adult oysters can survive and spawn. Salinity throughout much of the estuary changes rapidly and, in many areas, greatly based on changes in flow and freshwater input.

Oysters are much more susceptible to changes in salinity than to actual salinity levels. The rate of change is also extremely important. Oyster larvae are more susceptible to salinity changes and generally can not acclimate sufficiently to survive. Areas of greatest potential reproductive activity should be defined. Although oysters may reach a sexually mature stage within one growing season, significant reproduction capability requires two to three years to develop. Thus, prime areas would need to be protected from high mortality events for at least this interval to maintain a sustainable population.

Currently, there is little historical data on the reproductive cycle of oysters in the SLE. A recent study has demonstrated peak spawning of oysters in the St. Lucie Estuary begins in early spring (March, April) and a secondary peak in early fall. Understanding spawning periods and distribution of spawning activity within the SLE is regarded as one of the most important aspects of managing oysters for salinity during these critical times.

In summary, a practical lower limit of 7.5–10 ppt may be a suitable SFWMD planning objective in the SLE for most of the year. However, a period of at least a month to six weeks, in most if not all years, may be required during which salinities well above 7.5 ppt (ideally > 10 ppt) are virtually constant. This period should coincide with one of the spawning "peaks". Realistically, it appears unlikely that restoration or enhancement of sustainable eastern oyster beds in the SLE can be achieved if salinities remain below 10 ppt most of the year.

Submerged Aquatic Vegetation (SAV)

Historic Distribution

There are very few published references to SAV distribution in the St. Lucie Estuary. Woodward Clyde International-Americas (1998) used information gained through a literature review and from interviewing those with historic knowledge of the area to develop historic St. Lucie Estuary SAV maps (Figure 7-7). These maps should not be interpreted as absolute locations or acreages, but as generalized estimates of historic distributions.

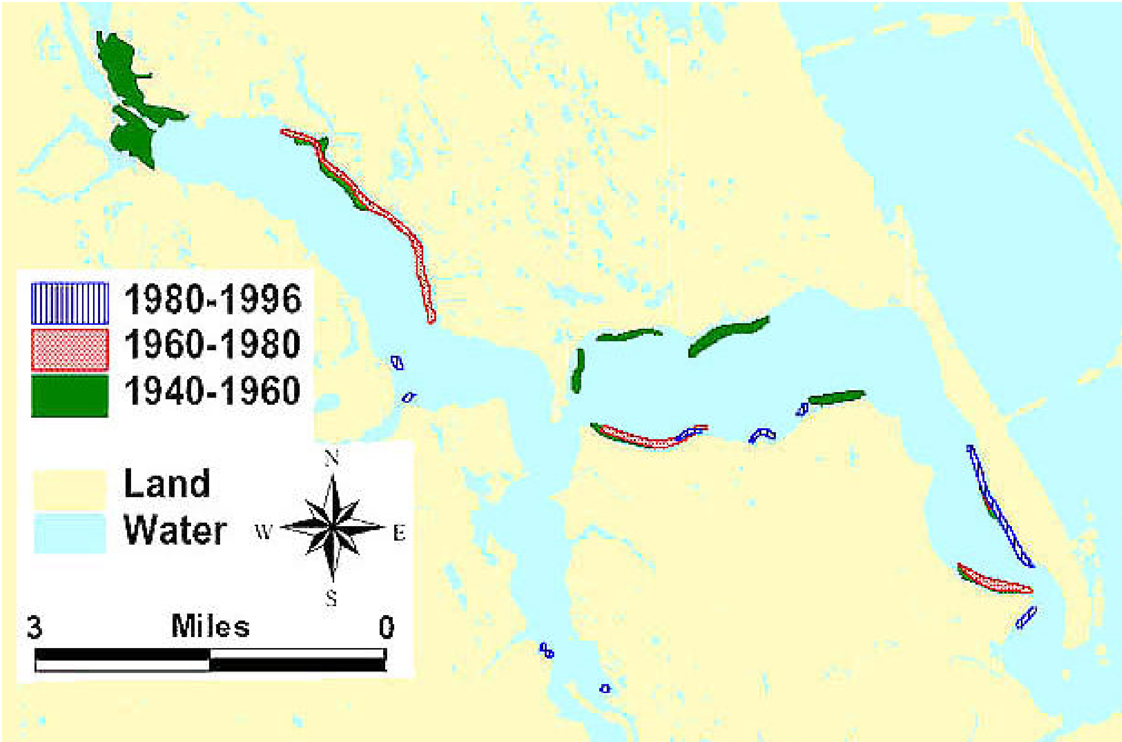


Figure 7-7. Historic Submerged Aquatic Vegetation

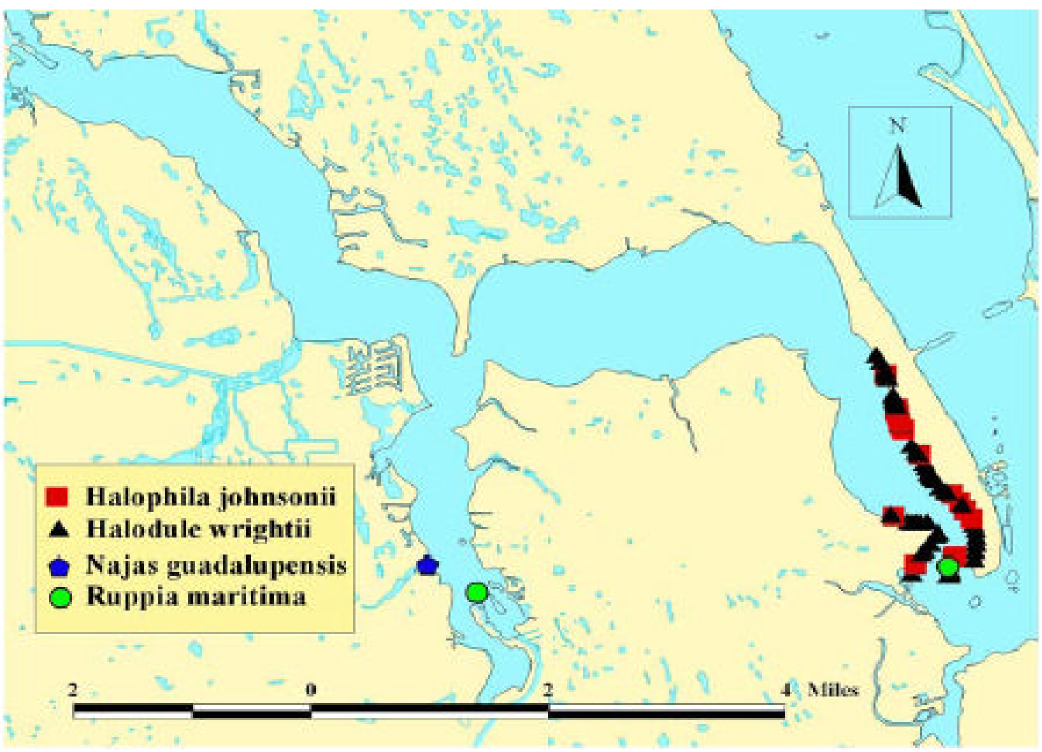


Figure 7-8. Range of submerged aquatic vegetation in the SLE as of 1997

However, based on available published and anecdotal information, SAV (primarily shoal grass, star grass, and Johnson's seagrass with occasional turtle grass) appears to have always been relatively sparse in the lower estuary. Relatively large and moderately dense beds of SAV (shoal grass and widgeon grass) have been reported in the middle estuary. Very little SAV (rare patches of wild celery, common water nymph, widgeon grass, and possibly shoal grass) has been observed in the South Fork. With the exception of scattered patches of widgeon grass along the northwest shore, no significant SAV has been reported in the North Fork in recent times. However, moderately dense beds of SAV (widgeon grass) were reported on the east side of the North Fork near Britt Creek between the 1940s and the early 1960s.

Current Distribution

The 1997 SAV survey conducted by URS Greiner Woodward Clyde revealed very little SAV. The SAV found during the survey was so sparse that only point locations (not beds) could be mapped (Figure 7-8). Very sparse distributions of SAV (primarily shoal grass) were present in the lower estuary. No SAV was documented in the middle estuary or North Fork. And only small patches of SAV were found in the South Fork (near the mouth of Danforth Creek).

High turbidities due to sediment resuspension and freshwater inflow limit light penetration and reduce the potential for sea grass colonization (Schropp *et al*. 1994). Modeling indicates that some species of SAV could grow in the shallow zones with sandy or mucky sand substrates throughout most of the estuary (URS Greiner Woodward-Clyde 1999).

However, the easily re-suspended sediments of the St. Lucie Estuary have covered habitats and caused turbidity, limiting or preventing growth. The SLE has become a plankton-dominated system with limited seagrass and macroalgae (Chamberlain and Hayward 1996; USACOE and SFWMD 2001). Plankton dominated systems are subject to decreased photic zones, algal blooms, decreased and fluctuating dissolved oxygen levels, and shifts in ecosystem structure and function.

Resource Assessment

The limited distribution of SAV that was observed in the St. Lucie Estuary during the 1997 survey can be attributed to environmental stress, probably caused by exposure to low salinity conditions. Natural salinity ranges for the SAV target species are shown in Table 7-1. Shoal grass can tolerate salinities down to about 5 ppt to 10 ppt and possibly lower for a few days. However, persistent dense beds typically occur between 22 ppt to 38 ppt. Under restoration conditions, this species will likely be restricted to the lower estuary. It is likely that widgeon grass could become much more widely distributed in the St. Lucie Estuary under restoration conditions. This species has shown the ability to acclimate to different salinities if changes are relatively slow. Much of the South and North Forks and the Middle Estuary would be suitable for colonization except for areas with highly organic or soft sediments.

Table 7-1. SAV Habitat Requirements

SAV Species	Light Requirements (% of open air surface light)	Common Natural Salinity (ppt)	Substrate Preference
Shoal Grass (Halodule wrightii)	10 – 20	22 – 38	Silty sand most common; some sands and silts
Widgeon Grass (Ruppia maritima)	5 – 20	1 – 25	Sand to mud; silt and silty sand most common
Wild Celery (Vallisneria americana)	0.5 – 3	0 – 10	Silts or silty to muddy sands; can tolerate soft muds

(Woodward Clyde International-Americas, 1998).

Wild celery has been shown to tolerate salinities as high as 10 to 12 ppt. This species could occur in the upper reaches of the South and North Forks where freshwater stream inflows buffer high salinities during drought periods. An advantage of this species is that it tends to have a resilient reproductive system and may be capable of faster recovery from adverse conditions than the true seagrasses (Woodward Clyde International-Americas, 1998).

A primary limitation to restoration of SAV beds in the St. Lucie Estuary is the light available for photosynthesis (light requirements of key SAV species are shown in Table 7-1). Color is also an important consideration in the SLE. Chamberlain and Hayward (1996) found that the effect of color on transparency and light penetration in the SLE is almost twice that of total suspended solids (TSS) and an order of magnitude larger than chlorophyll-a. Turbidity and TSS in the estuary are moderate in concentration, but high color, organic acid, and organic matter content combine with the TSS to severely limit transparency and light penetration. Improvement of light penetration through restoration efforts, is needed to establish SAV in the St. Lucie Estuary.

Water Quality

Monitoring Networks

In addition to establishing limits for the quantity of water, the quality of water entering the estuary also deserves attention. A suitable salinity environment alone will not guarantee a healthy ecosystem. Optimum loading ranges for nutrients and other critical materials must also be established. The SFWMD has two long-term surface water quality monitoring networks in place to provide data on the SLE and its watershed. In 2001, two additional monitoring networks were established. A New surface water data collection network, SLT, covering 38 sites in the coastal urbanized portion of the watershed was initiated in November 2001 and a groundwater/surface water network, covering six sites, began operation in early 2002 (Table 7-2).

Water Quality Monitoring (WQM) Network.

The Upper East Coast WQM is a long-term, routine part of a SFWMD-wide monitoring network initiated in 1979 (Germain, 1998). Water quality information is collected at five (5) coastal structures located throughout Martin and St. Lucie counties. Additional information concerning this network is provided in Chapter 6.

St. Lucie Estuary (SE) Network.

As part of the SWIM initiative a long-term water quality-monitoring program was started in October of 1989 in the SLE. Ten water quality monitoring stations (SE 0 - SE 10) were established to detect long-term spatial and temporal trends in the SLE. Data were collected bi-weekly from October 1990 through December 1996 and monthly from January 1997 to August 2000 (Figure 7-9). For statistical analyses, the SLE was divided into three distinct segments, the North Fork (SE 05, HR1, SE 06, and SE 07), South Fork (SE 08, SE 09, and SE 10), and Middle Estuary (SE 01, SE 02, SE 03, and SE 04).

St. Lucie Estuary/South Indian River Lagoon Tributary (SLT) Network.

The SLT water quality monitoring network is a three (3) year program (2001 - 2003) to monitor water quality at 38 sites tributary to the St. Lucie River, the St. Lucie Estuary and the SIRL located in Martin and St. Lucie counties (Figure 7-10). All sites are sampled on a bi-weekly basis under flow conditions or sampled monthly regardless of flow.

Table 7-2. SLE Water Quality Monitoring Programs, sample frequencies and parameters

Project Code	WQM	SLT[1]	SE[2]	[3]GW/SW
Frequency	**Parameters**	**Parameters**	**Parameters**	**Parameters**
CONTINOUS DAILY				Physicals: Temp, Sp. Cond, pH, Salinity, DO
WEEKLY COMPOSITE	Nutrients: T-PO_4, NOx, NH_4 & TKN			
BI-WEEKLY		Nutrients/Other: T-PO_4, o-PO_4, NOx, NH_4, TKN, Chlorophyll Physicals: Temp, Sp. Cond, pH, Turb, TSS, DO		
MONTHLY	Nutrients: T-PO_4, o-PO_4, NOx, NH_4, TKN Physicals: Temp, Sp. Cond, pH, Turb, TSS, DO Ions/Metals: Ca, Mg, T-Cu, T-As, T-Cr, Hardness	Nutrients/Physical : Same as bi-weekly. Ions/Metals: Ca, Mg, T-Cu, T-As, T-Cr, Hardness	Nutrients/Other: T-PO_4, o-PO_4, NH_4, NO_2, NOx, TKN, VSS, Chlorophyll, Color, TSS, Turb. Physical: Temp, pH, Sp. Cond, DO, Salinity, PAR	Nutrients/Other: T-PO_4, o-PO_4, NH_4, NO2, NOx, TKN, Na, Mg, Ca, K, Cl, Fe, SO_4, Hard, TSS, DOC, TDS, TOC, Alk.,.

1 – SLT samples collected bi-weekly under flow conditions and sampled monthly regardless of flow.
2 – SE samples collected monthly.
3 – GW/SW Interactive Study currently monitors "Nutrients/Other" on a semi-annual basis. These parameters will be monitored quarterly starting October 2002. In addition, fecal coliform, nitrogen isotopes and methyl blue activated surfactants (detergents) will be collected quarterly starting in October 2002.

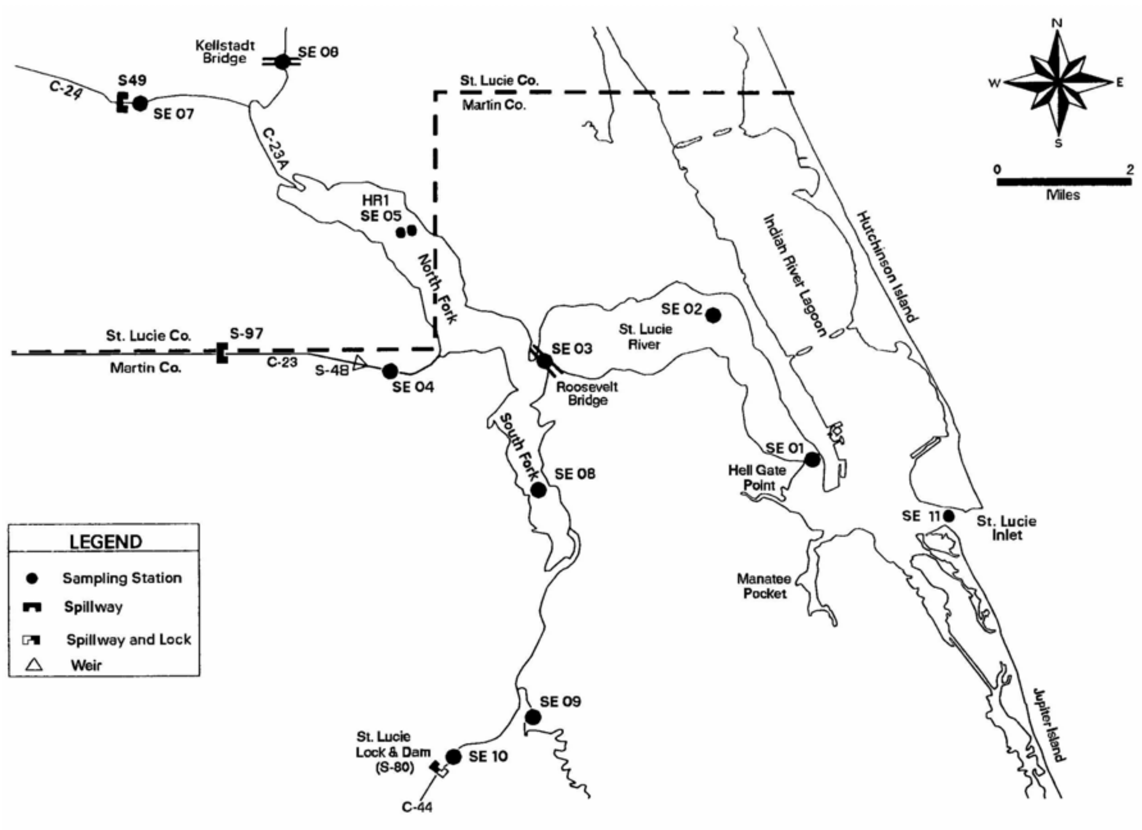


Figure 7-9. SE Water Quality Monitoring Network

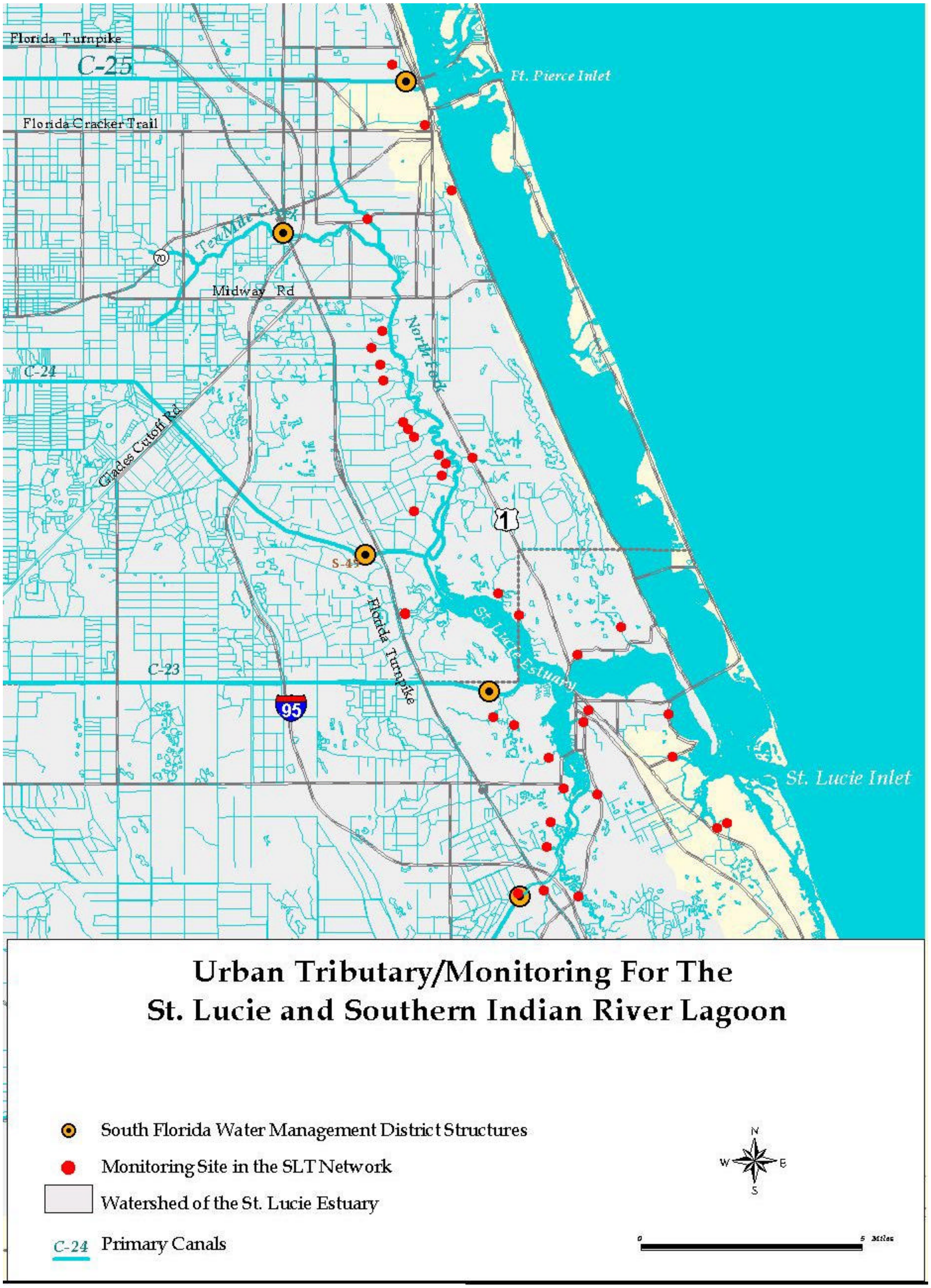


Figure 7-10. SLT Monitoring Network for the St. Lucie Estuary

Groundwater - Surface Water (GW/SW) Network.

This new network was established at six sites to better understand contributions of groundwater input to the SLE&R and SIRL. Fifteen monitor wells were recently installed at six sites (see Figure 6-6 in Chapter 6). Chemical characterization of groundwater and surface water is key to understanding the exchange and movement of water (inflows and outflows) and spatial and temporal effects on the water, the aquifer, and solute movement to and from the aquifer and surface water. Analysis of the field parameters, major ions, iron, manganese, total organic carbon, dissolved organic carbon, total dissolved solids, and total suspended solids, will allow evaluation of water from different layers, sampling or analytical inconsistencies, and sampling problems. Analysis of nitrogen and phosphorous will address nutrient questions. Additional tests include Methyl Blue Activated Surfactants (MBAS), which measures surfactants in the water (an indicator of detergents) and can be used to show input from septic systems.

Water Quality Analyses

The University of Florida, IFAS, and IRREC under contract to the SFWMD recently completed a one-year monitoring contract focusing on water quality discharges from the western portion of the watershed. This study provided a higher resolution assessment of temporal trends in the movement of the selected pesticides from a predominately agricultural watershed (citrus and pastures) by collecting samples on a daily or every-other-day basis. *N*-methylcarbamoyloxime and *N*-methylcarbamate pesticides included: aldicarb, aldicarb sulfoxide, aldicarb sulfone, carabryl, methomyl, and oxamyl. Organophosphates are also measured, including azinphos-methyl, chlorpyrifos, diazinon, dimethoate, ethion, fenamiphos, malathion, and methidathion. All of these pesticides (except diazinon) were labeled for use in citrus production. The sampling site for this study was located at Gordy Road and Ten Mile Creek (see pictures).

Gordy Road Structure

North St. Lucie River Water Control District

All of the canals in the predominantly citrus-producing area within the North St. Lucie River Water Control District (NSLRWCD) normally drain by gravity through this discharge structure. This watershed encompasses approximately 65,000 acres. The NSLRWCD comprises the headwaters of Ten Mile creek. Water that passes through/over this structure goes into Ten Mile Creek, a tributary creek that discharges into the North Fork of the St. Lucie River Aquatic Preserve, an Outstanding Florida Water (OFW) body. Specific objectives of this study were to:

1. Identify whether selected pesticides were present in water leaving the NSLWCD
2. Characterize possible seasonal trends in movement of pesticides that were present.

Aldicarb, aldicarb sulfone, and aldicarb sulfoxide were detected in 16, 30, and 14 samples, respectively, from a total of 280 samples analyzed. Methomyl was detected in one sample and oxamyl was never detected between April 4th and September 30, 2001. Ethion and diazinon were present in 19 and 2 of 332 consecutive samples, respectively, analyzed between February

12, 2001 and February 12, 2002. No other organophosphate pesticides were detected. Copper and total phosphorus levels peaked during the summer months when discharges were greatest.

Recently, FDEP has been conducting Total Maximum Daily Load (TMDL) analyses in compliance with Section 303 (d) of the Clean Water Act. Other laws that relate to TMDLs include federal statutes 40 CFR 130.2 and 40 CFR 130.7 and Florida Statutes, 403.067. The purpose of the TMDL program is to identify causes and solutions to water quality impairment in water bodies and establish upper limits or ceilings on specific amounts of pollutants that the water body can incorporate and still meet standards. The first draft of this analysis was issued in December 2001. The FDEP has continued to identify portions of the SLE for inclusion on the impaired water body planning list for nutrients (303(d) listing) and dissolved oxygen, and may include other portions on the final list where long-term monitoring of nutrient concentrations has documented elevated concentrations (St. Lucie and Loxahatchee Basin Status Report: Draft, FDEP, 2001).

As part of an effort to evaluate potential toxic effects of contaminants borne in flows to the estuary on resident biota (macro-invertebrates), the Florida Department of Environmental Protection (FDEP) has collected quarterly samples for nutrients, pesticide and heavy metals at the near-tide structures on C-23, C-24, C-25, and C-44. In addition, the FDEP collected quarterly samples at the structures on Ft. Pierce Farms canal, at the Midway Road bridge on the North Fork of the St. Lucie River, and from a sampling point located upstream of the urban developed area on the South Fork of the St. Lucie River. The SFWMD and the FDEP water quality findings agree: inflows to the IRL and the SLE contain excessive concentrations of nutrients, as well as relatively frequent detections of pesticides and heavy metals. Pesticides at concentrations that exceed state water quality standards were detected in all monitored inflows except the historic South Fork St. Lucie River.

The SLE has periodically experienced outbreaks of fish lesions, large phytoplankton blooms, and periods of hypoxia in its bottom waters (Chamberlain and Hayward, 1996; Graves and Strom, 1992). In 1998 the Florida Department of Environmental Protection (FDEP) listed portions of the SLE as impaired water bodies, unable to support their designated uses, in the USEPA section 303(d) report, of the Clean Water Act. The North Fork St. Lucie River Aquatic Preserve (AP) is monitored regularly and Outstanding Florida Waters rules and water quality criteria are often violated for dissolved oxygen and turbidity. Agricultural and residential stormwater discharges negatively impact this preserve and algae looms are often observed.

Nutrient Enrichment

Table 7-3 provides summaries of dry season and wet season water quality data for commonly-monitored parameters, including nutrients, at 10 stations in the St. Lucie Estuary during the past nine years (SFWMD, unpublished). In contrast to other portions Indian River Lagoon, the St. Lucie Estuary shows signs of advanced eutrophication: changes to benthic community composition (loss of SAV and oysters), nuisance algal blooms, and periods of hypoxia (Chamberlain and Hayward 1996, Graves and Strom 1992, Gray 1992). Preliminary analysis of data collected during a recently completed productivity–benthic flux study indicate that nitrogen potentially limits primary productivity. Chlorophyll concentrations provide an indirect assessment of phytoplankton biomass, and an indicator of estuarine eutrophication (McErlean and Reed 1981, USEPA 1999). Reduction of chlorophyll is one of many factors needed to reestablish SAV in the St. Lucie and other degraded estuaries (Dennison *et al.* 1993). The latest draft of the Impaired Waters Report by FDEP has proposed a target annual average chlorophyll concentration of 11 µg/l.

Analyses conducted by the District indicate that chlorophyll-*a* concentrations in the St. Lucie are high relative to other estuaries that have displayed problems with water quality (Columbia River

Table 7-3 - SLE - Median Water Quality Parameters (Nine Year Data Set)

Parameters	Middle Estuary				North Fork				South Fork		
Dry Season											
STATION	**SE O1**	**SE 02**	**SE 03**	**SE 04**	**SE 05**	**HR1**	**SE 06**	**SE 07**	**SE 08**	**SE 09**	**SE 10**
DO mg/l	6.73	7.0	6.72	5.97	7.3	6.84	4.6	6.32	6.985	5.695	6.4
pH units	7.77	7.77	7.65	7.42	7.59	7.69	7.29	7.31	7.54	7.43	7.45
Salinity ppt	26.81	22.3	15.1	11.52	9.26	6.9	1.4	1	6.1	0.61	0.630
Secchi m	1.2	1.2	1	1	1	1.03	1	1	0.61	0.85	0.9
Chl *a* mg/m^3	4.8	5	6.4	7.7	7.2	9.6	9.3	8.65	8.35	8.4	7.6
NH_4 mg/l	0.02	0.02	0.02	0.057	0.005	9.6	0.04	0.078	0.038	0.022	0.062
NO_2 mg/l	0.002	0.003	0.002	0.005	0.002	0.002	0.004	0.006	0.006	0.006	0.009
NO_3 mg/l	0.018	0.032	0.059	0.065	0.026	0.012	0.067	0.031	0.064	0.069	0.153
NO_X mg/l	0.023	0.032	0.058	0.06	0.031	0.013	0.07	0.038	0.086	0.089	0.177
TKN mg/l	0.738	0.748	0.843	.964	0.92	1.062	1.02	1.117	1.087	1.01	1.1
ORGN mg/l	0.65	0.665	0.800	.905	0.88	0.987	0.97	1.015	0.995	0.99	1.025
TOTN mg/l	0.763	0.809	0.917	1.086	1.047	1.123	1.115	1.168	1.225	1.126	1.291
OPO4 mg/l	0.064	0.095	0.125	0.173	0.16	0.158	0.174	0.152	0.123	0.101	0.111
TP mg/l	0.072	0.094	0.132	0.167	0.139	0.2	0.215	0.203	0.181	0.155	0.172
TSS mg/l	19	14	14	10	8	8	7	5	13	8	9
Turbidity NTU	5	4.8	6.09	3.895	3.8	3.605	4.915	3.71	8.08	5	5.5
VSS mg/l	7	5	6	4	4	3	3	2	5	5	5.5
Color cu	23	31	40	56	56	50	64.5	74.5	56	65	60
Wet Season											
STATION	**SE O1**	**SE 02**	**SE 03**	**SE 04**	**SE 05**	**HR1**	**SE 06**	**SE 07**	**SE 08**	**SE 09**	**SE 10**
DO mg/l	5.6	5. 5	5.0	4.8	5.8	6.3	3.8	6.4	6.1	4.9	6.1
pH units	7.7	7.7	7.5	7.2	7.5	7.6	7.3	7.3	7.5	7.4	7.4
Salinity ppt	24	16	11	6.9	4.2	7	0.7	0.5	5.0	0.4	0.4
Secchi m	1.0	1.0	1.0	0.9	0.9	1.0	0.9	0.9	0.6	0.8	0.9
Chl *a* mg/m^3	5.8	7.2	10.2	9.3	12.4	12.1	10.2	8.9	9.5	10.3	9.2
NH_4 mg/l	0.070	0.059	0.050	0.102	0.022	0.030	0.046	0.119	0.044	0.022	0.071
NO_2 mg/l	0.002	0.005	0.006	0.006	0.005	0.002	0.005	0.007	0.008	7	0.020
NO_3 mg/l	0.012	0.023	0.021	0.026	0.008	0.008	0.069	0.019	0.045	0.051	0.107
NO_X mg/l	0.013	0.024	0.031	0.034	0.008	0.009	0.070	0.027	0.062	0.060	0.141
TKN mg/l	0.798	0.990	1.080	1.238	1.124	1.117	1.065	1.259	1.176	1.51	1.108
ORGN mg/l	0.700	0.860	0.970	1.103	0.999	1.026	0.999	1.122	1.065	1.010	1.045
TOTN mg/l	0.830	1.053	1.129	1.309	1.183	1.144	1.198	1.281	1.292	1.128	1.300
OPO4 mg/l	0.096	0.126	0.170	0.207	0.192	0.196	0.208	0.193	0.152	0.129	0.142
TP mg/l	0.126	0.165	0.207	0.264	0.232	0.229	0.262	0.268	0.206	0.175	0.203
TSS mg/l	14	12	11	6	7	7	7	5	11	7	7
Turbidity NTU	5.2	5.0	5.1	3.8	3.6	3.4	5.2	3.4	7.6	5.0	4.5
VSS mg/l	6	5	4	3	3	3	3	2	5	3	2
Color cu	31	51	63	89	91	53	77	87	70	78	71

Source: SFWMD, Unpublished

Estuary, Chesapeake Bay, and the Dutch Wadden Sea). These systems rank close to the annual average concentration seen in the St. Lucie Estuary (Boynton *et al.* 1995, Nienhuis *et al*. 1992, Nixon *et al.* 1986, NOAA 1997a, NOAA 1998, Philippart et al. 2000, Simenstad et al. 1994). The seasonal range is most similar to that in the upper Chesapeake Bay. According to NOAA (1997a, 1997b, 1998), these same systems continue to show peak chlorophyll-*a* levels that are "high" (20-60 µg/l) to "hypereutrophic" (>60 µg/l). While annual maximum values in the St. Lucie Estuary occur in the "high" range, they are more often "moderate" (5-20 µg/l) to "low" (<5 µg/l). According to Boynton *et al* (1982), systems where rivers serve as direct sources of water from the land are prone to have higher chlorophyll levels. Over the past decade, chlorophyll levels in the St. Lucie Estuary have increased at 2 of 11 sites and decreased at none, which suggests that there has been no general improvement in water quality.

Among many factors that control chlorophyll levels in estuaries, nutrient concentrations receive the most attention. In the St. Lucie and other estuaries where nitrogen is the limiting nutrient to phytoplankton growth, a high correlation between chlorophyll and this nitrogen might be expected to occur (Chamberlain and Hayward 1996, Day *et al.* 1989, Doering 1996, Smith *et al.* 1999). Boynton *et al.* (1982) and Monbet (1992) have demonstrated this relationship in many systems. No association between chlorophyll-*a* and available nitrogen (dissolved inorganic nitrogen, DIN) has been detected in the St. Lucie Estuary. Further analysis needs to be performed to clarify the exact relationship between nutrient loading and algal blooms in the SLE.

Temporal Analysis

The Middle Estuary shows an increase in NH_4 at three of four stations (SFWMD, unpublished). Color showed a negative trend in the middle estuary except at site SE 03. Site SE 03, at the confluence of the Middle, North and South Forks and adjacent to Roosevelt Bridge, shows a increasing concentrations of ammonia, organic nitrogen and color. Site SE 06 in the North Fork south of the Kellstadt Bridge showed decreasing trends in NO_2, NO_3, NO_X, TSS, TURB, VSS, and Color and increases in chlorophyll (Chl *a*) and TP. At HR1, an *in situ* continuous recording station and grab site, trends for salinity, TSS and VSS increased and the trend for color decreased. SE 07, located east of S-49 in the North Fork, showed an increase in Chl *a*. In the South Fork, color showed a significant negative trend for color at all stations. Significant increases of TP at SE 08 and DO at SE 09 (located in the Old South Fork) also occurred.

Spatial Analysis

Concentrations of TKN, TOTN, TP, color, ORGN, Chl *a*, tended to increase from the mouth of the SLE West into the North and South Forks during both the wet and dry seasons (SFWMD, unpublished). Conversely the concentrations of TSS, NH_4, DO and Salinity decreased from the mouth of the SLE with no significant change for NOX. Total suspended solids also decreased from the mouth to the head of the estuary. However, TSS was unusually high at SE 08(km = 17). This station is on a shoal where wind driven re-suspension is common.

Seasonal Values

Median seasonal values in the SLE (Table 7-3) indicate that nutrient laden water consistently comes from the North and South Forks (SFWMD, unpublished). This was based on samples from Kellstadt Bridge (SE 06), the most northerly station, which often had higher nutrient concentrations than samples from SE 07 in the C-24 basin adjacent to S49. In the South Fork, SE 09 and SE 10 consistently input poorer water quality into the SLE. Dry season salinities (Figure 7-11a and b) ranged from a high of 26.81 ppt at SE 01 to a low value of 1.0 ppt at SE 07 in the North Fork and 0.63 ppt at SE 10 in the South Fork. Conversely, median wet season salinities ranged from a high of 24 ppt at SE 01 to lows of 0.7 ppt at SE 06 in the North Fork and 0.4 ppt at SE 10 in the South Fork. TSS values in the wet season ranged from 14 mg/l at SE 01 to 7 mg/l in the North Fork at SE 05 and in the South Fork a high of 11 mg/l at SE 08 and 7 mg/l at SE 10. Mean DO values were generally above 5 mg/l except that wet season values at stations SE 04 and SE 06 were 4.02 mg/l and 3.83 mg/l, respectively. With the exception of NO_x, the various forms of nitrogen (TKN, TOTN, NH_4, and ORGN) had higher concentrations in the wet season (May through October) then during the dry season (November through April) (Doering 1996). Color, TP and OPO_4 also exhibited this pattern (Figure 17-12a and b).

Dissolved Oxygen

Dissolved Oxygen values have been a source of concern in the SLE. The Environmental Protection Agency sets guidelines for hypoxic waters as >2 mg/l and ≤5mg/l and anoxic waters as ≤2mg/l. Using these guidelines, Figure 7-13 shows the normalized distribution of DO in the SLE by station. Figure 7-14 shows the number of samples taken over time and the distribution

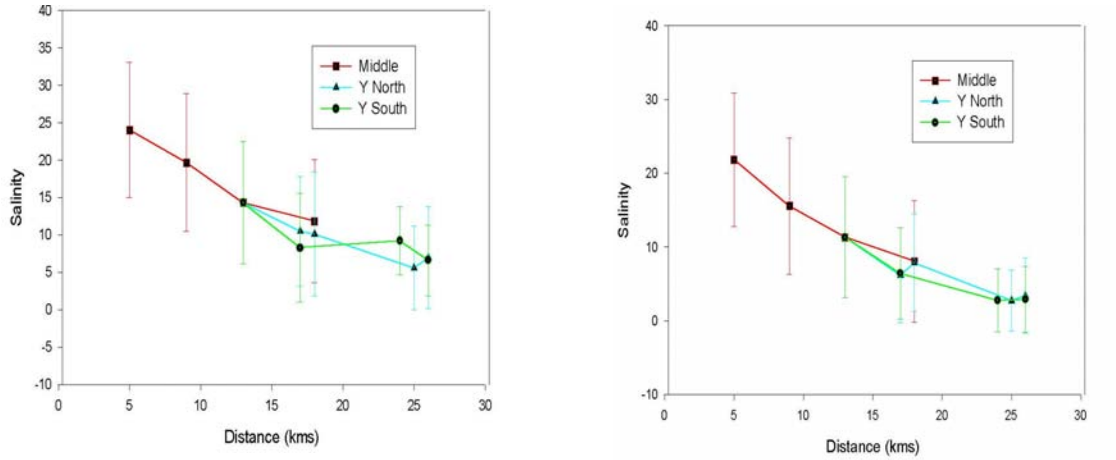


Figure 7-11. Dry Season (left) and Wet Season (right) salinities in the St. Lucie Estuary

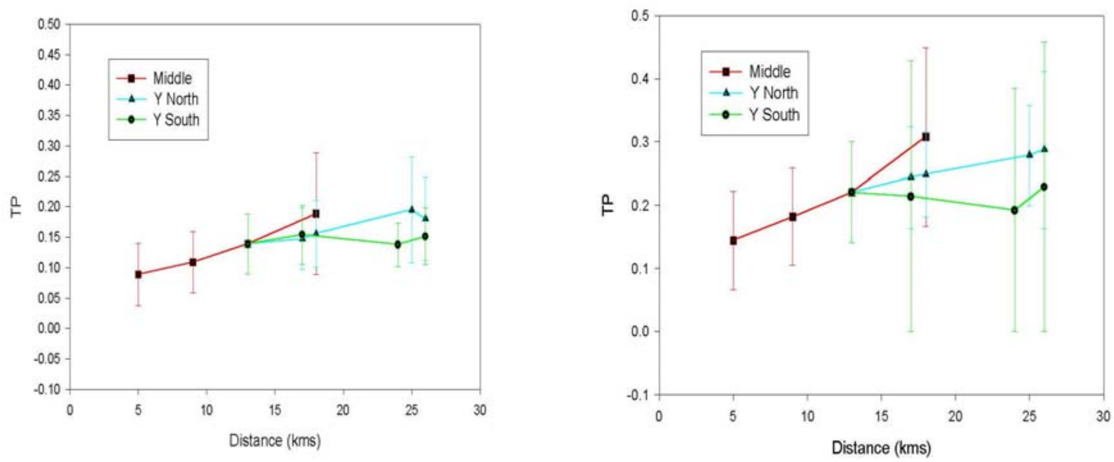


Figure 7-12. Dry Season (left) and Wet Season (right) TP in the St. Lucie Estuary

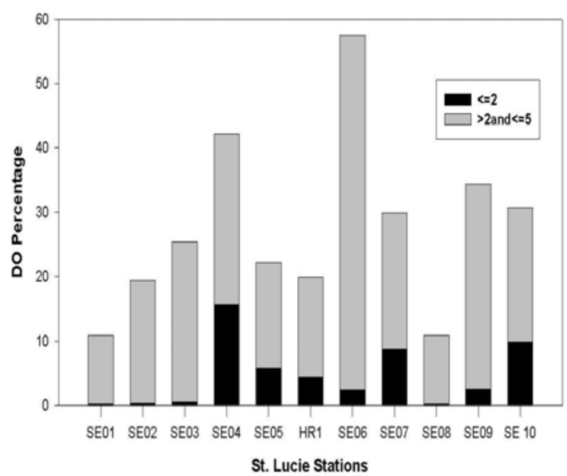


Figure 7-13. DO Bottom Percentages

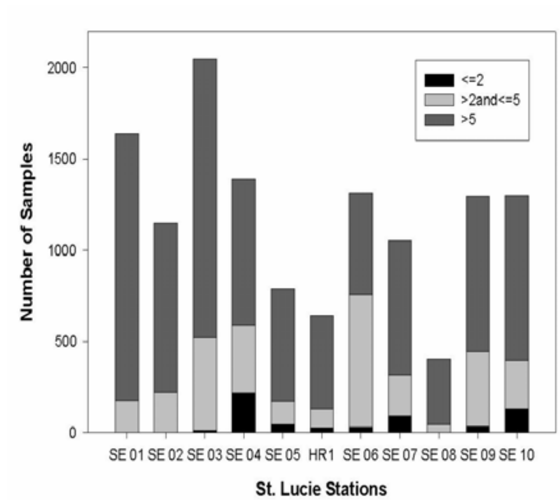


Figure 7-14. Sample Counts

of DO concentrations by station based on EPA criteria. All DO samples were taken between 0900h. and 1600h. DO values tended to decrease as you move West toward the North and South forks where the majority of fresh water inputs are located.

General Trends

Excepting TSS, the concentrations of most water quality parameters decreased in a westerly direction from the mouth of the SLE due to nutrient laden freshwater inputs from both the North and South Forks. In most cases the water quality of the South Fork appears similar to the water quality of the North Fork although they drain different basins. Increased freshwater inputs during the wet season through the North and South Forks of the SLE tend to explain the majority of the seasonal variability (Doering, 1996).Hand *et al* (1994) established median water quality standards for four parameters; Chl *a* (9 µg/l), TOTN (0.8 mg/l), TP (0.01 mg/l), and Secchi depth (1.1m) for Florida Estuaries. Total nitrogen and TP values for the SLE far exceeded the median values for comparable Florida estuarine systems. These values can be attributed to increased nutrient laden fresh water inflows (Chamberlain and Hayward, 1996). The SLE values for Chl *a* and Secchi depth were comparable to the water quality values derived by Hand *et al* (1994). Chamberlain and Hayward (1996) found that the highest Chl *a* values were associated with low flow and low nutrient and color concentrations. At low flow, flushing time is long and light availability is high. These conditions favor the accumulation of Chlorophyll biomass.

Dissolved oxygen is a critical indicator of ecosystem health. Most stations in the North and South fork of the SLE exhibit hypoxia and some stations exceeded EPA standards more then 20 percent of the time over the last decade. These values were taken during the day, when DO values are typically higher. DO values at night could be significantly lower. Stations co-located with structures tended to have high exceedances of hypoxic and anoxic conditions due to the stratification between fresh and brackish waters under low or no flow conditions. The sites of concern are the stations that are not adjacent to structures and still exhibit hypoxic profiles.

Progress of Projects

Seagrass and Oyster (VEC), Water Quality, and Bathymetry Projects

Current status, description and lead agencies for these projects are summarized in Table 7.4. A literature review of the history of seagrass and oyster populations and a survey of SLE seagrass and oyster distributions is complete. Thirteen projects are related to monitoring of bottom communities and water quality, of which five have been completed. Bathymetry of the estuary has been determined and the North Fork River will be mapped in 2003.

Major Water Quality Improvement Projects

A large number of water resources projects are currently underway in the SLE Watershed. Many of these projects, such as; stormwater retrofits, implementation of best management practices (BMPs), sediment removal, and habitat restoration, etc., can immediately contribute to the achievement of SWIM goals and objectives. Other projects have longer-term implications for the IRL or SLE, i.e., Implementation of IRL - South Feasibility Study and the Lake Okeechobee Restoration Plan, major stormwater improvement projects. Projects nominated by the St. Lucie River Issues Team have received more than $53 million, including $26.5 million came from the State’s Florida Water Resource Projects (FWAP) process or state allocations, and more than $26.5 million from matching county, city, state and federal sources. This state/ local/federal cooperation has greatly accelerated implementation of many of the projects. The Issue Team has successfully funded 88 projects from 1999-2002.

Table 7-4. Seagrass and Oyster (VEC)/Water Quality/Bathymetry Projects

Project Name	Description	Status	Lead Agency
Historical Assessment			
SLE Seagrass & Oyster Literature Review 1998	Contract with Woodward-Clyde for literature review of history of seagrass and oyster populations in the SLE and data on substrates and salinity requirements for restoration.	Completed	SFWMD
Community Modeling			
Survey and Modeling of Oyster & Seagrasses in the SLE – 1999.	Contract with URS Greiner Woodward-Clyde for field surveys, bathymetry, GIS coverages, mapping, and modeling, to determine current distribution of oysters and seagrasses and forecast potential strategies for restoration .	In progress	SFWMD
Habitat and Water Quality Monitoring			
SLE Oyster Bed Monitoring	Periodic field inspection to note health and distribution.	Continuing	SFWMD
Seagrass Bed Monitoring	Periodic field inspection to note health and coverage	Continuing	SFWMD
SE Water Quality Monitoring Network	Ten stations located in SLE, North & South Forks, monitored monthly, from 1990 – 1996.	Completed	SFWMD
SE Water Quality Monitoring Network	Ten stations located in SLE, North & South Forks, monitored bi-weekly 1997 to present.	Continuing	SFWMD
WQM Water Quality Monitoring Network	Long term monitoring at five SFWMD coastal structures, 1979 to present.	Continuing	SFWMD
SLT Water Quality Monitoring Network	Three year project monitoring 38 watershed sites tributary to the SLE & IRL, 2001 - 2004	On-going	SFWMD
GW/SW Water quality Monitoring Network	Six groundwater/surface water stations, 4 @ SLE & 2 @ IRL, 2002.	Continuing	SFWMD
SLE Tide/Salinity Station Network	Three stations located in SLE, 1997 to present.	Continuing	SFWMD
SLE Water Quality Data Summary	Trend analysis and summary of SLE water quality data, 1990 –1999.	Completed	SFWMD
Organophosphate, Carbamate, Urea, & Metallic Pesticides Monitoring	Contract with IFAS, IRREC, for 12 month data set from water quality monitoring at the Gordy Road structure in St. Lucie County, 2001-2002.	Completed	SFWMD
FDEP Water Quality Monitoring Network 1998 - 2000	Periodic event sampling associated with development of criteria for referencing watershed land use and water quality indices.	Completed	FDEP @ PSL
Martin County Water Monitoring Network	15 gauges at 12 sites rainfall, groundwater, and stage data. Initiated January 2000.	Continuing	Martin County
Canal Watch Surface Water Quality Monitoring Network 2002	IFAS, IRREC, monitoring network covering sites in Martin and St. Lucie counties to provide baseline data for evaluating water quality impacts of BMP implementation..	In progress	IFAS, & FDACS
Bathymetry Studies			
SLE Bathymetry	Determine depth profiles throughout the estuary	Completed	SFWMD
North Fork Bathymetry	To be performed in 2003	In Progress	SFWMD
Herbicide Effects on SAV			
Effects of Herbicides on tapegrass	IFAS 2001-2002. Contract with IFAS for bioassay of herbicide impacts. Details to follow.	In progress	SFWMD

See the Issues Team 2001 report at http://www.sfwmd.gov/org/exo/mslsc and Figure 6-4 and Table 6-6 in Chapter 6 for more project details, locations and rankings. In addition, partnerships with Martin and St. Lucie counties and local municipalities have helped to accelerate progress on longer-term restoration/retrofit projects. Martin County has devoted extensive funding, through it's "Healthy Rivers" Tax to partner with the state and SFWMD to purchase properties with significant regional impact, such as Atlantic Ridge, Allapattah Ranch and Tenmile Creek Water Preserve Area, which are discussed later in this chapter.

Pollution Load Reduction Goal (PLRG) Development.

In the SLE a two-step approach is being taken to develop PLRG's. The first step was to develop interim concentration targets based on work done to support the IRL–South Feasibility Study (IRL SFS). The primary goal of the project is regulation of freshwater flows to maintain optimum salinities in the SLE. The SFWMD has developed freshwater flow targets based on salinity preferences of oysters and seagrasses. However, to maximize overall water quality benefits, nutrient and contaminant loads in freshwater flows to the estuaries must also be reduced. The IRL SFS water quality subteam recommended establishment of phosphorus reduction goals, since facilities designed to treat for phosphorus could also remove inorganic nitrogen, heavy metals, and pesticides, as well. The subteam produced a comparison of St. Lucie Estuary median nutrient concentrations versus those of all other Florida estuaries for the 19-year period of record from 1980 to 1998, as shown in Table 7-5. Only total nitrogen and total phosphorus had elevated levels. However, the median phosphorus concentration of 101 ppb for Florida's estuaries reflects a bias because several Florida estuaries, especially on the west coast, have high phosphorus levels due to phosphate mining activities in their basins. More recent data (1989-1998) indicate that the median total phosphorus concentration in Florida's estuaries is 81 ppb (Hand 1999).

Table 7-5. Median nutrient values for all Florida estuaries and St. Lucie Estuary (1980-1998 combined FDEP and SFWMD data set). All units in ppb.

	All Florida Estuaries	St. Lucie Estuary
Total P	101	192*
Total N	630	927
Ammonia N	30	30
Nitrate/nitrite N	30	30
Color	73	52
Chlorophyll *a*	5	7.7

***Note: Median of annual median values presented to reduce bias from intensive sampling in some years.**

Recent estimates of total phosphorus in St. Lucie Estuary were over 190 ppb. Thus, despite the bias, total phosphorus in the St. Lucie is well above the state's median. To meet the 81 ppb target requires a 50% or greater decrease in phosphorus loads. The subteam recommended an annual average phosphorus concentration of 81 parts ppb at low ebb tide at Roosevelt Bridge (see the Draft IRL SFS Report and Supplemental EIS, Appendix A, pp 90 – 101). The next step will be to use these target values with the hydrodynamic/water quality and watershed models to develop PLRGs for particular basins. Water quality concentration targets will be reevaluated and may be modified as additional water data and modeling results become available.

Stormwater Discharge Management Projects

As previously noted long-term solutions to damaging freshwater discharges to the South IRL will be addressed through CERP projects, specifically, the IRL South Plan, and the Lake Okeechobee Restoration Plan. However, implementations of major stormwater projects, such as, Ten Mile Creek Water Preserve Area, by the U.S. Army Corps of Engineers (USACOE) and the SFWMD, and projects currently under way by local governments will have significant positive impacts. Water quality impacts to the SLE are dominated by stormwater runoff from urban and agricultural sources. Several strategies are being implemented in the SLE watershed to better manage urban and agricultural runoff. Implementation of best management practices is on-going. Stormwater utilities are in place in each county. Counties, municipalities, and other agencies in the watershed are implementing a variety of stormwater retrofit projects. Funding provided through the St. Lucie River Issue Team program has assisted many of these efforts (Table 6-6). Additional information on these projects is provided in Table 7-6.

Table 7-6. Pollutant Load Reduction - Non-point Sources - Stormwater Projects

Project Name	Description	Status	Lead Agency
Local Government Projects- - St. Lucie County			
Platt's Creek / Sunrise Blvd. Stormwater – Habitat Restoration Project	Decommissioning and floodplain restoration of a 102 acre citrus grove on the North Fork of the St. Lucie River. Construction of a 16 acre wet detention area for stormwater quality improvement from the 1,000 acre watershed.	In progress	St. Lucie County
Indian River Estates Storm-water – Savannas State Preserve Restoration	Indian River Estates (IRE0 subdivision is located adjacent to the Savannas State Preserve. IRE presently discharges poor quality stormwater through a swale system to the preserve.	In progress	St. Lucie County
Hidden River Estates Retrofit	Provide retention area for existing 70-acre drainage basin that discharges directly to the North Fork of the St. Lucie River	In progress	St. Lucie County
C-23 and 28 Basin retrofit	Provide water control structures for drainage basins of 1400 acres that currently discharges to the North Fork St. Lucie River	In progress	St. Lucie County
River Park Baffle Boxes	Provide enhanced stormwater discharge for 150 acre basin that drains to the North Fork St. Lucie River	In progress	St. Lucie County
Local Government Projects- - City of Stuart			
Frazier Creek Stormwater Retrofit	Multi-phase project for sediment removal, stormwater detention and retention facilities, exotic removal and habitat restoration.	Completed	City of Stuart
Poppleton Creek Basin Stormwater Retrofit and Restoration Project	Multi-purpose project involving sediment removal, a retention and flow through marsh, exotic removal and habitat restoration, additional land acquisition for native habitat preservation.	In progress	City of Stuart
Haney Creek Basin Stormwater Retrofit and Restoration Project	Multi-purpose project involving water quality treatment improve-ments for stormwater, a retention and flow through marsh, exotic removal and habitat restoration, additional land acquisition for native habitat preservation, passive recreation , and education.	In progress	City of Stuart
Kruger Creek Stormwater Retrofit	This project involved sediment removal, installation of baffle boxes at storm sewer outfalls to the SLE.	Completed	City of Stuart
The Pine Riverdale Stormwater retrofit	This project is in an older section of the City with limited options for stormwater treatment. Baffle boxes have been installed and a dry retention areas is under consideration.	In progress	City of Stuart
Fork Road Basin Stormwater Retrofit and Restoration Project	This project is located in an older developed area of the City and proposes using an existing remnant wetland for improved stormwater treatment.	In progress	City of Stuart
The Anchorage Basin Project	Multi-purpose project involving water quality treatment improve-ments for live aboard boats anchored in the SLE. It provides a controlled mooring area and requires visiting boaters to register and utilize sanitary pump out facilities. The project also involved construction of harbormaster residence, ship store, showers and other amenities for passive recreation and education.	Completed	City of Stuart
Local Government Projects- - Martin County			
Willoughby Creek Project	Combination sediment removal and stormwater improvement project. Approximately 40,000 cubic yards of material will be removed improving water quality and navigation.	In progress	Martin County
Palm Lake Stormwater Retrofit Project	A 125 acre project to improve flooding and water quality through improvement of swales and renovation of an existing retention pond.	In progress	Martin County
Old Palm City Stormwater Retrofit	A multi phase project that provides renovation of existing facilities and construction of new discharge and retention facilities. The project includes exotic removal and habitat restoration.	In progress	Martin County
Poinciana Gardens Stormwater Retrofit	A 188 acre project consisting of swale improvements new retention facilities and enhancement of wetlands.	In progress	Martin County
Martin County GIS	Geographic Information Systems (GIS) work to support a storm water management program	Completed	Martin County

Table 7-6. Pollutant Load Reduction – Stormwater Projects (Cont.)

Project Name	Description	Status	Lead Agency
Local Government Projects- - Martin County (Continued)			
Fishermans Cove Stormwater Retrofit	A multi-phase project to provide improved water quality treatment of stormwater and flood control relief to existing residential areas within the 2,075 acre watershed.	In progress	Martin County
Airport Ditch Project	A joint Martin County and City of Stuart project to provide improved water quality treatment of stormwater and flood control relief to existing residential areas within this heavily urban basin.	In progress	Martin County & City of Stuart
Coral Gardens Basin Water Quality Retrofit	Proposed water quality retrofit improvements include a 6.4 acre lake and a 3.2 acre STA designed to improve basin stormwater hydraulics and reduce sediment and nutrient loading to the S. Fork of the St. Lucie River and the SLE.	In progress	Martin County
Fern Creek Water Quality Retrofit/Wetland Diversion	Proposed water quality retrofit improvements, including a retention/detention area , wetland flow through marsh, creek protection, channel stabilization, and baffle box installation, to provide water quality treatment and a reduce flow to the SLE	In progress	Martin County
Rio Water Quality Retrofit	Improve stormwater treatment for a previously developed area that discharges directly to the SLE through an uncontrolled culvert, by providing increased retention in an existing pond, new facilities and a control weir.	In progress	Martin County
Palm City Farms Retrofit	Enhanced stormwater management and improve water quality in Bessey and Danforth Creeks by improving basin stormwater hydraulics and reducing sediment and nutrient loading to the S. Fork of the St. Lucie River and the SLE.	In progress	Martin County
Regional Projects			
Baffle Box Installation	Installation of baffle boxes as a stormwater BMP in the urban and coastal areas of Martin and St. Lucie counties.	Ongoing	Counties and cities in UEC
Know The Flow Program	This program provides the public with information on the hydrologic cycle, the function of primary and secondary water control systems. Emphasis is placed the design and operation these systems and the role that homeowner associations and individual residents must play in maintaining their stormwater systems for flood control and water quality benefits.	Continuing	SFWMD
Adopt A Drop Program – Pilot Projects started in 2001.	St. Lucie River Initiative program that gathers information on non-point source pollution from established residential neighborhoods and businesses, in order to identify potential improvements through voluntary changes and local government retrofit projects.	On-going	St. Lucie River Initiative
Florida Yards & Neighborhoods	Education and training for the public to identify water quality and water conservation improvements that can be made through voluntary changes in residential and commercial lawn and garden care.	Continuing	IFAS/ St. Lucie and Martin County Extension
2004 Upper East Coast Watershed Symposium	The symposium is intended to present the status of activities programs or projects in the watershed aimed at achieving water quality and environmental progress. Interested individuals and organizations may include farmers, private landowners, commercial businesses, watershed and environmental interest groups, engineers, academicians, community leaders, county/city planners, commissioners, recreational water users, and members of the general public.	In progress	SFWMD

Table 7-6. Pollutant Load Reduction – Stormwater Projects (Cont.)

Project Name	Description	Status	Lead Agency
Regional Projects (Cont.)			
Watershed Agricultural Best Management Practices (BMPs) Pilot Program	Cost sharing for initial projects to assist grower implementation of BMPs in citrus systems in SLE and IRL.	Ongoing	SFWMD
Indian River Citrus League BMP Implementation Committee	Administrative and technical support to the Committee responsible for evaluating the Indian River Citrus League's projects and progress in implementing voluntary citrus BMPs.	Continuing	SFWMD
Indian River Citrus League BMP Implementation Team	IFAS, IRREC technical field support team that works with growers to plan and implement validated citrus BMPs.	Continuing	IFAS & FDACS
Citrus BMP Research and Validation	Cooperative agreement with IFAS IRREC to support field and laboratory research and documentation necessary to validate BMP efficiency and effectiveness.	Continuing	SFWMD
Indian River Citrus BMP training for equipment operator and applicators	U of F, IFAS, and St. Lucie County Extension education and training in Martin, St. Lucie, and Okeechobee counties	Continuing	UF,IFAS Extension
Water Table Management BMP	Pilot project by IFAS, IRREC to evaluate effectiveness of water table management systems as a valid BMP.	In-progress	IFAS

Local Government Sponsored/Cooperative Projects

St. Lucie County The county has completed design plans for the Platt's Creek/Sunrise Boulevard Wetland Restoration Project, and the Indian River Estates/Savannas Ecosystem Stormwater Project. Both projects are large, and construction of facilities will take several years to implement (see Table 7-6, page 7-25 for more information). The Platt's Creek Project involves purchase, decommissioning, and eventual restoration of approximately 102 acres of existing citrus groves adjacent to the North Fork of the St. Lucie River. Indian River Estates (IRE) is a 1,200 acre subdivision developed in the 1950's adjacent to the Savannas State Reserve, a 4,900 acre environmental area managed by Florida Department of Environmental Protection (FDEP). IRE is a major contributing drainage area to the Savannas Reserve.

Savannah State Preserve

The City of Stuart (City) has developed an ambitious schedule of projects and has been very successful in acquiring funding from different sources to accomplish them. The City has installed 21 baffle boxes throughout the City and has purchased a cleanout vacuum truck for maintenance. The City has integrated their stormwater retrofit projects into a comprehensive long range planning effort. The total budget for these projects exceeds $13 million.

Vacuum Truck for Baffle Box Cleanout/Maintenance

The City's initial efforts were the East Stuart Infrastructure Improvements began in 1993 with the reconstruction and expansion of major stormwater retention areas and sediment cleanup of the upper reaches of Frazier Creek. A weir and a retention pond were installed to treat drainage

Frazier Creek Stormwater Retrofit

from a large portion of the City's older developed area. Exotic removal and habitat restoration needs were evaluated and also incorporated into this project by the City. More recently, additional improvements have been completed that include expansion of the original pond by 1.8 acres to create a retention lake, and exotic and muck removal from the lower portion of the creek to its confluence with the SLE.

The City revised its approach to water quality planning to the watershed basis, because each basin offers unique opportunities. The City has not conducted extensive water quality sampling in each basin, but has elected to implement the most cost-effective and documented Best Management Practices suitable to the individual characteristics of each basin. Additional projects are underway by the City of Stuart within the Poppleton Creek, Haney Creek, Anchorage, Krueger Creek and Fork Road basins. The Pine Riverdale Retrofit proposes construction of a dry retention area over existing vacant property in an older platted subdivision within the City. The Airport Ditch Project began in 1993 as a joint City/County drainage project to remedy flooding in an existing residential area, and evolved into a complete water quality retrofit of a very large urban basin.

Anchorage Basin – City of Stuart

Martin County has also been very proactive in implementing large and small stormwater projects. Projects such as Willoughby Creek Improvement involves removing a minimum of 40,000 cubic yards of muck sediments to provide improved water quality and navigation. Dredged material will be used to build noise abatement structures at Witham Field. A smaller but very important project is the Palm Lake Park Stormwater Retrofit. This 125-acre project is located in the Palm Lake Park subdivision in the north Stuart area. The retrofit is designed to improve water quality and reduce chronic flooding in this older development through the improvement of swales and renovation of the existing retention pond.

Additional projects in Martin County include Old Palm City, 30th Street Stormwater improvements, Phase I, the Poinciana Gardens Stormwater Retrofit Project, and the Fisherman's Cove Drainage Study.

Regional Projects

Best Management Practices (BMPs). As outlined in the Florida Watershed Restoration Act (1999), Florida agriculture is encouraged to develop effective voluntary BMPs to help meet state water quality goals. The efforts of the Indian River Citrus BMP Implementation Committee, a collaborative public/private group, to guide the process for voluntary implementation of citrus BMPs in the watershed were discussed previously in Chapter 6. Additional information can be obtained from the following website:

http://www.irrec.ifas.ufl.edu/Bomanpdf/BMP%20Implementation%20-%20Annual%20Report.pdf

Other examples of voluntary BMP implementation are the recently sponsored "Canal Watch" program that will combine periodic monitoring and citizen reporting at sites throughout the watershed. For additional details see http://www.irrec.ifas.ufl.edu/.In the urban areas of the watershed, a new program called "Adopt a Drop" is being piloted by the St. Lucie River Initiative (The Initiative) Figure 7-15. This program focuses on gathering site specific information by engineers on non-point source pollution to the SLE & River, for residential neighborhoods and businesses. The information is then analyzed and mapped to provide analysis and potential improvements to homeowners and businesses with respect to non-point source impacts.

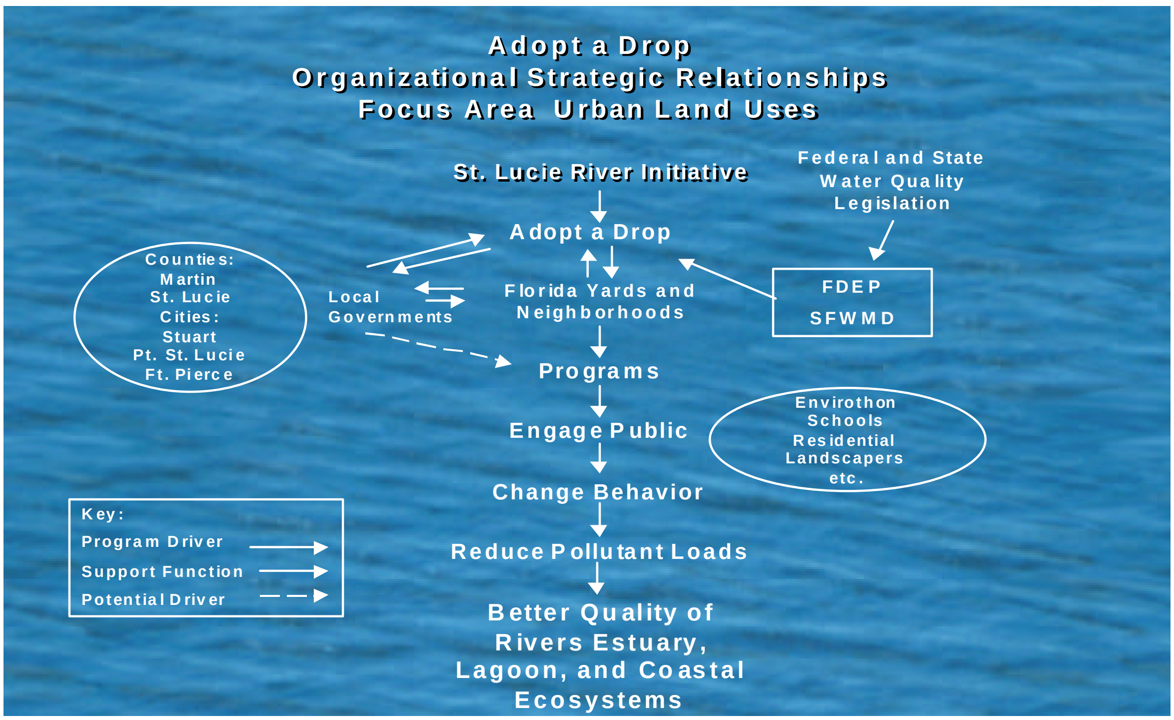


Figure 7-15.-- Adopt a Drop

This information can then be utilized by residents, homeowner associations, for immediate changes in cooperation with the IFAS, Florida Yards and Neighborhood (FYN) program. Local governments can utilize the information to develop plans and implement retrofit stormwater improvements. The FYN program is the primary cooperator in the implementation of this program. Additional support has been provided by SFWMD, FDEP, and the some local governments. This innovative program has been endorsed by the City of Stuart, Martin and St. Lucie Counties. Several neighborhoods have been enrolled in the pilot phase of the project.

The Initiative plans to evaluate the results of these early efforts, make changes as necessary, and then fully implement the program throughout the watershed.

Water quality improvements in the older urbanized portion of the watershed are extremely important since much of this area is directly adjacent to the SLE and River. Plans by local governments to implement stormwater retrofits, and elimination of widespread septic tank utilization will have a positive impact on water quality. However, providing the residents and businesses in this area with information about local hydrology and stormwater systems, and encouraging voluntary implementation of best management practices will continue to be a necessity, as population growth continues to impact this portion of the watershed.

Muck. Projects related to this issue are listed in Table 7.7 The general sedimentation pattern is one where coarse sand accumulates at areas of higher current velocity, with increasingly fine sediments deposited as currents decline. The areas of greatest muck sediment deposition are where the narrow areas of the North and South Forks widen, and where the Middle Estuary widens east of the Roosevelt Bridge. This SLE “ooze” is troublesome because it is unconsolidated and is easily re-suspended by wind or boat traffic. In a suspended state, it blocks light penetration adversely affecting seagrasses. It also smothers oyster and other benthic habitat, and is aesthetically very displeasing. Remediation or removal of muck and sediments is required to restore the health of the St. Lucie Estuary.

Excellent maps of muck sediments are found in Haunert (1988). Muck sediment accumulations during this century average 2-3 feet in most of the Estuary that is deeper than 6 feet. However, some local areas, such as the mouth of Poppleton Creek, now average only 3 feet deep, and are essentially choked with deep muck deposits (Henderson 2001). In September 2000, the United Army Corps of Engineers (USACOE) performed a muck survey in the SLE.

Table 7-7. Pollutant Load Reduction - Non-Point Sources–Muck Projects

Project Name	Description	Status	Lead Agency
USACOE Muck Survey	In support of the IRL Feasibility Study four areas in SLE were surveyed and mapped for potential muck removal. A total of 79 transects were established. Analysis of the data collected resulted in an estimate of 5,514,563 cubic yards of material. This is action is proposed as a remediation and habitat restoration element in the recommended plan.	Complete	USACOE
SLE Beneficial Reuse of Marine Muck	This project was a contract to IFAS, IRREC to provide information on the origin and chemical makeup of SLE muck/ooze and its potential for use as an agricultural soil amendment.	Complete	SFWMD
St. Lucie River Initiative / SFWMD Muck Removal Pilot Project	This joint project consists of dredging 1500 cubic yards of muck out of the South Fork of the St. Lucie River and barging it upstream for land disposal. A series of experiments will be performed by IFAS to determine potential utilization and disposal techniques for the material.	In progress	St. Lucie River Initiative & SFWMD

A variety of sediment/muck removal projects have been completed, or are under way, or are planned in the SLE Watershed. Muck removal is also planned as a part of the IRL South Feasibility Study. Four areas were identified in the Estuary where muck remediation was believed to be most advantageous: two in the North Fork, one in the South Fork, and one in the Mid-Estuary. The total muck volume in these four areas was estimated as 5.5 Million cubic yards, and the cost for muck remediation and habitat restoration was estimated as $105.5 Million. Muck remediation and habitat restoration as proposed in the IRL – South Plan will not occur until 2008 or later.

The St Lucie River Initiative (The Initiative) in cooperation with the SFWMD, IFAS, and others, has been actively pursuing better data on the characteristics, sources, and potential uses for SLE ooze, in anticipation of eventual removal as outlined in the CERP IRL South Plan. IFAS has recently completed a literature review, and field sampling and analysis of this material (He *et. al.* 2001). Based on the need for further information as to potential technologies for removal and disposition of muck, prior to the large scale restoration project envisioned in the CERP IRL – South Plan, a pilot study is currently underway. Dredging of approximately 1500 cubic yards of muck out of the South Fork of the St. Lucie River is underway and will occur in the summer of 2002. The muck will be transported inland and tested for use as pasture amendments and native land restoration materials. The project should be completed in 2004.

Septic Tanks. Pollutant loads from on-site disposal systems (OSDS), a.k.a. "septic tanks," or from inflows of groundwater contaminated by OSDS are considered by many to pose a potential threat to water quality in certain areas with close proximity to the lagoon and its tributaries. Projects that address this issue are summarized in Table 7-8. Conclusive evidence is not yet available, but results from ongoing groundwater monitoring studies being done by the SFWMD will soon provide data on both quantity and quality of water entering the estuary and Lagoon. These studies may provide additional insight into the potential impacts of septic tanks. Progress is also being made by local governments to identify priority areas, develop plans and obtain funding to convert OSDS to central sewer systems within the SIRL/SLE watershed.

One of the most ambitious efforts to reduce the impacts of septic tank systems on the SLE and River has been undertaken by the City of Port St. Lucie. The City has significant development and large drainage areas that are adjacent to the North Fork of the St. Lucie River. Although it may take another 3 or 4 years to finish construction, when completed about 95 % of the City's lots will have access to water and sewer infrastructure.

Table 7-8. Pollutant Load Reduction - Non-Point Sources–Septic Tank Projects

Project Name	Description	Status	Lead Agency
City of Port St. Lucie	This project will provide about 95% of the City with water and sewer service. Approximately 75% of the project has been completed to date.	In progress	City of Port St. Lucie
Martin County	The County has a formal Septic Elimination program and has evaluated feasibility of providing sewer service to 7,500 existing homes within the watershed. If a majority of residents request such a project and are willing to assume the hookup costs, the County will initiate planning and development for future infrastructure improvements.	In progress	Martin County
St. Lucie County	The County will evaluate the feasibility of providing sewer service to existing neighborhoods if a majority of the residents request such a project. The costs to residents often preclude initiation and development of widespread infrastructure improvements.	Case by case evaluation.	St. Lucie County

Extensive portions of Martin and St. Lucie Counties are served by individual septic systems. While both counties have acknowledged the need to decrease the use of septic tanks in environmentally sensitive areas, progress has been difficult. The septic systems of some neighborhoods along the SLE and the SIRL have been identified by county and state agencies as potential threats to water quality.

City of Port St. Lucie Aerial Photograph

The main impediment to discontinuing reliance on septic tanks is the costs. Martin County estimated it would cost about $82 million to provide sewer service to 7,500 homes in 13 riverfront neighborhoods currently served by septic systems. Martin County has a formal Septic Tank Elimination Program covering over 8,500 homes and discussions are underway concerning how best to make the transition in several subdivisions and older residential areas. Generally speaking counties have identified areas of greatest need, but without consensus from area residents and businesses, rapid progress is unlikely

Total Maximum Daily Loads (TMDLs). Portions of the St. Lucie River were placed on the FDEP Impaired Water Body List in 1998. Passage of the 1999 Watershed Restoration Act, has provided significant non-point source pollution abatement policy as well as establishing specific guidance and requirements for agencies and impacted stakeholders relative to both Pollution Load Reduction Goals (PLRGs) and TMDLs. Additional information of these processes and their relationships to IRL SWIM planning and projects was described in Chapter 6, Figure 6-8.

Monitoring, Modeling and Applied Studies

Information concerning the status and sponsors of monitoring, modeling and applied studies projects is summarized in Table 7-9.

Monitoring

In addition to the previously described existing monitoring networks, current plans are for a limited number of sites where large scale additional monitoring will be undertaken over the next several years. The North Fork of the St. Lucie River will be a primary area of focus of these efforts, based on the need to document the effectiveness and impacts of the Ten Mile Creek Critical Restoration Project, and the North Fork Floodplain Restoration Project and future CERP components. In addition, the adoption of Minimum Flows and Levels (MFLs) for the North and South Forks will identify future monitoring requirements. The continuing data requirements to develop PLRGs, and the need to characterize the impacts of BMP implementation, where possible, may also increase the need for monitoring. As a first step toward establishing pollution load reduction goals, it is necessary to quantify the relationship between external inputs to the estuary and water quality in the estuary.

Table 7-9. Monitoring, Modeling, and Applied Studies Projects

Project Name	Description	Status	Lead Agency
Monitoring Studies			
North Fork Nursery Study	Obtain physical, chemical and biological data from oligohaline areas of the North Fork, before and after Ten Mile Creek facilities are built, to support water quality models and define tem-poral and spatial relationships among flow and estuary flora and fauna.	In progress	SFWMD
Joint Pilot Projects - North Fork Floodplain Restoration Monitoring	SFWMD and FDEP project to monitor water quality and hydrol-ogy and conduct field surveys to test methods and define effects projects to reconnect areas of the floodplain to the North Fork.	In progress	SFWMD & FDEP @ PSL
Minimum Flows & Levels (MFL) Impact Assessment	Continue water quality monitoring and evaluation of future data to better define effects of MFLs on biota in the oligohaline zone.	In progress	SFWMD
St. Lucie River Watershed Assessment	Assessments of the C-25, C-23, C-44, and Tidal St. Lucie basins, and Basins 1, 4, 5, and 6	Complete	SFWMD
Citrus Herbicide and BMPs - Determine quality of off site discharges	Determine effect of groundcover management on loss of herbi-cides to irrigation and drainage ditches in two grove systems.	In progress	IFAS
Agrochemical and nutrient loadings in runoff from golf, urban, pasture water quality	Quantify nutrient and metal loadings from urban areas, golf courses, and pastures. Identify sites where pesticides in runoff may be a problem.	In progress	IFAS
NRCS Co-Op Study	Monitoring Floridan water use in cooperation with the Natural Resources Conservation Survey (NRCS)	Continuing	NRCS
Modeling Studies			
Watershed Water Quality Model Development	Currently in development, anticipated completion date for the development phase is 2002.	In progress	SFWMD
Estuary Water Quality Model Development	Currently in development anticipated completion date for the development phase is 2003.	In progress	SFWMD
Applied Studies			
BMPs for Citrus and Vegetable Crops to Improve Surface Water Quality	Demonstrate the effectiveness and desirability of applying newly developed best management practices for citrus and vegetable production system in the IRL/SLE Watershed	In progress	IFAS
Oyster Restoration Experiments – GLML.	Conduct experiments at the Gumbo Limbo Mesocosm Laboratory to evaluate oyster reproduction and environmental tolerance for various levels of salinity, temperature and disease.	In progress	SFWMD
In-situ Oyster Restoration Substrate Experiments	Field experiments to test the effectiveness of various artificial substrate materials to enhance oyster reproduction and growth.	In progress	SFWMD
Seagrass Restoration Experiments - GLML	Continue seagrass salinity experiments at Gumbo Limbo Meso-cosm Laboratory to focus on restoration parameters for the SLE.	In progress	SFWMD
Enhanced use of Citrus Pesticide BMPs in St. Lucie Estuary Watershed	Cooperative agreement with IFAS, IRREC to assess precision spray application to improve pesticide spray practices, reduce environmental contamination and sustain or improve efficacy.	In progress	SFWMD & IFAS
BMPs for citrus and vegetable crops to evaluate nutrient and metal loading	Characterization of nitrogen, phosphorus, and heavy metals in surface water runoff from citrus groves and vegetable fields in the IRL/SLE Watershed	In progress	IFAS
Environmental Toxicity in St. Lucie Estuary/Indian River Lagoon	NOAA study of adverse biological effects associated with chemical contamination	In progress	NOAA
Sediment Control BMP Evaluations for Indian River Citrus	Determine the effectiveness of water furrow sediment traps for reducing phosphorus and copper losses in runoff. Compare the amount of sediments released from grove ditches where water levels are controlled by screw gates and riser boards	In progress	IFAS
Upper East Coast (UEC) Water Supply Plan 1998	Establish a basis for future water use decisions to provide water supply for urban areas, agriculture, and the environment.	Complete	SFWMD

Some information on nutrient loading in the estuary exists based on water quality data collected by the District and other agencies. However, there are virtually no data that quantify the effects of nutrient load reductions on nutrient concentrations in the estuary. While the District has identified several components that are necessary to produce these estimates of load reduction goals, ultimately, computational models (under development by the District) will be required to predict estuarine water quality parameters as a function of external inputs, internal hydrodynamics and relevant processes and transformations occurring within the estuary. The calibration and verification requirements of two new models, the Watershed Water Quality Model (WaSh) and the Estuary Water Quality Model may require additional short term monitoring projects.

Finally, in addition to future requirements for monitoring that may arise as a result of implementing the CERP IRL – South Plan, there are on-going restoration and environmental enhancement studies, i.e., oysters, SAV, fisheries, nutrients, and fresh water inflows that will necessitate additional monitoring activity. The requirements for increased monitoring that may result from the TMDL process, such as designation of portions of the SLE & River as impaired waters on the FDEP planning list, cannot be evaluated at this time.

Modeling

Under the SWIM Program the SFWMD is mandated to develop Pollution Load Reduction Goals (PLRGs). Development and application of computer models is a critical step in accomplishing this goal. In order to evaluate the effectiveness of pollutant reduction strategies, the modeling efforts will include predicting estuarine water quality parameters as a function of external inputs, internal hydrodynamics, relevant processes, and transformations occurring within the estuary. The reliability of a receiving water model depends on the accuracy of freshwater input data. A receiving water modeling project can not succeed without dependable watershed input.

Hydrodynamic Estuary Model

Hydrodynamic modeling has been the primary tool used to understand changes within the South IRL and SLE. Modeling has been used to develop salinity-flow relationships under stable conditions and to study salinity shock within the estuary under storm-event conditions. The 2-D salinity model was developed by the SFWMD, based on combining features of two versions (RMA-2 and RMA-4) on a model that was originally developed for the Army Corps of Engineers by a consultant, Research Management Associates, Inc. The SFWMD hydrodynamic/salinity model covers the entire St. Lucie Estuary and a portion of Indian River Lagoon. See Chapter 6 for further discussion of this model. Model outputs have provided scientific support to the CERP – IRL–South Plan and system operations. The model was also adapted and extended to predict present and future salinity conditions for the St. Lucie River and Estuary MFL study.

Drainage canal discharge has a major impact on the salinity condition in the estuary. The estuary model was applied to various freshwater inflow conditions to establish a relationship between the magnitude of freshwater inflow and the estuarine salinity condition. The freshwater inflow included both surface and subsurface (groundwater) input to the estuary. Figure 7-16 is a mosaic of six salinity contour maps that show the trend of salinity declining when fresh water inflow increases. The Waterways Experiment Station (WES) of the United States Army Corps of Engineers (USACOE) is converting the existing St. Lucie hydrodynamics/salinity model to a three dimensional version that will be able to simulate salinity and temperature stratification and the formation and movement of a salt wedge. WES is also extending the model to cover the Indian River Lagoon between Fort Pierce Inlet and Jupiter Inlet (including Loxahatchee River).

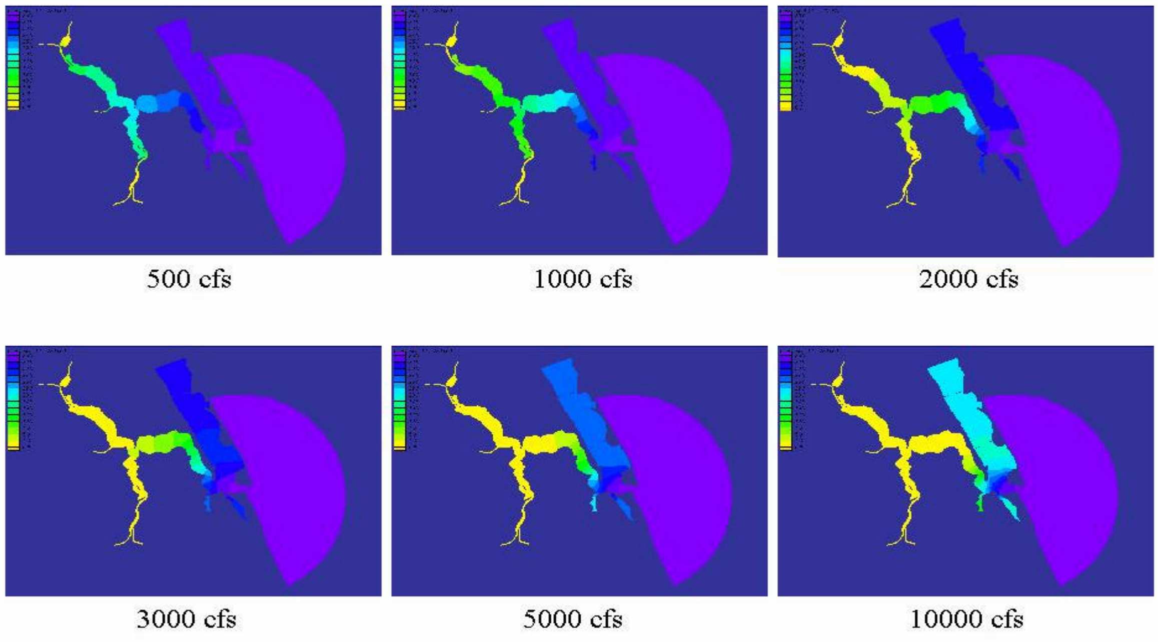


Figure 7-16. Sample output from the St. Lucie hydrodynamics/salinity model used to assess the effects of canal discharges on salinity gradients in the estuary.

Watershed Hydrology, Reservoir Optimization and Oyster Stress Models

Restoration of the SLE/IRL ecosystem is a major component of the Comprehensive Everglades Restoration Plan (CERP). During the restoration plan formulation, an integrated modeling approach was employed to establish the hydrologic restoration target and to refine the restoration alternatives. The plan focuses on hydrologic restoration to the pre-drained or natural hydrologic characteristics in the watershed to aid the recovery and protection of salinity sensitive biota in the estuary. To achieve this goal, a suite of models dealing with watershed hydrology, reservoir optimization, estuary salinity and oyster stress was applied. Results from the Natural Systems Model (NSM), which simulates the hydrologic response of the pre-drained watershed to recent climatic conditions, were used as the basis to establish the hydrologic restoration target, size reservoirs, and justify flow transfers between basins within the watershed. The Hydrologic Simulation Program - Fortran (HSPF) was used to simulate the hydrology of the present and future conditions. A genetic algorithm based optimization model (OPTI), coupled with HSPF, was used to size the storage reservoirs and generate operational rules that govern water release to the SLE. Finally, an estuary salinity model and an oyster stress model were used to develop a numerical performance measure to evaluate the effectiveness of the project on estuarine ecosystem restoration.

As noted, HSPF was applied to the South IRL watershed and SLE watershed for long-term hydrological simulations (from 1965 to 1995). The modeling characterizes the basins as combination of six land uses including irrigated agriculture (primarily citrus), non-irrigated pasture, forest, wetland, urban lands having an impervious surface, and urban lands have a pervious surface. The land-uses were based on GIS land-use coverages for the areas. Nine separate HSPF models were developed for each of the large SFWMD drainage basins including South Fork, North Fork, C-44, S-153, C-23, C-24, C-25, and Basin 1, as well as the three small drainage basins (Basins 4, 5, & 6) which were combined into a single model. Stream hydraulics was simulated for the primary canals in the basins and the hydraulic characteristics of the primary canal structures were simulated. Where possible, the HSPF models were calibrated against reliable flow and stream stage data. The models for C-23, C-24, C-25, and C-44 were calibrated. The calibrated model parameters from these basins were then applied to the non-calibrated basins of S-153, South Fork, North Fork, Basin 1 and Basins 4, 5, and 6 where no SFWMD water control structures are available. The uncontrollable portion of the SLE watershed comprises 128,000 acres or 26% of the entire 500,000-acre St Lucie watershed. In addition, the open water portion of the estuary has 5,900 acres that receive direct rainfall and evaporation.

Using HSPF, the SFWMD estimated the future (in the year of 2050) conditions with the consideration that there will be substantial increases in urban lands and a decrease in wetlands, forest and pasture areas.

The hydrology of the pre-developed SLE watershed was simulated using the SFWMD's Natural Systems Model (NSM). The NSM-SLE model is a relatively course (2 mile by 2 mile cells) finite element model that simulates all elements of the hydrologic cycle including groundwater flow and overland flow. The model uses the same rainfall and potential evapotranspiration data as the HSPF model. Watershed boundaries are different, with NSM-SLE boundaries being based only on topography. The NSM-SLE modeling results were used to size reservoirs, justify diversions and irrigation supplies, and establish minimum flows for SLE restoration. For example, the NSM-SLE model showed low flow rates entering the estuary during dry periods, implying that the estuary did not require flow augmentation during dry periods and, consequently, that irrigation demands were not competing with environmental demands from the estuary. The NSM-SLE model outputs were also used to drive hydrodynamic salinity models and oyster growth models.

Watershed Water Quality Model

The SFWMD initiated another model development project in 1999 in order to model watershed water quality. The URS Corporation developed a watershed hydrology and water quality model (WaSh) for use in areas that have dense drainage canal systems, high water tables, and multiple irrigation sources. The model has a cell-based representation of watershed surface where hydrology and water qualities are modeled with Hydrologic Systems Program Fortran (HSPF). The infiltrated water is routed to a groundwater model that represents the surficial aquifer. Runoff is routed to a drainage system model that has the capacity to simulate bi-directional flow, branches, and common flow structures. An Arcview Graphic User Interface (GUI) was developed to facilitate BMP implementation, land use changes, reservoir and stormwater treatment system operations that are key watershed management strategies in South Florida. The new model will be evaluated in the C-24 and North Fork basins before the end of 2002. The ultimate goal of this effort is to develop watershed management strategies to achieve PLRGs for the watershed.

Applied Studies.

The South Florida Water Management District (SFWMD) has developed a comprehensive estuary research plan based on current ongoing activities and the identification of future information requirements.

Role and Importance of Oysters as a Valued Ecosystem Component

Studies indicate that the Middle Estuary contains the majority of the oyster resources in the St. Lucie Estuary. An analysis of inflows for 31 years (1965 to 1995) were modeled, daily salinity resulting from these flows for the middle estuary (Hu, 2001) indicated that existing water management practices frequently caused stress and lethal low salinity conditions for the SLE oyster population. The physiological response of oysters to salinity and season was estimated by using literature values. Additional analysis revealed that pre-drainage, natural watershed inflows would significantly reduce the occurrence of stress and death of oysters and, therefore, promote the existence of a healthy oyster population if suitable substrate is available (Haunert and Konyha 2000).

To date, restoration efforts for oysters in the SLE have been limited to reducing the frequency and duration of Lake Okeechobee inflows by changing floodwater management of the Lake. CERP will retrofit the hydrology of the SLE watershed to emulate natural inflow characteristics, improve water quality and virtually eliminate floodwater releases from the Lake to the estuary. Monitoring of health and utilization of oyster reefs is a measure of successful restoration. Since limited scientific information was available for this estuary it is important to acquire a better understanding of endemic oyster life history, salinity tolerances, and test technologies for the development of oyster reefs. A program to address the life history, salinity tolerance, health, and restoration techniques for the SLE oyster began in April 2000. Sampling sites within existing oyster reefs were selected in the North and South Forks as well as the Middle Estuary to provide information on water quality, gonad development, and recruitment of spat and presence of diseases (dermo). According to Creswell and Vaughan (1990), oysters spawn several times a year in Florida. Spawning begins in early spring (February to March) as water temperatures increase and continue through early summer and spawn again in the fall (September and October). Monitoring in the SLE showed major annual recruitment of spat began in April and peaked in May 2001. Since planktonic larval development usually takes about two or three weeks before metamorphosis to a spat (Kennedy. Chap 10, p372), spawning most likely began in early March and peaked in April, 2001.

Salinity in the SLE can decrease quickly at the oyster reefs from watershed runoff. It is critical that a thorough understanding is developed concerning the quantity of runoff, salinity at the oyster reefs and the response of the oysters to the salinity. Although considerable general information is available on the tolerance of oysters to salinity (URS Greiner Woodward Clyde, 1999), limited data exist on the relationship among salinity, temperature, duration and condition of this species. Laboratory studies at Gumbo-Limbo Research Facilities in Boca Raton, began in 2002 to determine this relationship using endemic oysters. Once a relationship is established, watershed runoff can be better managed to consider oyster salinity tolerances.

In order for spat recruitment to be successful, the appropriate substrate (cultch) must be available. Various substances have been used in oyster restoration programs with success including oyster shell and limestone rock. The cultch should be free of silt; however, a surface bacteria population is desirable. Since the major annual spat recruitment occurs in the SLE during April and May, pilot cultch reefs with various dimensions will be placed in the SLE in 2002. The pilot reefs will be placed in the middle estuary where salinity fluctuations are attenuated, near exiting reefs, where current velocity is favorable, and at a depth of about 1m below mean low water. These reefs will be kept silt free and will be monitored for recruitment of spat, species utilization and succession. Results from all these efforts will help define large-scale restoration once watershed flows can be managed appropriately.

Role and Importance of Submerged Aquatic Vegetation as a Valued Ecosystem Component

The 1997 SAV survey conducted by URS Greiner Woodward Clyde revealed very little SAV in the SLE. The SAV found during the survey was so sparse that only point locations (not beds) could be mapped. Very sparse distributions of SAV (primarily shoal grass) were present in the lower estuary. No SAV was documented in the middle estuary or North Fork. And only small patches of SAV were found in the South Fork (near the mouth of Danforth Creek). Probably the greatest limitation to SAV beds in the St. Lucie Estuary is the light available for photosynthesis. If light attenuation is not improved through CERP and other on-going restoration efforts, then the establishment of SAV in the St. Lucie Estuary will be limited. Current efforts are limited to periodic monitoring of the health and distribution of SAV.

Primary Production and Benthic Nutrient Flux.

This research quantifies internal nutrient loading from bottom sediments and determines the role this loading plays in supporting the production of organic matter in the system. The SFWMD has monitored water quality in the SLE for over a decade. While it is clear that the estuary exhibits the classic signs of eutrophication (large algal blooms and hypoxic and anoxic events), little is known about the nutrient loading from internal or external sources that may be the ultimate cause of these problems. This 3-year project addresses internal nutrient and oxygen cycling processes within the estuary and focuses on the production and respiration of organic matter by planktonic communities in the water column and bottom communities in the sediments. Internal loading of nutrients by bottom communities is also addressed.

It is critical to establish the link between material loading and water quality prior to, during, and following the hydrological modifications implemented during CERP. The results of this study help establish the current relationship between freshwater discharge and the dynamics of oxygen and nutrients in the St. Lucie Estuary. A before and after comparison allows researchers and planners to evaluate effects of modifications implemented during the restudy.

The project includes *in situ* measurement of planktonic productivity and respiration at four stations in the St. Lucie Estuary. At each station, vertical profiles of production and respiration of oxygen (light-dark bottle method) are obtained. Pertinent environmental data, such as salinity, temperature, photosynthetically active radiation (PAR), nutrient concentrations, chlorophyll *a* and the N and P content of suspended particulate matter are also obtained. Measurements were made on a monthly basis. Construction of production versus irradiance curves furnishes information about the physiological status of phytoplankton populations and the potential for light limitation.

At these same four stations, the exchange of plant nutrients and dissolved oxygen between bottom sediments and the overlying water column was measured using *in situ* chambers. Gas and nutrient fluxes will be measured monthly. Results of these measurements will allow investigators to determine the amount of phytoplankton production that is sustained by nutrients supplied by bottom sediments.

In addition, more intensive studies are conducted during two 8-week periods: one in the dry season and one in the wet season. Sampling of productivity and benthic flux is sampled at two stations on a weekly basis. These studies in concert with other projects addressing external loads furnish a more complete picture of nutrient cycling in the St. Lucie Estuary, and assist in water quality modeling and establishing PLRG s.

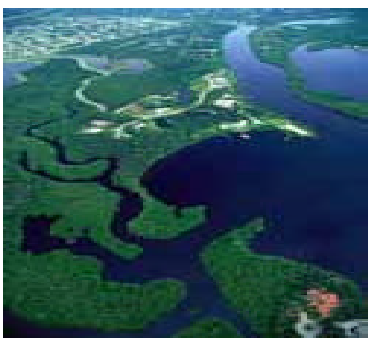
Preliminary analysis of the data collected during the productivity-benthic flux study provides some useful conclusions about nutrient cycling in the St. Lucie Estuary. This study clearly demonstrates the importance of the flux of nutrients from bottom sediments to the overlying water. First, the forms of nitrogen and phosphorus released from bottom sediments are readily available to primary producers in the overlying water. The primary productivity of plankton in the overlying water is limited by the supply of nitrogen and sediments in the St. Lucie are nitrogen rich. Secondly, the fluxes of these nutrients to the overlying water are high relative to other estuaries and high enough to support the rates of productivity observed during the study. The results to date suggest that nutrient management strategies need to focus on nitrogen and account for the large internal source from bottom sediments.

While evidence from water quality monitoring suggests that nitrogen is the nutrient that limits primary production, experimental data is required. Therefore, a nutrient addition bioassay, that examines the response of phytoplankton to nutrient additions (nitrogen and phosphorus) should be conducted. Sediments are clearly a major source of recycled nutrient. The response of the estuary to reductions in external loads depends on the magnitude and longevity of the sedimentary source. Mesocosm experiments or laboratory experiments with cores should be designed to address this question.

Minimum Flows and Levels

Minimum flows (MFLs) for the North Fork (21 cfs) and South Fork (7 cfs) St. Lucie Rivers and the Estuary were established during 2002, based on maintaining a sufficient area of low salinity (oligohaline) habitat to prevent significant harm from occurring to this resource. While the MFL is based on 'best available information', there are easily identifiable deficiencies. Foremost among these are: (1) a need for an enhanced modeling capability in the upper, low salinity zones of the estuary; and, (2) better flow and salinity data for the rivers and estuary, and (3) better biological data for the rivers and estuaries, including seasonal use of the oligohaline zone and salinity needs of benthic, planktonic and nectonic species and communities.

North Fork of St. Lucie River.



North Fork St. Lucie River

A significant portion of the floodplain of the North Fork St. Lucie River is completely or partially isolated from the river's main branch because of dredging conducted during the 1920s through the 1940s. FEDP Projects are underway to determine the effectiveness of various restoration strategies and techniques. The North Fork Reconnection Pilot Study is nearly completed. Three breaches were installed in June, 2002 at a 25-acre island and fish and vegetation monitoring will continue. The North Fork Oxbow Reconnection and Feasibility Study has yet to begin. During the next year, a contractor will analyze the feasibility of the complete restoration of the North Fork and also reconnecting one oxbow endpoint. The feasibility plan will encompass topography, hydrology, and natural community elements. Proposed restoration plans include spoil bank breaching with creeks or culverts, oxbow reconnections, and oxbow creation in the Five and Ten Mile Creeks

http://www.sfwmd.gov/org/wrp/wrp_ce/projects/oxbow.html
http://www.dep.state.fl.us/coastal/sites/indianriver/

The North Fork Nursery Study is designed to obtain physical, chemical and biological information in the oligohaline portion of the North Fork, before and after the Ten Mile creek attenuation facilities are constructed in the drainage basin. This information will be used for a water quality model and to define the temporal and spatial relationships among flow and estuarine flora and fauna. The synthesis and interpretation of the information obtained from this study will also support the development of water management recommendations for refining MFL criteria and operational guidelines for controlled releases from CERP facilities and wetlands. http://www.sfwmd.gov/org/wrp/wrp_ce/projects/n_fork_nursery.html

Land Acquisition and Habitat Restoration

These projects are summarized in Table 7-10.

Table 7-10. Land Acquisition and Habitat Restoration Projects

Project Name	Description	Status	Lead Agency
Indian River Lagoon License Plate Program	Proceeds from the sale of the Indian River Lagoon plate are used to restore habitat and water quality through reconnection of historic floodplain, shoreline stabilization, mangrove restoration, stormwater treatment projects, and environmental education.	Continuing	SFWMD
North Fork, St. Lucie River Aquatic Preserve and Buffer Preserve.	Restoration of approximately 3,000 acres on the North Fork is proposed. To date, 1600 acres have been purchased. The major emphasis has centered on the St. Lucie River Aquatic Preserve and the adjacent Buffer Preserve. Most of these properties are being managed by FDEP collectively to promote native species and natural community function.	In progress	FDEP, SFWMD, Counties, City, NGOs
Atlantic Ridge	Acquisition of over 6,000 acres in the headwaters of the South Fork of the St. Lucie River through cooperative funding from State, SFWMD, and Martin County.	Completed	SFWMD
Allapattah Ranch – Phase 1.	Acquisition of 13,186 acres in the C-44 Basin through cooperative funding from State, SFWMD, and Martin County. Future use will be for natural storage and water quality treatment area	Completed	SFWMD

North Fork St. Lucie River

Restoration of 2,984 acres along the North Fork St. Lucie River (NFSLR) is proposed. 1,600 acres were purchased and are managed by local, state, and regional agencies. Appraisals have been ordered on remaining parcels. Since 1994, the Conservation and Recreation Lands Program, the SFWMD Save Our River's Program, Florida Communities Trust, and St. Lucie County's Environmental Lands program have spent about $7 million on lands acquisition along the NFSLR and over $1 million on removal of exotic plants. Public management and restoration will benefit existing public lands, eliminate an existing ornamental nursery and exotic plants, control access including prohibiting motor boats to protect and restore wetland functions that are needed to support the river and downstream estuaries.

The Oxbow EcoCenter is a St. Lucie County Environmental Learning Center. The preserve at the Oxbow is a living laboratory, offering year-round 'in-the-field' opportunities to youth groups, adults, and families on a variety of nature related subjects. Through partnership between St. Lucie County and the South Florida Water Management District, a 220-acre tract on the NFSLR was purchased using Environmentally Significant Lands and Save Our Rivers funds. The land is managed by St. Lucie County to sustain native wildlife, utilizing boardwalks, trails, bridges, and observation towers that allow visitors to fully experience the river and adjacent uplands.

In November, 1994, 67% of St. Lucie County voters approved a bond referendum authorizing issuance of ad valorem tax bonds, not to exceed $20 million, to participate in state and federal land acquisition programs targeting the protection of natural areas. On December 7, 1995, Spruce Bluff, a 97-acre site along the North Fork was the first site acquired through this program. Since that time almost 600 acres have been acquired by St. Lucie County for recreation and preservation along the St. Lucie River. The County has adopted a greenway and blueway plan to guide future land acquisitions. (see also http://www.stlucieco.gov/esl/)

Lands for Healthy Rivers

In Martin County, a three-year sales tax was enacted after voters approved the Lands for Healthy Rivers and Natural Resource Protection in November 3, 1998. Half the money is for buying lands to restore the St. Lucie River and Indian River Lagoon through the Comprehensive Everglades Restoration Plan (CERP). The other half of the money is for buying lands for natural resource protection identified by the State's Florida Forever program. The three-year income from this tax totals $47.2 million, $9.2 million more than originally forecast. Over 3,100 acres acquired in the Atlantic Ridge Coastal Ecosystem property using the one-cent tax (Figure 7-17). Over 6,000 acres of the Atlantic Ridge is now in public ownership. Martin County invested $6.5 million in the Atlantic Ridge CARL purchases. (see http://www.martin.fl.us, then click "Healthy Rivers" http://www.martin.fl.us/GOVT/depts/gmd/gme/maps/waosc1b.jpg)

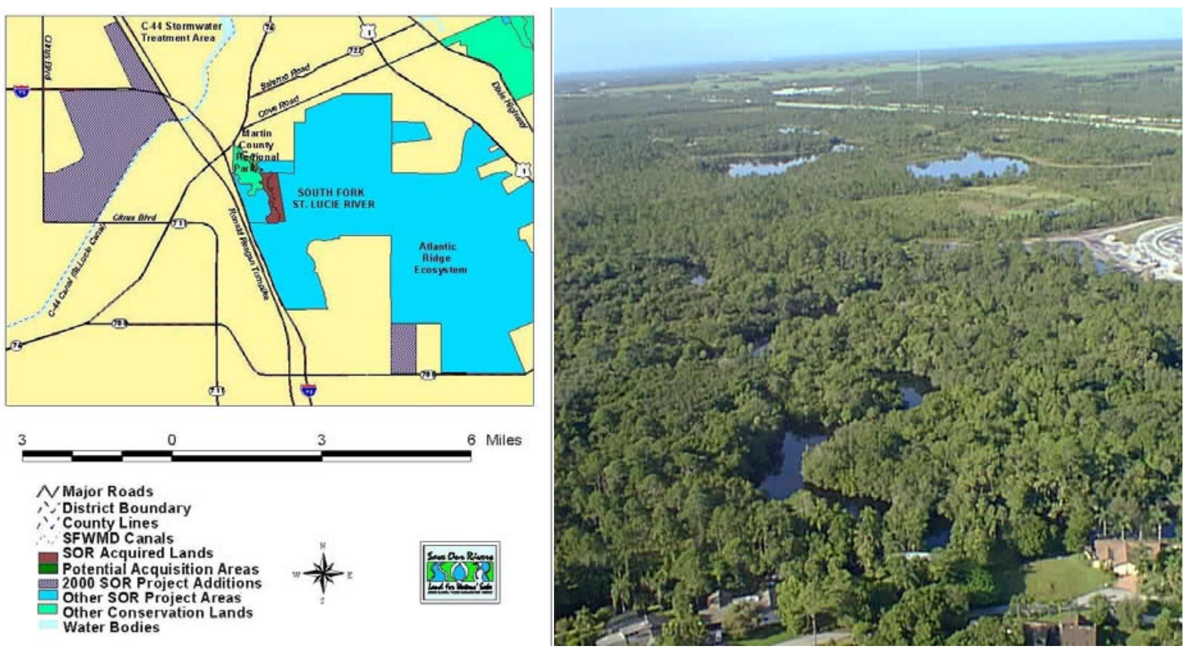


Figure 7-17 Atlantic Coastal Ridge Property and South Fork St. Lucie River

Allapattah Ranch Acquisition

Martin County also contributed $7.5 million to the $29.7 million deal to acquire 13,186 acres of the Allapattah Ranch was in March 2002. In addition to the initial purchase of property at Allapattah Ranch, the SFWMD has begun acquisition of property for the 4,398 acre C-23/24 north reservoir. Almost 100,000 additional acres are going to be required for the full implementation of the recommended plan contained in the IRL – South Plan. Figures 7-18 and 7-19 provide a summary of the project, facilities, and land requirements.

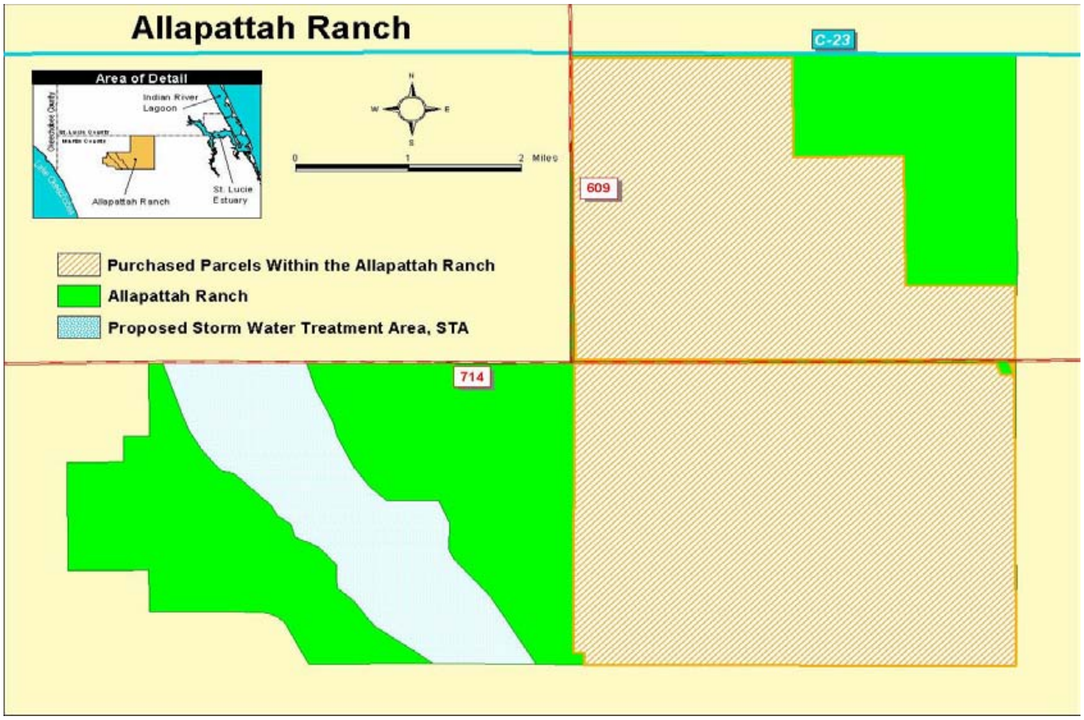


Figure 7-18. Allapattah Ranch Acquisition Project Boundaries and Purchase Status

Figure 7-19. Major Features of the Allapattah Ranch Acquisition and Wetland Restoration

City of Stuart Watershed Planning

The City of Stuart has adopted a comprehensive watershed/basin approach that includes land acquisition for preservation, habitat restoration and stormwater quality improvement projects. With a watershed planning approach, the City is able to establish a comprehensive view of the potential for stormwater quality improvements, freshwater discharge timing, acquisition and development of greenways and conservation lands, recreation opportunities and wildlife conservation. In 1998, the City formally adopted a Blueways/Greenways plan that identifies tributary creeks to the SLE, and related environmentally-sensitive lands, on a watershed basis.

Regional/ USACE Projects

These projects are summarized in **Table 7-11.**

Table 7-11. Pollutant Load Reduction - Non-point Sources –Joint USACOE Projects

Project Name	Description	Status	Lead Agency
Ten Mile Creek Basin Water Preserve Area	The Ten Mile Creek Project begins construction in 2002, in advance of facilities proposed in the IRL Feasibility Study - Recommended Plan, This 910 acre project will provide seasonal or temporary storage of stormwater from the Ten Mile Creek Basin, which is the largest sub-basin in the North Fork of the St. Lucie River and contributes the second largest volume of stormwater to the SLE. Improvements consist of a 500 acre above ground reservoir, a 110 acre polishing cell, and an adjoining natural preserve area. Estimated completion date is the end of 2004.	In progress	USACOE & SFWMD
Lake Okeechobee Water Supply and Environment (WSE) Regulation Schedule 2000	This joint project consists of a revised operating schedule for regulatory releases from Lake Okeechobee that incorporates additional environmental criteria and a variety of climate forecasting tools.	In progress	USACOE & SFWMD
IRL - South Plan 2002	The Recommended Plan, resulting from the multi-year IRL Feasibility Study, incorporates construction of reservoirs, canals, pump stations, stormwater treatment areas, and natural storage and water quality treatment areas, to reduce the impacts of watershed runoff. Significant land acquisition for habitat restoration and preservation is included in the Plan. The plan depends on completion of other CERP components to reduce high volume Lake Okeechobee discharges to the SLE. All elements in the Plan are anticipated to be finished by 2010, if future projected funding requirements are met.	In progress	USACOE & SFWMD

Ten Mile Creek Water Preserve Area.

This is one of the largest stormwater and restoration improvement projects to impact the SLE and River in advance of the CERP IRL – South. Major features of this plan are shown in Figure 7-20. This project is a Critical Restoration Project that has been going through land acquisition and project design for several years. Construction will begin in the summer of 2002. The purpose of this water preserve area (WPA) is the seasonal or temporary storage of stormwater from the Ten-Mile Creek Basin. The Ten-Mile Creek Basin is the largest sub-basin and contributes the second largest volume of stormwater to the St. Lucie River Estuary (SLE). Stormwater will be captured in a reservoir and then passed through a polishing cell for additional water quality treatment before being released into the North Fork. Stored water can be released in the drier winter months to augment current insufficient flows. The project is a 50/50 cost share between the SFWMD and the USACOE.

The project is situated at the headwaters of the North Fork of the St. Lucie River Aquatic Preserve. The Preserve is one of the last remaining freshwater/estuarine wilderness areas in this region of Florida and supports a wide variety of fish and wildlife. The total site is 910 acres and consists of 725 acres of a former orange grove and 185 acres of pastureland. Ten-Mile Creek runs west to east across the northern portion of the site.

Infrastructure improvements for this site include the construction of an aboveground reservoir with a pump station for filling the reservoir from Ten-Mile Creek and a gated water-level control structure for the release of water back to the creek. The total project will consist of a 500-acre reservoir, a polishing cell of roughly 110 acres and an adjoining natural preserve area consisting

Figure 7-20. Tenmile Creek Water Preserve Area Project

of scrub habitat and a borrow pit. Based upon existing topography, stored water depths in the reservoir will average ten feet. Total storage capacity will be approximately 5,000 acre-feet. The height of the reservoir levee will range from about 12 to 15 feet above surrounding natural ground. Side slopes for the levees will be about 1 vertical to 4 horizontal. Construction will begin in the summer of 2003, and project completion is planned for December 2004.

Lake Okeechobee.

The USACOE formally adopted a new regulation schedule for the lake in July 2000. This schedule, the Water Supply and Environment (WSE) schedule uses climate forecasting to determine how much water to release from the lake under flood control conditions, and has the potential to provide environment benefits for the lake and downstream systems without sacrificing water supply. The Lake Okeechobee SWIM Plan Update was also recently completed (SFWMD, 2002a).

Indian River Lagoon – South Feasibility Study

The Indian River Lagoon - South Feasibility Study identifies a recommended plan that, when implemented, will help restore, protect, enhance, and preserve the south Indian River Lagoon and the St. Lucie Estuary and River. The IRL-South Plan provides an opportunity to reverse the course of declining ecosystem health and restore a highly productive system. The reconnaissance and feasibility phases of the Restudy demonstrated that the Indian River Lagoon is an integral part of the Comprehensive Everglades Restoration Plan (CERP). The Indian River Lagoon – South Feasibility Study is a continuation of the Restudy, with a purpose to further develop the conceptual designs of CERP components within Martin and St. Lucie counties. Hydrologic modeling, environmental modeling, water quality analyses, and water supply studies were conducted to refine the information developed in CERP. The IRL – South Plan reduces the impacts from the watershed runoff while relying on the development of other CERP components which significantly reduce the number and frequency of high volume discharges from Lake Okeechobee through C-44 canal to the estuarine system. See Chapter 6 for additional details on plan components, also http://www.sfwmd.gov

Public Involvement and Intergovernmental Coordination

Public Involvement.

In 1991, the St. Lucie River Initiative (SLRI), a non-profit organization, was formed. The SLRI was made up of concerned business, conservation, and other community leaders, area citizens, and members of the scientific community. The SLRI has been successful in focusing public attention on the need to return the SLE and River a more healthy and productive resource. The SLRI has also had significant input with local governments and the agencies involved in SWIM, the South Florida Ecosystem Restoration Task Force, the USACOE Restudy, and the IRL Feasibility Study.

In 1998, as a result of the discharges from Lake Okeechobee and the resulting economic impacts to the local tourism and recreational business, the Rivers Coalition was formed. The Rivers Coalition is a broad-based non-profit organization composed of the business community, conservation groups, fisherman, and local agencies, that lobbies for river improvement and coordination of restoration efforts.

Another key organization is the Florida Oceanographic Society, a non-profit organization founded in 1964. The organization 's mission is to protect, preserve and restore Florida's ocean and coastal ecosystems through education, research and personal stewardship. The Florida Oceanographic Coastal Center is located on a 40-acre parcel on Hutchinson Island. Situated between the Atlantic Ocean and the Indian River Lagoon. With its coastal hardwood hammocks and mangrove forest communities, the site provides excellent opportunities for education and research aimed at increasing the general knowledge of these unique environments.

Coordination with Other Agency Plans.

Various SFWMD work groups and the Martin/St. Lucie (MSL) Service Center have extensive coordination and regular communication with the IRL NEP, FDEP, FDACS, SJRWMD, and Federal agencies such as the USACE, USGS, USFWS, etc. Likewise, the MSL Service Center works closely with local governments and stormwater utilities in St. Lucie and Martin counties.

Development of the IRL - South Feasibility Study required extensive interaction among local, state and Federal agencies and the various stakeholders in the watershed, and this will continue as the project moves forward. The IRL South Feasibility Study is undergoing final review, prior to final submission to Congress for authorization and funding under WRDA 2002. Updates and coordination associated with SWIM, the UEC Water Supply Plan, UEC BMPs, PLRGs and potential TMDLs, also require that the SFWMD work closely with various agencies.

The South Florida Ecosystem Restoration Task Force appointed the St. Lucie River Issues Team. The team is made up of a variety of federal, state, and local governments in addition to agricultural and environmental interests. The FDEP Port St. Lucie Regional Office Director and the Director of the SFWMD Martin/St. Lucie Service Center meet on a regular basis and co-chair the St. Lucie River Issues Team. The team prepared a report on the conditions of the SLE in response to the 1998 water releases, and developed consensus on local projects that could be undertaken to make immediate or near term improvements to the SLE & River and the SIRL. The team conducts an annual evaluation of projects, prepares quarterly progress reports and provides additional opportunities for consistent coordination and communication. The team nominates local/regional projects for matching dollars from various state and federal sources. To date, the Issues Team has received more than $26 million in state and federal funds, which was matched with SFWMD and local government funds to total more than $52 million.

Recently, the University of Florida, IFAS, Indian River Research and Education Center coordinated a Research Forum that allowed the Indian River Citrus BMP Working Group and the St. Lucie Issues Team to present information on the status of current projects for agencies stakeholders and the public. It is anticipated that this will be on annual event to provide information and coordinate project planning and development in the South IRL/SLE Watershed.

As outlined in the Florida Watershed Restoration Act (1999), Florida agriculture is encouraged to develop effective voluntary BMPs to help meet state water quality goals. The Indian River Citrus BMP Implementation Committee, a collaborative public/private group, guides the process for voluntary implementation of citrus BMPs . Activities of the committee include identification of research and educational needs, work on rule development, and on-going support for implementation of science based BMPs. Aiding in this effort are various agencies and groups that provide funding for technical projects and cost sharing for grower implementations.

Future Resource Conditions

Over the next decade, significant opportunities exist for restoration and preservation of the St. Lucie Estuary and its watershed. The preceding sections have summarized the current issues and the scope of both opportunities and challenges. Positive changes are being made by public and private stakeholders, and plans are in place to accelerate and enhance these efforts.

Population and Land Use Trends

The SLE watershed now has a total area of 501,000 acres, of which approximately 50% is agricultural lands, 17% is urban and only 16% remains as wetlands. However, this is clearly a watershed in transition. The pace of development and population growth will continue to challenge our abilities to enhance water quality and preserve the natural resources and lifestyles that have made this watershed so attractive. It is anticipated that the land use pattern in the watershed will generally remain the same, i.e., the largest population will be concentrated in urban coastal areas and agriculture will dominate the western portion of the watershed. However, there is a significant shift of residential land use occurring that will impact the currently undeveloped portion of the watershed. Both Martin County and the City of Port St. Lucie are currently planning projects to build new bridges over the St. Lucie River, to ease traffic congestion from the urban coastal areas to the western portion of the watershed.

Martin County population grew 25% from 100,900 in 1990 to 126,731 in 2000 and is anticipated to be approximately 154,000 by the year 2010. Recent population projections indicate that St. Lucie County grew 28% from 150,171 in 1990 to 192,695 in 2000 and will continue to add 3,000 new households a year for the next twenty years. Southern St. Lucie County is most likely to continue rapid residential and associated commercial development. St. Lucie County population is projected to be almost 300,000 by the year 2010. This projected growth includes the City of Port St. Lucie, which is currently the largest City on the Treasure Coast and, according to the 2000 Census, is the second fastest growing City in the State of Florida.

Recent studies continue to indicate that pollution in coastal waters is increasing, due to urban runoff from growth, increased amounts of impervious surfaces and atmospheric deposition. Much of this non-point source pollution comes directly from increases in residential and commercial development, and the associated impacts of stormwater discharge, automobiles, trucks, boats, and two-stroke engines.

http://www.nap.edu/books/0309084385/html/

http://www.pewoceans.org/reports/water_pollution_sprawl.pdf

The Next Five Years -

Seagrass & Oysters (VEC) / Water Quality / Bathymetry

- Finalize strategies for SLE and River oyster restoration.
- Finalize strategies for SLE and River SAV restoration.
- Continue documentation of the status of existing VEC in the SLE and River.
- Continue existing WQM, SE, GW/SW, and Tide/Salinity networks.
- Evaluate changes to SLT network to include stage data and site additions or deletions.
- Provide Annual Reporting on SLT network data.
- Continue the Martin County Water Monitoring Network.
- Continue the “Canal Watch” Surface water Quality Monitoring Network.
- Provide SLE Water Quality Summary Report in 2005.

Strategies for Pollutant Load Reduction

PLRG Implementation

- Finalize strategies for PLRG adoption and implementation.
- Publish proposed PLRGs for SLE.

Non-point Source Strategy – Stormwater Discharge

- Continue to support existing programs for stormwater education in the watershed.
- Continue to support the Indian River Citrus League Voluntary BMP Implementation Program.
- Continue support for research and pilot projects to validate agricultural and urban BMPs in the watershed.
- Continue support for stormwater retrofit projects in the watershed.
- Continue support for the St. Lucie River Issues Team Program.

Non-point Source Strategy – Muck

- Publish results of Joint Pilot Project on SLE Muck Removal, Utilization, and Disposal.
- Finalize strategies for SLE muck removal and disposal.

Non-point Source Strategy – Septic Tanks

- Provide support for septic tank elimination projects where studies justify the need.

Non-point Source Strategy –Joint USACOE Projects

- Construct and operate the Ten Mile Creek Water Preserve Area Project.
- Publish a report on implementation of the Lake Okeechobee WSE Regulation Schedule and its impact on discharges to the SLE.
- Continue implementation of the IRL-South Plan as currently proposed.

Monitoring, Modeling, and Applied Research

- Continued application of VEC based management goals and strategies for the SLE and watershed.
- Development and application of the watershed water quality model (WaSh).
- Development and application of the three-dimensional estuary water quality model.
- Determination of final Pollutant Load Reduction Goals (PLRGs) for the SLE.
- Participation in the Total Maximum Daily Loads (TMDLs) process for the SLE and watershed.
- Monitoring, modeling, and field studies to assess the effects of St. Lucie MFL criteria.
- Monitoring, modeling, and field studies to assess the effects of the Ten-Mile Creek project
- Evaluate the oligohaline zone of the North Fork of the SLR and its function as a nursery area.

- Document the response of SAV, and oysters to rapid changes in salinity through a series of controlled experiments at the Gumbo-Limbo Mesocosm Facility.
- Completion of benthic nutrient loading studies for the St. Lucie River and Estuary.
- Completion of floodplain reconnection pilot projects in the North Fork.
- Completion of oyster restoration pilot projects in the St. Lucie River and Estuary.
- Evaluate the relationship of exchange between the Atlantic Ocean water with the IRL and SLE to sea level rise.
- Evaluate the relationship of near-shore reef to altered freshwater flows.
- Analyze the relationship of macro-invertebrate community shift to altered salinity envelope

Land Acquisition and Habitat Restoration

- Continue land acquisition in support of IRL-South Plan Implementation.
- Continue land acquisition in support of St. Lucie River North Fork restoration and preservation.
- Continue land acquisition in support of St. Lucie River South Fork restoration and preservation.
- Continue to utilize IRL License Plate Program for project funding.
- Continue to utilize the St. Lucie River Issues Team Program for project funding.
- Continue shoreline habitat restoration and mangrove planting where appropriate.

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CHAPTER 8. PROGRAM BUDGETS

Introduction

The IRL program has matured beyond its early years of development to become a well-established initiative, respected for its scientifically based mission and vision for the restoration of the IRL system. One aspect of the IRL program that has developed significantly in recent years is the federal participation; particularly by the U.S. Army Corps of Engineers (USACE) through its partnership with the SFWMD and SJRWMD in the IRL South and North feasibility studies. These feasibility studies, and the resultant construction plans and designs, will require hundreds of millions of federal dollars to build many of the major regional projects, watershed BMPs, and other IRL aquatic and wetland restoration projects in the IRL basin. This new phase of work is reflected in the projected 5-year budgets of SJRWMD and SFWMD (please refer to **The Next 5 Years** below). These budgets also reflect the continuation of monitoring and research as part of the ongoing pursuit to further our understanding of the IRL system, to develop better restoration policies, priorities and strategies, and, in general, improve management of this estuary.

However, budgets do not simply reflect the programmatic policies, priorities, and strategies; rather, budgets – especially funding or spending constraints -- can often shape them. This is the case with the IRL programs. A brief description of the budgetary history of the IRL programs, included below, may help the reader gain greater appreciation of that fact, and should help explain the fiscal factors that led to both the present and projected budgets of SJRWMD, SFWMD, and their multi-agency partnerships.

The Early Years (1988 – 1995)

During the initial years of SWIM, 1988 through 1991, the state's SWIM Trust Fund and the ad valorem funds of SJRWMD and SFWMD constituted nearly the total financial support for the programs. At that time, the SWIM Trust Fund provided up to 80% of the cost and the Districts provided at least 20% (a few hundred thousand dollars each per year). This cost-share funding supported program planning and the initiation of projects, many being multi-year and Lagoon-wide in scope and primarily diagnostic in purpose.

By 1992, the cost-share was legislatively revised to 60% funding from the state and 40% from the Districts. However, the Districts typically contributed more than 50% of the total annual budget each year from 1992 through 1995. If it was the state legislature's intent to provide time-limited, seed-money support to SWIM, it certainly followed through on that intent by 1995. By that year, and the years to follow, the Districts could no longer rely on the stability or continuance of any state trust funds. Instead, District funding increased even further to keep pace with programmatic demands. The Districts' individual, annual contributions of a few hundred thousand dollars in 1987/88 increased to several millions of dollars by 1995. Even though the Districts were willing at that time to shoulder much of the programmatic costs, it was realized that such a high level of support could not continue indefinitely; outside funding at a substantial level was needed to ensure long-term success.

The Recent Years (1996 – 2001)

By 1996, outside funding was beginning to play a significant supporting role. The Districts' efforts to attract outside funding coupled with the emergence of federal funding programs were having a major effect. Programmatic costs could now be largely divided among several funding sources, and the Districts' ad valorem contribution, percentage-wise, decreased as the annual budgets increased.

The EPA's budget for the IRLNEP and the IRL license plate revenues could now be considered stable sources of funds, approximately $300,000 to $500,000 per year. Additionally, other federal, state, regional, and local agency funding sources were tapped to the extent possible to support the various and ongoing monitoring, diagnostic, and restoration projects.

Local governments especially have given significantly toward the overall effort. Their contributions are typically demonstrated in the large amount of labor and equipment expended each year assisting the Districts in water quality and seagrass monitoring, reconnection of mosquito control impoundments, construction and maintenance of urban stormwater BMPs, and in other projects. Participation by cities, counties, and water control districts will grow as they work to meet their responsibilities for fulfilling NPDES permit requirements and achieving PLRGs or TMDLs.

Since 1997/98, the Districts and local government partners have been fortunate in receiving rather large cost-share and grant awards for diagnostic research and restoration. Various federal program monies – well over $10 million thus far -- have bolstered research and monitoring (e.g., U.S. EPA – Wetlands Management Research Initiative, NASA support in developing high-tech monitoring methods and IRL databases) as well as watershed planning, developing PLRGs, and implementing non-point source controls (e.g., USACE/SFWMD IRL-South Feasibility Study and U.S. EPA 319 Non-Point Source Program). In 1997-1999, the Florida Inland Navigation District contributed over $1.1 million toward muck removal from Crane and Turkey creeks.

From 1999 through 2001, state funding re-emerged in a substantial way. Florida Forever program funds and special state appropriations, generally funneled through either the Water Management Lands or Ecosystem Management trust funds, were earmarked for major muck removal, surface water management projects, and wetland restoration (e.g., Sebastian River muck removal: $4.4 million; Indian River Farms WCD surface water management: ~$4.3 million; impounded wetland reconnections: ~$250,000). During the same time period, the state legislature appropriated $21.5 million to the St. Lucie River Issues Team to support various projects, which was slightly overmatched by local, state and federal funds (>$21.5 million). This recent outlay of millions of state dollars is expected to be short-lived; nonetheless, it provided a timely boost to a number of major projects.

The Next 5 Years (2002 – 2007)

As was previously mentioned, IRL restoration has entered into a phase of design and construction work. The next 5 years will be marked by a major federal presence consisting primarily of the USACE, U.S. EPA, U.S. Fish and Wildlife Service, the National Park Service, and NASA. The next 5 years will also be marked by increased local government involvement in watershed plans, PLRGs, and related surface water management projects. Even though more effort will be spent on design and construction, the Districts will maintain the same level of effort on monitoring and research as in recent years.

The projected budgets are tabulated below. The first series of budget tables (Tables 8-1a through 8-1f) show SJRWMD and SFWMD cost estimates for the major projects broken out Lagoon-wide and by sub-lagoon region. The SJRWMD and SFWMD costs include ad valorem revenue, state legislative appropriations directed to the Districts, license plate funds, and EPA/IRLNEP funds. The second budget table (Table 8-2) shows the projected budgets of other large, complementary programs; for example, USACE's costs for conducting the IRL-North Feasibility Study and implementing the recommendations of the IRL-South Feasibility Study Report. Other complementary programs that are included in Table 8-2 are the *Blueway* land acquisition (land purchase costs only) and the St. Lucie River Issues Team.

It's important to keep in mind, when reviewing the tables of projected budgets, that the dollar estimates are just that – estimates. The budgets reflect an approximation of costs and schedule based on past experiences with the work and on "good-faith" outside funding projections provided by other agencies. Funding sources at any governmental level are affected, positively or negatively, by priority shifts or rates of revenue generation. To date, both of those factors have favored the Indian River Lagoon. We are hopeful that this positive trend will continue.

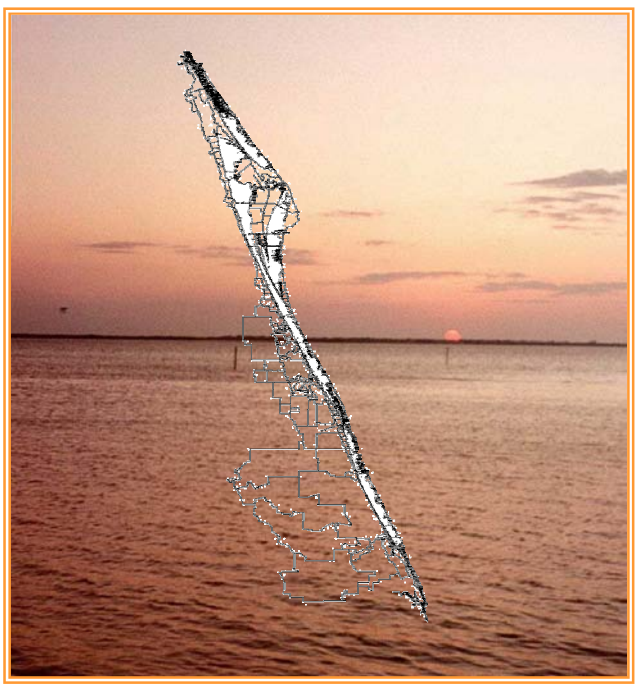

Table 8-1a. Lagoon-wide Budget *Monitoring, Research, PLRG development, Planning, Education, Administration*	**SJRWMD (SJ) and SFWMD (SF) Budget Estimates** ***Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts*** **Fiscal Year**					
	FY 02	**FY 03**	**FY 04**	**FY 05**	**FY 06**	**FY 07**
Seagrass & Water Quality						
Seagrass photography & mapping*	SJ: $159,000 SF: $ 68,745	SJ: $ 82,750 SF: $104,780	SJ: $155,500 SF: $ 77,000	SJ: $ 72,750 SF: $130,000	SJ: $155,500 SF $ 81,500	SJ: $ 72,750 SF: $129,750
Seagrass field monitoring*	SJ: $94,000 SF: $74,869	SJ: $ 94,000 SF: $132,497	SJ: $ 94,000 SF: $128,250	SJ: $ 94,000 SF: $122,750	SJ: $ 94,000 SF: $127,000	SJ: $ 94,000 SF: $128,000
Ambient water quality monitoring*	SJ: $266,000 SF: $236,008	SJ: $248,500 SF: $360,443	SJ: $248,500 SF: $358,500	SJ: $248,500 SF: $358,500	SJ: $248,500 SF: $310,000	SJ: $248,500 SF: $290,000
Assessment of new methods to monitor resources & manage data	SJ: $425,000 SF: $224,384	SJ: $485,000 SF: $161,504	SJ: $405,000 SF: $150,000	SJ: $260,500 SF: $150,000	SJ: $160,500 SF: $150,000	SJ: $160,500 SF: $150,000
Drift macroalgae monitoring*	SJ: $106,500 SF: $0	SJ: $16,500 SF: $35,257	SJ: $163,750 SF: $40,000	SJ: $23,750 SF: $40,000	SJ: $163,750 SF: $40,000	SJ: $23,750 SF: $40,000
Investigation of factors limiting sea-grass (light, salinity, hydrodynamics, etc.)	SJ: $103,000 SF: $ 43,345	SJ: $213,750 SF: $ 36,351	SJ: $171,500 SF: $ 48,000	SJ: $318,750 SF: $ 50,500	SJ: $131,500 SF: $ 52,000	SJ: $79,750 SF: $40,000
Quantification of boundary conditions for IRL modeling*	SJ: $263,750 SF: $219,579	SJ: $483,750 SF: $204,266	SJ: $377,500 SF: $210,500	SJ: $277,500 SF: $220,000	SJ: $277,500 SF: $200,000	SJ: $227,500 SF: $200,000
General development of models*	SJ: $180,000 SF: $ 31,579	SJ: $440,000 SF: $ 33,162	SJ: $77,000 SF: $35,000	SJ: $60,500 SF: $38,000	SJ: $27,500 SF: $38,000	SJ: $27,500 SF: $39,500
PLRG/TMDL development	SJ: $5,000 SF: $63,158	SJ: $ 5,500 SF: $67,224	SJ: $ 5,000 SF: $78,000	SJ: $ 5,500 SF: $89,500	SJ: $ 5,000 SF: $92,000	SJ: $ 5,000 SF: $82,750
Muck and toxic substances survey	SJ: $0 SF: $10,800	SJ: $0 SF: $0	SJ: $11,000 SF: $0	SJ: $116,500 SF: $0	SJ: $55,500 SF: $0	SJ: $2,750 SF: $0
Inventory of domestic WWTPs	SJ: $2,750	SJ: $0	SJ: $0	SJ: $0	SJ: $5,500	SJ: $0
Staff effort to acquire land for stormwater projects*	SJ: $22,000 SF: $0	SJ: $16,500 SF: $0	SJ: $5,500 SF: $0	SJ: $11,000 SF: $0	SJ: $5,500 SF: $0	SJ: $5,500 SF: $0
Land purchase costs for stormwater projects*	SJ: $2M SF: $0**	SJ: $1M SF: $0	SJ: $0 SF: $0	SJ: $2M SF: $0	SJ: $0 SF: $0	SJ: $2M SF: $0
TOTALS *rounded to nearest $1,000*	***SJ: $ 3.627M*** ***SF: $ 972,000***	***SJ: $3.086M*** ***SF: $1.135M***	***SJ: $1.714M*** ***SF: $1.125M***	***SJ: $3.489M*** ***SF: $1.199M***	***SJ: $1.330M*** ***SF: $1.090M***	***SJ: $2.947M*** ***SF: $1.073M***
Coastal Wetlands						
Wetland component of IRL-N. Feasibility Study (USACE/SJRWMD)*	SJ: $2,750	SJ: $2,750	SJ: $2,750	SJ: $2,750	SJ: $2,750	SJ: $2,750
Blueway land acquisition program (staff costs only; estimated land costs in Table 8-2)	SJ: $11,000	SJ: $16,500	SJ: $27,500	SJ: $22,000	SJ: $27,500	SJ: $33,000
Wetland rehabilitation and management	SJ: $8,250 SF: $5,000	SJ: $8,250 SF: $6,000	SJ: $5,500 SF: $5,750	SJ: $5,500 SF: $5,500	SJ: 8,250 SF: $5,500	SJ: 8,250 SF: $4,850
Wetlands Management Research Initiative***	SJ: $1,650	SJ: $1,650	SJ: $8,250	SJ: $8,250	SJ: $5,500	SJ: $5,500
TOTALS *rounded to nearest $1,000*	***SJ: $24,000*** ***SF: $ 5,000***	***SJ: $29,000*** ***SF: $ 6,000***	***SJ: $44,000*** ***SF: $ 6,000***	***SJ: $38,000*** ***SF: $ 6,000***	***SJ: $44,000*** ***SF: $ 6,000***	***SJ: $50,000*** ***SF: $ 5,000***
Public Involvement & Education						
Public Presentations & Seminars*	SJ: $84,500 SF: $19,500	SJ: $84,100 SF: $21,000	SJ: $85,500 SF: $35,000	SJ: $85,500 SF: $22,500	SJ: $85,500 SF: $22,500	SJ: $85,500 SF: $35,000
Citizens WQ monitoring network	SJ: $68,250	SJ: $71,000	SJ: $68,250	SJ: $68,250	SJ: $71,000	SJ: $71,000
Informational materials and campaigns, license plate promotion	SJ: $167,500 SF: $ 6,500	SJ: $425,500 SF: $ 9,500	SJ: $260,500 SF: $ 6,500	SJ: $260,500 SF: $ 6,500	SJ: $260,500 SF: $ 6,500	SJ: $260,500 SF: $ 6,500
TOTALS *rounded to nearest $1,000*	***SJ: $320,000*** ***SF: $ 26,000***	***SJ: $580,000*** ***SF: $ 30,000***	***SJ: $414,000*** ***SF: $ 42,000***	***SJ: $414,000*** ***SF: $ 29,000***	***SJ: $417,000*** ***SF: $ 29,000***	***SJ: $417,000*** ***SF: $ 42,000***
WMD/IRLNEP *						
Planning & Administration	*SJ: $165,000* *SF: $ 92,494*	*SJ: $165,000* *SF: $ 23,216*	*SJ: $165,000* *SF: $ 50,000*	*SJ: $165,000* *SF: $ 99,750*	*SJ: $165,000* *SF: $ 42,000*	*SJ: $165,000* *SF: $ 32,000*
GRAND TOTALS *rounded to nearest $1,000*	***SJ: $4.136M*** ***SF: $1.095M***	***SJ: $3.860M*** ***SF $1.196M***	***SJ: $2.337M*** ***SF $1.222M***	***SJ: $4.106M*** ***SF $1.334M***	***SJ: $1.956M*** ***SF $1.167M***	***SJ: $3.579M*** ***SF $1.152M***

* SJ costs also included in the IRL-North Feasibility Study (USACE/SJRWMD).

** Estimated costs to be determined and shown in the South IRL or St. Lucie River budget tables (Tables 8-1e and f)

*** $550,000 in EPA funds were encumbered in previous fiscal years to cover contractual work in this 3.5-year study, which culminates in FY03

Table 8-1b. *Mosquito Lagoon Budget* *Research, Non-point source controls, watershed and coastal wetland plans and projects*	**SJRWMD Contractual and Staff Estimates** *Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts* **Fiscal Year**					
	FY 02	**FY 03**	**FY 04**	**FY 05**	**FY 06**	**FY 07**
Seagrass & Water Quality						
Seagrass photography & mapping	**These projects are applied Lagoon-wide, including Mosquito Lagoon, and the estimated costs are found in the Lagoon-wide Budget (Table 8-1a)**					
Seagrass field monitoring						
Ambient water quality monitoring						
Quantification of inputs/boundary conditions for IRL modeling						
Drift macroalgae monitoring						
Assessment of new methods to monitor and manage data						
Investigation of factors limiting seagrass growth (light, salinity, hydrodynamics, etc.)						
Muck and toxic substances survey						
Inventory of domestic WWTPs						
Application of watershed & IRL models	$ 2,750	$ 2,750	$ 27,500	$ 8,250	$0	$0
PLRG/TMDL development & coordination	$ 1,100	$ 2,750	$ 5,500	$ 2,750	$0	$0
Turbidity Investigation in Mosquito Lagoon	--	$122,000	$ 66,500	$ 2,750	$0	$0
Non-point (stormwater) control projects	$182,550	$150,550	$151,100	$251,100	$251,100	$151,100
TOTALS rounded to nearest $1,000	***$186,000***	***$278,000***	***$251,000***	***$265,000***	***$251,000***	***$151,000***
Coastal Wetlands						
Conduct wetland component of IRL-North Feasibility Study (USACE/SJRWMD)*	$ 1,100	$ 2,750	$ 5,500	$ 2,750	$ 2,750	$ 2,750
Wetland rehabilitation and management	$ 52,750	$ 1,100	$ 51,100	$ 1,100	$ 51,100	$ 1,100
Rehabilitation of draglined marshes*	$155,500	$155,500	$205,500	$208,250	$308,250	$308,250
TOTALS rounded to nearest $1,000	***$209,000***	***$159,000***	***$262,000***	***$212,100***	***$362,000***	***$312,000***

*Also included in the IRL-North Feasibilty Study (USACE & SJRWMD)

Wetland/shoreline restoration work in Canaveral National Seashore, Mosquito Lagoon

Water Quality Monitoring: top -- taking subsurface light measurements; bottom, l to r -- collecting and lab-processing chlorophyll samples

Table 8-1c. ***Banana River Lagoon Budget*** *Research, Non-point source controls, watershed and coastal wetland plans and projects*	**SJRWMD Contractual and Staff Estimates** *Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts* **Fiscal Year**					
	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07
Seagrass & Water Quality						
Seagrass photography & mapping	**These projects are applied Lagoon-wide, including Banana River Lagoon, and the estimated costs are found in the Lagoon-wide Budget (Table 8-1a)**					
Seagrass field monitoring						
Ambient water quality monitoring						
Quantification of inputs/boundary conditions for IRL modeling						
Drift macroalgae monitoring						
Assessment of new methods to monitor seagrass & water quality						
Investigation of factors limiting seagrass growth (light, salinity, hydrodynamics, etc.)						
Muck and toxic substances survey						
Inventory of domestic WWTPs						
Application of watershed & IRL models	$ 2,750	$ 2,750	$116,500	$ 13,750	$ 2,750	$0
PLRG/TMDL development & coordination	$ 3,300	$ 3,300	$108,250	$ 11,000	$ 2,750	$0
Non-point (stormwater) control projects	$252,750	$152,750	$255,500	$261,000	$316,500	$263,750
Other muck removal projects (e.g., southern Banana R.)	$0	$0	$0	$5,500	$11,000	$1.527M
TOTALS rounded to nearest $1,000	***$259,000***	***$159,000***	***$480,000***	***$291,000***	***$333,000***	***$1.791M***
Coastal Wetlands						
Conduct wetland component of IRL-North Feasibility Study (USACE/SJRWMD)	$ 550	$ 550	$ 550	$ 550	$ 550	$ 550
Wetland rehabilitation and management	$5,500	$5,500	$35,500	$105,500	$55,500	$105,500
TOTALS rounded to nearest $1,000	***$6,000***	***$6,000***	***$36,000***	***$106,000***	***$56,000***	***$106,000***

Seagrass monitoring in northern Banana R. Lagoon

Installing a baffle box: traps soil and debris in urban runoff

Table 8-1d. ***North & Central IRL Budget*** *Research, Non-point source controls, watershed and coastal wetland plans and projects*	**SJRWMD Contractual and Staff Estimates** *Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts* **Fiscal Year**					
	FY 02	FY 03	FY 04	FY 05	FY 06	FY 07
Seagrass & Water Quality						
Seagrass photography & mapping*	**These projects are applied Lagoon-wide, including the North and Central IRL, and estimated costs are found in the Lagoon-wide Budget (Table 8-1a)**					
Seagrass field monitoring*						
Ambient water quality monitoring*						
Quantification of inputs/boundary conditions for IRL modeling*						
Assessment of new methods to monitor & manage data						
Investigation of factors limiting seagrass growth (light, salinity, hydrodynamics, etc.)						
Drift macroalgae monitoring*						
Muck and toxic substances survey						
Inventory of domestic WWTPs						
Application of watershed and IRL models*	$260,000	$165,000	$118,250	$110,000	$ 82,500	$ 82,500
PLRG/TMDL development & coordination	$122,000	$ 27,500	$113,750	$ 5,500	$ 2,750	$ 2,750
Non-point (stormwater) control projects*	$3.758M	$2.055M	$3.082M	$3.582M	$6.116M	$6.116M
Sebastian R. muck removal	$1.916M	$2.555M	$2.555M	$227,500	$0	$0
Other muck removal projects; incl. plans & surveys*	$602,250	$100,000	$ 8,250	$1.522M	$1.522M	$ 8,250
TOTALS rounded to nearest $1,000	***$6.659M***	***$4.902M***	***$5.878M***	***$5.448M***	***$7.723M***	***$6.209M***
Coastal Wetlands						
Conduct wetland component of IRL-North Feasibility Study (USACE/SJRWMD)*	$ 1,100	$ 1,100	$ 1,100	$ 1,100	$ 1,100	$ 1,100
Shoreline vegetation plantings (coord. w/ ELC)	$ 51,050	$ 550	$ 50,550	$ 25,550	$ 25,550	$ 25,550
Wetlands Management Research Initiative	$ 13,750	$ 13,750	$ 5,500	$ 5,500	$116,500	$ 5,500
Wetland rehabilitation and management	$ 58,250	$458,250	$178,250	$ 78,250	$ 78,250	$ 78,250
TOTALS rounded to nearest $1,000	***$124,000***	***$474,000***	***$235,000***	***$110,000***	***$221,000***	***$110,000***

*Also included in the IRL-North Feasibility Study (USACE/SJRWMD)

Reconnecting an impounded wetland in Central IRL

Turkey Creek muck removal (dredge) and...

discharge to a temporary containment area

Table 8-1e. *South Indian River Lagoon Budget*

Research, Non-point source controls, watershed and coastal wetland plans and projects

	SFWMD Budget Estimates *Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts* **Fiscal Year**					
	FY 02	**FY 03**	**FY 04**	**FY 05**	**FY 06**	**FY 07**
Seagrass & Water Quality						
Seagrass photography & mapping	**These projects are applied Lagoon-wide, including South IRL, and estimated costs are found in the Lagoon-wide Budget (Table 8-1a)**					
Seagrass field monitoring						
Ambient water quality monitoring						
Quantification of inputs/boundary conditions for IRL modeling						
Drift macroalgae monitoring						
Assessment of new methods to monitor & manage data						
Investigation of factors limiting seagrass growth (light, salinity, hydrodynamics, etc.)						
Muck and toxic substances survey						
Inventory of domestic WWTPs						
Application of watershed and IRL models	$18,500	$34,0000	$85,000	$85,000	$120,000	$120,000
PLRG/TMDL development & coordination	$12,000	$20,000	$20,000	$20,000	$20,000	$20,000
Non-point (stormwater) control projects	$247,150	$496,949	$500,000	$500,000	$500,000	$500,000
Moores Creek Stormwater Retrofit	$460,000	--	--	--	--	--
Taylor Cr. muck removal*	$0*	$0	$0	--	--	--
Applicable IRL-South F.S. components**	$0	$0	$2.0M	$2.0M	$2.325M	$2.0M
TOTALS rounded to nearest $1,000	***$738,000***	***$551,000***	***$2.605M***	***$2.605M***	***$2.965M***	***$2.640M***
Coastal Wetlands						
Shoreline Habitat Restoration	$152,730	$75,000	$75,000	$75,000	$75,000	$75,000
Shoreline vegetation plantings – coordination with ELC	$3,500	$3,500	$3,500	$3,500	$3,500	$3,500
Mosquito Impoundment Rehabilitation	$102,311	$175,000	$175,000	$150,000	$125,000	$100,000
Gen. planning/coordination for wetland rehabilitation and management	$4,000	$4,000	$4,000	$4,000	$4,000	$4,000
TOTALS rounded to nearest $1,000	***$263,000***	***$258,000***	***$258,000***	***$233,000***	***$208,000***	***$183,000***

* SFWMD contributed funds in previous fiscal years to help cover contractual work managed by St. Lucie County. Muck removal from Taylor Creek may be completed by 2004. ** IRL-South F.S. program is funded 50/50 by USACE/SFWMD; this table shows SFWMD costs only.

Planting red mangrove seedlings in the South IRL

Public awareness & education is an ongoing campaign reaching from South IRL to the Mosquito Lagoon

Table 8-1f. *St. Lucie River Estuary (SLR) Budget* *Monitoring, research, Non-point source controls, other watershed plans and projects*	**SFWMD Budget Estimates** *Includes ad valorem, IRLNEP (EPA), license plate, and state-appropriated funds directed to the Districts* **Fiscal Year**					
	FY 02	**FY 03**	**FY 04**	**FY 05**	**FY 06**	**FY 07**
Water Quality & Biological Resources						
VEC restoration - oysters	$239,168	$80,623	$90,000	$90,000	$90,000	$90,000
Development & application of models	$125,000	$60,000	$80,000	$105,000	$120,000	$100,000
PLRG/TMDL development & application	$100,000	$20,000	$40,000	$50,000	$75,000	$50,000
Non-point (stormwater) control projects	$745,067	$1.114M	$1.950M	$1.80M	$1.80M	$1.80M
Ten Mile Creek Water Preserve Area*	$475,615	$0	--	--	--	--
Muck removal pilot project	$ 75,486	$0	--	--	--	--
North Fork nursery study	$ 7,500	$10,000	$20,500	--	--	--
IRL/Savannas Preserve	$0	$1.0M	--	--	--	--
Applicable IRL South F.S. components**	$20.415M	$422.222M	$145.665M	$126.543M	$57.782M	$15.583M
TOTALS rounded to nearest $1,000	***$22.183M***	***$445.070M***	***$167.470M***	***$147.198M***	***$58.867M***	***$17.623M***
SLR Floodplain & Tributary Habitats						
Shoreline Habitat Restoration	$0	$20,000	$20,000	$20,000	$30,000	$35,000
Tributary Habitat Restoration	$0	$50,000	$50,000	$50,000	$75,000	$90,000
TOTALS rounded to nearest $1,000	***$0***	***$70,000***	***$70,000***	***$70,000***	***$105,000***	***$115,000***

* SFWMD contributed funds in previous fiscal years to help cover project planning, design and other cost elements

** IRL-South F.S. program is funded 50/50 by USACE/SFWMD; this table shows SFWMD costs only (Table 8-2 shows USACE costs.

Table 8-2. Other Major Programs Benefiting the Indian River Lagoon System

- **U.S. Army Corps of Engineers (USACE): Feasibility Studies & Project Implementation**
- ***Blueway* Land Acquisition Program (estimated land purchase costs only)**
- **St. Lucie River Issues Team**

	Fiscal Year					
	FY 02	**FY 03**	**FY 04**	**FY 05**	**FY 06**	**FY 07**
IRL- NORTH Feasibility Study* USACE costs only,** *less inflation & any sponsor in-kind (IRL-North F.S. Project Plan, 6/17/02)						
Public meetings; social, cultural, institutional, & economic studies	$12,000	$122,000	$83,000	$68,000	$53,000	$17,000
NEPA and USFWS reviews and reports	--	$65,000	$255,000	--	--	--
Geotechnical & hydrological surveys, mapping, modeling, and project design	$34,300	$157,500	$878,400	$219,000	$125,000	$85,000
Administration, planning, reports, and reviews	$35,000	$205,000	$138,000	$143,000	$124,000	$110,000
Totals *rounded to the nearest $1,000*	***$81,000***	***$1.550M***	***$1.354M***	***$430,000***	***$302,000***	***$212,000***
IRL-SOUTH Feasibility Study & Project Implementation ***USACE costs only*** *(IRL-South F.S. Report)**	***$3.300M***	***$6.636M***	***$23.872M***	***$40.867M***	***$89.255M***	***$92.218M***
BLUEWAY Land Acquisition (Phase I) – Approximate Land Purchase Costs*						
Mosquito Lagoon, Banana R. Lagoon, N. and Central IRL (up to 7,705 acres)	$0	$4.0M	$5.0M	$5.0M	$5.0M	$10.0M
South IRL and St. Lucie River (up to 1,253 acres)	------------To Be Determined------------					
Totals *rounded to the nearest $1,000*	***$0***	***$4.0M***	***$5.0M***	***$5.0M***	***$5.0M***	***$10.0M***
ST. LUCIE RIVER Issues Team *Legislative appropriations only*	***$4.0M***	***$5.0M***	***$5.0M***	***$5.0M***	***$5.0M***	***$5.0M***

* The IRL-North and IRL-South programs are funded 50/50 by the USACE and the Districts (as the local sponsors). The budgets shown above are the estimated USACE costs only. The Districts' match is represented in the preceding tables; indicated by asterisked projects.

** The total 1998 assessed value of the 8,857 acres of land targeted for Phase I of *Blueway* acquisition is ~$60,000,000. Funds would be derived from individual county land acquisition programs (especially in the case of South IRL – St. Lucie and Martin counties), and from the state's Florida Forever program, FDOT mitigation bank, and the Districts' Save Our Rivers program.

APPENDIX A

TMDLs, Watershed Management Approach, the Clean Water Act, and the Florida Watershed Restoration Act

The Florida Department of Environmental Protection (FDEP), Bureau of Watershed Management has responsibility for development of Total Maximum Daily Loads (TMDLs). A TMDL is the maximum amount of a given pollutant that a waterbody can absorb and still maintain its designated uses (e.g., suitable for fishing or swimming with respect to the IRL). FDEP receives its guidance and statutory authority for developing and implementing TMDLs from Section 303(d) of the federal Clean Water Act and the Florida Watershed Restoration Act (see further descriptions of these Acts below). TMDLs must be developed for all waters that do not meet applicable water quality standards and are thus defined as “impaired” waters. These impaired waters are listed in Florida’s 303(d) list. Chapter 62-303, F.A.C, Identification of Impaired Surface Waters, describes the methodology used to define impaired waters and the process used to list impaired waterbodies. The Pollutant Load Reduction Goals developed by the SJRWMD and SFWMD will be considered in the development of TMDLs; presumably providing the technical basis for the TMDLs of nutrients and total suspended solids in the IRL.

FDEP has adopted a *watershed management approach* in the TMDL process. Water resources are managed on the basis of hydrologic boundaries, such as river basins, rather than political or regulatory boundaries. Instead of focusing only on individual sources of pollution, water resources are assessed from a basin-wide perspective that considers the cumulative effects of human activities. Public involvement in the process will be strongly encouraged. The water management approach is not new, nor does it compete with or replace existing programs. Rather than relying on a single solution to address aquatic resource issues, the approach is intended to improve the health of surface water and ground water resources by strengthening coordination among such activities as monitoring, stormwater management, wastewater treatment, wetland restoration, land acquisition, and public involvement.

Application of the *watershed management approach* toward the development of TMDLs will proceed in a prioritized order through five groupings of the state’s fifty-two surface water basins. The SFMWD portion of the IRL system, South IRL and St. Lucie River, are included in Group 2. The SJRWMD portion of the IRL system is in Group 5 (Table A.1). The development of TMDLs within the groups consists of 5 phases, as follows:

Phase 1: Watershed Evaluation. FDEP will conduct preliminary evaluations of the status of the quality of surface water and ground water. This information will be used to generate a planning list of potentially impaired waters for which TMDLs may be needed. At the end of Phase 1, a strategic monitoring plan will be developed.

Phase 2: Strategic Monitoring. Monitoring will be conducted to help verify whether waters are, in fact, impaired and to collect the data needed to calibrate and verify models for TMDL development. At the end of the second phase, an Assessment Report will be produced. This report will contain an updated and more thorough assessment of water quality, associated biological resources, and current restoration plans and projects. Waters that are verified as being impaired will be placed on a basin-specific list of impaired waters that will be adopted by FDEP through a Secretarial Order. This verified list will be submitted to the U.S. EPA as the state’s Section 303(d) list of impaired waters for the basin.

Phase 3: Developing and Adopting TMDLs. TMDLs for priority impaired waters in the basin will be developed and adopted by rule. Because TMDLs cannot be developed for all listed waters during a single watershed management cycle due to fiscal and technical limitations, waterbodies will be prioritized using the criteria in the impaired surface waters rule (Identification of Impaired Surface Waters Rule, Section 62-303, Florida Administrative Code).

Phase 4: Developing Watershed Management Plans. A watershed management plan will be developed specifying how pollutant loadings from point and nonpoint sources of pollution will be allocated and reduced, in order to meet TMDL requirements. The plans will include regulatory and non-regulatory (i.e., voluntary), structural and nonstructural improvements. The involvement and support of affected stakeholders in this phase will be especially critical.

Phase 5: Implementing Watershed Management Plans. Implementation of the activities specified in the watershed management plan will begin.

The phases described above are repeated once the watershed management plan (or Phase 5) is completed as part of TMDL implementation (Table A.1). For example, the monitoring conducted in Phase 2 that served the initial assessments will be resumed or continued for the purpose of evaluating whether water quality objectives are being met and whether individual waters are no longer impaired. The information from such monitoring may indicate that adjustments are needed to the water management plan or, perhaps, to the way in which it is implemented. The FDEP will also track the implementation of scheduled restoration activities, whether required or voluntary, to ensure continued progress towards meeting the TMDLs.

Table A.1. TMDL Development and Implementation Schedule

Group 2 includes the South IRL and St. Lucie River.
Group 5 includes Mosquito Lagoon, Banana River, and North & Central IRL

Year/ Group	2000	2001	2002	2003	2004	2005	2006	2007	2008
Group 1	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	*Phase 1*	*Phase 2*	*Phase 3*	*Phase 4*
Group 2		Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	*Phase 1*	*Phase 2*	*Phase 3*
Group 3			Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	*Phase 1*	*Phase 2*
Group 4				Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	*Phase 1*
Group 5					Phase 1	Phase 2	Phase 3	Phase 4	Phase 5

In summary, the *watershed management approach*, as part of TMDL development, recognizes the need for and serves to promote the holistic management of natural systems and the cumulative effects of human activities on these interconnected systems within watersheds. The approach provides a framework for setting priorities and focusing the state's funding and other resources on protecting and restoring water quality. The approach is intended to increase cooperation among state, regional, local, and federal interests; to avoid duplication by building on existing assessments and restoration activities; and to provide a system of accountability through monitoring that is specific to the TMDLs and other objectives of the watershed management plan. By emphasizing public involvement, the approach encourages stewardship by all Floridians to preserve water resources for future generations.

More information on TMDLs and the watershed management approach can be obtained from FDEP's internet site: http://dep.state.fl.us/water/watersheds/basin411/default.htm.

Summary of the Clean Water Act Requirements Related to the TMDL Program

Congress enacted the Clean Water Act in 1972 with the goal of restoring and maintaining the "chemical, physical, and biological integrity of the nation's waters"—33 U.S.C. § 1251(a). The ultimate goal of the act is to eliminate the "discharge of [all] pollutants into navigable waters"—33 U.S.C. § 1251(a)(1). The TMDL program is an important step towards cleaning up our rivers. The Clean Water Act sets out the federal requirements that Florida must follow in implementing its TMDL program under the Florida Watershed Restoration Act. The Clean Water Act and the federal TMDL program include the following provisions:

- *Requires states to establish water quality standards that will protect the public health and welfare—33 U.S.C. § 1313(c)(2).*
- *Requires states to identify waters that do not meet applicable water quality standards (Water Quality Limited Segments, or WQLSs) and identify the pollutants causing the water quality threats—33 U.S.C. § 1313(d)(1)(A-B).*
- *Requires the state to establish for each WQLS the TMDL for each pollutant that can be introduced into that waterbody without violating water quality standards—33 U.S.C. § 1313(d)(1)(C).*
- *Requires that each TMDL be established "at a level necessary to implement the applicable water quality standards with seasonal variations and a margin of safety that takes into account any lack of knowledge concerning the relationship between effluent limitations and water quality"—33 U.S.C. § 1313(d)(1)(C).*
- *Requires states to update their 303(d) list of impaired waters (WQLSs) every two years or else the U.S. Environmental Protection Agency (EPA) will be required to develop a complete WQLS list and/or TMDLs for the impaired waters on behalf of the state—33 U.S.C. § 1313(d)(2).*
- *Requires EPA approval or disapproval within thirty days, once the WQLS list and TMDLs are submitted. If approved, the list and TMDLs are to be incorporated into the state's water quality management plan—33 U.S.C. § 1313(d)(2).*

Summary of the Florida Watershed Restoration Act

In recognition of the important role that TMDLs play in restoring state waters, the 1999 Florida legislature enacted the Florida Watershed Restoration Act. In addition to clarifying the FDEP's statutory authority to establish TMDLs, the act established a process for identifying and listing impaired waters and for developing TMDLs and the associated watershed management plans needed to allocate and achieve the needed pollutant load reductions. The legislation contains the following provisions:

- *Establishes that the 303(d) list submitted to the EPA in 1998 is for planning purposes only.*

- *Requires the FDEP to adopt 303(d) listing criteria (that is, the methodology used to define impaired waters) by rule.*

- *Requires the FDEP to verify impairment and then establish basin-specific verified lists. The FDEP must also evaluate whether proposed pollution control programs are sufficient to meet water quality standards, list the specific pollutant(s) and concentration(s) causing impairment, and adopt the basin-specific 303(d) list by Secretarial Order.*

- *Requires the FDEP's Secretary to adopt TMDL allocations by rule. The legislation requires the FDEP to establish "reasonable and equitable" allocations of TMDLs, but does not mandate how allocations will be made among individual sources.*

- *Requires that TMDL allocations consider existing treatment levels and management practices; the differing impacts that pollutant sources may have; the availability of treatment technologies, best management practices (BMPs), or other pollutant reduction measures; the feasibility, costs, and benefits of achieving the allocation; reasonable time frames for implementation; the potential applicability of moderating provisions; and the extent that non-attainment is caused by pollution from outside Florida, discharges that have ceased, or alteration to a waterbody.*

- *Required a report to the legislature by February 2001 addressing the allocation process.*

- *Authorizes the FDEP to develop basin plans to implement TMDLs, coordinating with the water management districts, the Florida Department of Agriculture and Consumer Services, the Soil and Water Conservation Districts, regulated parties, and environmental groups in assessing waterbodies for impairment, collecting data for TMDLs, developing TMDLs, and conducting at least one public meeting in the watershed. Implementation is voluntary if not covered by regulatory programs.*

- *Authorizes the FDEP and the Florida Department of Agriculture and Consumer Services to develop interim measures and BMPs to address nonpoint sources. While BMPs would be adopted by rule, they will be voluntary if not covered by regulatory programs. If they are adopted by rule and the Department verifies their effectiveness, then implementation will provide a presumption of compliance with water quality standards.*

- *Directs the FDEP to document the effectiveness of the combined regulatory/voluntary approach and report to the legislature by January 1, 2005. The report will include participation rates and recommendations for statutory changes.*

APPENDIX B

Lists of Outstanding Florida Waters and Permitted Industrial Facilities that Discharge to the IRL

B.1. List of Outstanding Florida Waters in the IRL System

Volusia, Brevard, Indian River, St. Lucie, Martin Counties, and Palm Beach counties; current as of October 21, 2002.

<u>Volusia County</u>
Merritt Island National Wildlife Refuge
Canaveral National Seashore
Mosquito Lagoon State Aquatic Preserve

<u>Brevard County</u>
National Wildlife Refuges:
- Archie Carr
- Merritt Island
- St. Johns (including Bee Line unit)

Canaveral National Seashore

State Parks, Wildlife Parks, and Recreation Areas:
- Sebastian Inlet State Recreation Area

State Aquatic Preserves:
- Mosquito Lagoon
- Banana River
- Indian River Malabar to Vero Beach

<u>Indian River County</u>

National Wildlife Refuges:
- Archie Carr
- Pelican Island

State Parks, Wildlife Parks, and Recreation Areas:
- Sebastian Inlet State Recreation Area

EEL, CARL, LATF, SOC:
- Indian River North Beach

State Aquatic Preserve:
- Indian River Malabar to Vero Beach
  (except Turkey & Sebastian Creeks)
- Indian River Vero Beach to Ft. Pierce

Appendix B.1 continued

St. Lucie County

State Parks, Wildlife Parks, and Recreation Areas:
- Avalon State Recreation Area
- Fort Pierce Inlet State Rec. Area

State Preserve or Reserve:
- Savannas State Reserve

EEL, CARL, LATF, SOC:
- Green Turtle Beach
- Surfside Additions

State Aquatic Preserves:
- Indian River Vero Beach to Ft. Pierce
- Jensen Beach to Jupiter Inlet
- North Fork, St. Lucie River

Martin County

Hobe Sound National Wildlife Refuge

State Parks, Wildlife Parks, and Recreation Areas:
- Jonathan Dickinson State Park

State Preserve or Reserve:
- Savannas State Reserve
- St. Lucie Inlet State Preserve

EEL, CARL, LATF, SOC:
- Martin County Tracts
- Sea Branch

State Aquatic Preserves:
- Jensen Beach to Jupiter Inlet
- North Fork, St. Lucie River

Palm Beach County

State Aquatic Preserves:
- Jensen Beach of Jupiter Inlet State Aquatic Preserve

B.2. Lists of Industrial Facility Stormwater and Wastewater Permit Holders in the IRL Basin (see attached tables)

For more information about any of the listed facilities, please contact the appropriate FDEP district office:

Central District Office for Volusia, Brevard, or Indian River counties
3319 Maguire Blvd., Suite 232, Orlando, FL 32803-3767
Phone: 407-894-7555

Southeast District Office for St. Lucie, Martin, or Palm Beach counties
P.O. Box 15425, West Palm Beach, FL 33416-5425
Phone: 561-681-6600

Also, FDEP has a web site that may help you find information and you may post a comment or question: www.dep.state.fl.us/secretary/feedback/feedback.html

Note: Domestic wastewater treatment facilities are listed in the 1994 IRL SWIM Plan, Appendix G.1. A discussion of their status is summarized in this update in each of the chapters 2 – 6. Significant reductions in their combined discharges have been documented since 1996 pursuant to Chapter 90-262, Laws of Florida (a.k.a. IRL "No Discharge" Protection Act).

Appendix B.2.a. Industrial Facilities, Stormwater Permit Holders, Active and Inactive

FACILITY ID	FACILITY NAME	ADDRESS_1	CITY	COUNTY	ZIP5	ZIP4	LAT_ DD	LAT_ MM	LAT_ SS	LONG _DD	LONG _MM	LONG _SS	PERMIT STATUS	ISSUE_ DATE	EXPIRE DATE
FLR05B992	WWG ASPHALT CO	5020 NOVA RD	ROCKLEDGE	BREVARD	32955		28	15	53	80	42	0	Active	10-Mar-01	09-Mar-06
FLR05B993	WWG ASPHALT CO	5855 INDUSTRIAL DR	COCOA	BREVARD	32927		28	27	20	80	46	16	Active	10-Mar-01	09-Mar-06
FLR05B470	HYDRO ALUMINUM ROCKLEDGE	100 GUS HIPP BLVD	ROCKLEDGE	BREVARD	32955		28	18	38	80	42	34	Active	11-Feb-01	10-Feb-06
FLR05C202	EXCELL COATING INC	745 SCALLOP DR	CAPE CANAVERAL	BREVARD	32920		28	24	20	80	37	47	Active	11-Jul-01	10-Jul-06
FLR05A224	COMMERCIAL CARRIER CORP	9010 MARLIN ST	CAPE CANVERAL	BREVARD	32920		28	24	23	80	36	24	Active	15-Feb-01	14-Feb-06
FLR05B426	HARRIS CORP AT MELBOURNE INTL AIRPORT	900 HARRY SUTTON ROAD	MELBOURNE	BREVARD	32901	1888	28	6	9	80	38	45	Active	11-Mar-01	10-Mar-06
FLR05C510	NORTHROP GRUMMAN CORPORATION	425 NORTH DR	MELBOURNE	BREVARD	32934		28	6	43	80	4	22	Active	07-Aug-01	06-Aug-06
FLR05D003	DRS OPTRONICS INC	100 N BABCOCK STREET	MELBOURNE	BREVARD	32935	6715	28	6	21	80	37	24	Active	05-Jan-01	04-Jan-06
FLR05D059	COCOA AUTO SALVAGE	775 CIDCO ROAD	COCOA	BREVARD	32926		28	24	34.3	80	46	4	Active	04-Jul-01	03-Jul-06
FLR05D050	FEDEX GROUND	501 HAVERTY COURT SUITE E	ROCKLEGE	BREVARD	32955		28	18	55	80	43	17	Active	21-Jan-01	20-Jan-06
FLR05B953	HARRIS SANITATION	7382 TALONA DR	WEST MELBOURNE	BREVARD	32904		28	5	48	80	40	27	Active	08-Feb-01	07-Feb-06
FLR05C299	INDIAN COVE MARINA INC	14 MYRTICE AVE	MERRITT ISLAND	BREVARD	32953		28	21	49	80	42	46	Active	18-Mar-01	17-Mar-06
FLR05A661	FEDERAL EXPRESS CORP MLBA	3960 DOW ROAD	MELBOURNE	BREVARD	32934		0	45	21	88	43	19	Active	04-Mar-02	03-Mar-07
FLR05A655	FEDERAL EXPRESS CORP COIA	2205 WEST HIGHWAY 520	COCOA	BREVARD	32926		28	24	6	80	49	17	Active	04-Mar-01	03-Mar-06
FLR05B135	PRAXAIR INCORPORATED	2801 HAMMOCK RD	MIMS	BREVARD	32754	5681	28	40	32	80	49	32	Active	02-Feb-01	01-Feb-06
FLR05E184	NORTHROP GRUMMAN CORPORATION	2000 NASA BLVD	MELBOURNE	BREVARD	32901	9650	28	5	51	80	39	18	Active	27-May-01	26-May-06
FLR05A345	GLOVER OIL CO INC	3109 S MAIN ST	MELBOURNE	BREVARD	32901		28	4	15	80	36	10	Active	01-May-01	30-Apr-06
FLR05C486	DAMRON AUTO PARTS EAST INC	7298 WAELTI DR	MELBOURNE	BREVARD	32940		28	22					Active	14-Jun-01	13-Jun-06
FLR05C065	NEWPORT MARINA	960 MULLET RD	CAPE CANAVERAL	BREVARD	32920		28	24	47	80	27	32	Active	07-Mar-01	06-Mar-06
FLR05B632	CANAVERAL CUSTOM BOATS INC	770 MULLET RD	CAPE CANAVERAL	BREVARD	32920		25	24	0.406	80	37	0.473	Active	03-May-01	02-May-06
FLR05A045	SEA RAY BOATS INC	200 SEA RAY DR	MERRITT ISLAND	BREVARD	32953		28	24	20	80	42	14	Active	24-Feb-01	23-Feb-06
FLR05B847	UNITED PARCEL SERVICE INC	1646 BARRETT DR	ROCKLEDGE	BREVARD	32955		28	19	46	80	44	1	Active	10-May-01	09-May-06
FLR05B842	UNITED PARCEL SERVICE INC	2730 KIRBY LANE	PALM BAY	BREVARD	32950		28	2	47	80	35	29	Active	10-May-01	09-May-06
FLR05A062	HARRIS ELECTRONIC SYSTEMS SECT	2400 PALM BAY RD NE	PALM BAY	BREVARD	32905		28	1	57	80	36	1	Active	26-May-01	25-May-06
FLR05A061	HARRIS ELECTRONIC SYSTEMS SECT	2800 JORDAN RD	MALABAR	BREVARD	32950		27	58	49	80	33	19	Active	26-May-01	25-May-06
FLR05C200	ELLER & COMPANY INC	230 JETTY DR	CAPE CANAVERAL	BREVARD	32920	0408	28	24	20	80	37	47	Active	27-May-01	26-May-06
FLR05B420	MELBOURNE AIRPORT AUTH	1 AIR TERMINAL PKWY	MELBOURNE	BREVARD	32901	1888	28	6	9	80	38	45	Active	04-Jul-01	03-Jul-06
FLR05C572	RANGER CONSTRUCTION IND INC	4210 OLD DIXIE HIGHWAY	GRANT	BREVARD	33949		28	57	2	80	32	21	Active	28-Feb-01	27-Feb-06
FLR05A947	CAPE CANAVERAL AIR STATION	45 CES/CEV, 1224 JUPITER STREET, MS 9125	PATRICK AFB	BREVARD	32925	3343	28	29	30	80	34	36	Active	28-Feb-01	27-Feb-06
FLR05A948	PATRICK AFB	45 CES/CEV, 1224 JUPITER STREET MS 9125	PATRICK AFB	BREVARD	32925	3343	28	15	10.5	80	36	21.6	Active	28-Feb-01	27-Feb-06
FLR05E163	CAPE MARINE SERVICES, INC	800 SCALLOP DR	CAPE CANAVERAL	BREVARD	32920		28	24	25	80	37	40	Active	26-Mar-01	25-Mar-06
FLR05F558	ALL AUTO SALVAGE, INC.	4755 CHENEY HIGHWAY	TITUSVILLE	BREVARD			28	32	36	80	55	41	Active	11-Sep-02	10-Sep-07
FLR05B201	STARK TRUSS INC	5050 KORBIN ROAD	ROCKLEDGE	BREVARD	32956	0057	28	19	11	80	43	44	Active	25-Jul-02	24-Jul-07
FLR05F534	AUTO SALVAGE UNLIMITED	7629 CORAL DR.	W. MELBOURNE	BREVARD	32904		28	6	1.5	80	40	31.5	Active	08-Aug-02	07-Aug-07
FLR05F513	SPACE COAST AUTO SALVAGE, INC.	5105 KORBIN AVENUE	ROCKLEDGE	BREVARD	32955		28	16	22	80	41	37	Active	14-Jun-02	13-Jun-07
FLR05F498	S&S SCRAP METAL	7050 KORBIN AVENUE	ROCKLEDGE	BREVARD	32955		28	16	16	80	41	54	Active	15-May-02	14-May-07
FLR05F466	MIMS EAST COAST AUTO SALVAGE, INC	2555 HAMMOCK ROAD	MIMS	BREVARD	32754		28	40	8.7	80	49	39	Active	05-May-02	04-May-07
FLR05C275	PROGRESSIVE RECYCLING	520 CIDCO RD	COCOA	BREVARD	32926		28	24	38	80	45	35	Active	22-Feb-02	21-Feb-07
FLR05C277	BANANA RIVER MARINE SERVICE	1360 S BANANA RIVER DRIVE	MERRITT ISLAND	BREVARD	32952		28	20		80	40		Active	20-Oct-01	19-Oct-06
FLR05F353	COAST ENGINE & EQUIPMENT COMPANY, INC DBA CEECO INC	8985 COLUMBIA RD UNIT A	CAPE CANAVERAL	BREVARD	32920		28	34	30	80	36	0	Active	16-Sep-01	15-Sep-06
FLR05F330	AIR LIQUIDE AMERICA CORPORATION	707 NORTH COURTENAY PARKWAY	MERRITT ISLAND	BREVARD	32953		28	28	30	80	41	15	Active	03-Oct-01	02-Oct-06
FLR05C132	SOUTHEAST PAPER RECYCLING CO	7300 F TECHNOLOGY DR	WEST MELBOURNE	BREVARD	32904		28	5	48	80	40	58	Active	27-Jul-01	26-Jul-06
FLR05E308	SUNRISE MARINA	505 GLEN CHEEK DRIVE	CAPE CANAVERAL	BREVARD	32920		28	24	20	80	37	47	Active	27-Jun-01	26-Jun-06
FLR05E294	BEYEL BROS INC	9155 GROUPER ROAD	CAPE CANAVERAL	BREVARD	32920		28	26	0	80	36	0	Active	27-Jul-01	26-Jul-06
FLR05B533	CANAVERAL PORT AUTHORITY	PO BOX 267	CAPE CANAVERAL	BREVARD	32920		28	34	30	80	36	0	Active	24-Feb-01	23-Feb-06
FLR05C407	BLUE HERON AWT PLANT	4800 DEEP MARSH RD	TITUSVILLE	BREVARD	32780		28	32	34	80	52	0	Active	02-Mar-01	01-Mar-06

Appendix B.2.a. Industrial Facilities, Stormwater Permit Holders, Active and Inactive (cont.)

FACILITY ID	FACILITY NAME	ADDRESS_1	CITY	COUNTY	ZIP5	ZIP4	LAT_ DD	LAT_ MM	LAT_ SS	LONG _ DD	LONG _ MM	LONG _ SS	PERMIT STATUS	ISSUE_ DATE	EXPIRE DATE
FLR05C408	OSPREY WATER RECLAMATION PLANT	1105 BUFFALO RD	TITUSVILLE	BREVARD	32796		28	37	30	80	49	15	Active	25-Feb-01	24-Feb-06
FLR05B950	PINEDA POINT MARINA	6175 N HARBOR CITY BLVD	MELBOURNE	BREVARD	32940		28	12	42	80	39	45	Active	21-Mar-01	20-Mar-06
FLR05A292	MELBOURNE VMF	680 N APOLLO BLVD	MELBOURNE	BREVARD	32935	5066	28	6	55	80	38	15	Active	25-Mar-01	24-Mar-06
FLR05B872	AARON SCRAP METALS	1745 BILTZ AVE	PALM BAY	BREVARD	32905	3413	28	2	33	80	35	22	Active	28-Feb-01	27-Feb-06
FLR05B440	SARNO ROAD LANDFILL	3379 SARNO RD	MELBOURNE	BREVARD	32935		28	7	53	80	41	30	Active	09-Mar-01	08-Mar-06
FLR05B439	CENTRAL DISPOSAL FACILITY	2250 ADAMSON RD	COCOA	BREVARD	32926		28	24	31	80	49	45	Active	09-Mar-01	08-Mar-06
FLR05B411	MELBOURNE AIRPORT AUTH	1 AIR TERMINAL PKWY, SUITE 220	MELBOURNE	BREVARD	32901	1888	28	6	9	80	38	45	Active	05-Mar-01	04-Mar-06
FLR05A049	APAC-FLORIDA INC, MACASPHALT DIVISON	6210 N US 1	MELBOURNE	BREVARD	32935		28	12	45	80	40	12	Active	21-Feb-01	20-Feb-06
FLR05B427	MELBOURNE AIRPORT AUTH	1 AIR TERMINAL PKWY	MELBOURNE	BREVARD	32901	1888	28	5	50	80	37	59	Active	27-Feb-01	26-Feb-06
FLR05C527	UNLIMITED GLASSWORKS INC	625 CHILDRE AVE	TITUSVILLE	BREVARD	32796		28	37	37	80	49	34	Active	28-Mar-01	27-Mar-06
FLR05C201	MID-FLORIDA FREEZER WAREHOUSE	9012 HERRING ST	CAPE CANAVERAL	BREVARD	32920		28	40	11	80	59	4	Active	22-Mar-01	21-Mar-06
FLR05C410	INTERSIL CORP	2401 PALM BAY RD NE	PALM BAY	BREVARD	32905		28	2	5	80	36	10	Active	09-Feb-01	08-Feb-06
FLR05C235	ROADWAY EXPRESS INC (T717)	4050 PINE INDUSTRIAL AVE	ROCKLEDGE	BREVARD	32955		28	17	22	80	42	7	Active	08-Feb-01	07-Feb-06
FLR05B951	WASTE MANAGEMENT/COCOA HAULING	3303 LAKE DR	COCOA	BREVARD	32926		28	21	34	80	46	42	Active	07-Feb-01	06-Feb-06
FLR05C306	DICTAPHONE MANUFACTURING	3900 W SARNO RD	MELBOURNE	BREVARD	32934	7298	28	4	1	80	38	0	Active	10-May-01	09-May-06
FLR05C180	VALKARIA AIRPORT	2865 GREEN BROOKE ST	VALKARIA	BREVARD	32950		27	57	42	80	33	37	Active	22-Feb-01	21-Feb-06
FLR05A010	SEA RAY BOATS	100 SEA RAY DR	MERRITT ISLAND	BREVARD	32953		28	24	19	80	41	52	Active	25-Feb-01	24-Feb-06
FLR05A042	SEA RAY BOATS INC	350 SEA RAY DR	MERRITT ISLAND	BREVARD	32953		28	25	0	80	42	30	Active	28-Feb-01	27-Feb-06
FLR05B251	DRS OPTRONICS INC	2330 COMMERCE PARK DR NE	PALM BAY	BREVARD	32905		28	3	3	80	36	8	Active	23-Feb-01	22-Feb-06
FLR05C039	AERC COM INC	4317-J FORTUNE PLACE	WEST MELBOURNE	BREVARD	32904		28	5	39	80	41	47	Active	15-Feb-01	14-Feb-06
FLR05C137	SEBASTIAN MUNICIPAL AIRPORT	1225 MAIN ST	SEBASTIAN	INDIAN RIVER	32958		27	48	46.09	80	29	44.19	Active	30-Jun-01	29-Jun-06
FLR05A691	FEDERAL EXPRESS CORP VRBA	685 8TH COURT	VERO BEACH	INDIAN RIVER	32962								Active	04-Mar-01	03-Mar-06
FLR05F377	PARKER HANNIFIN THD	1625 95TH AVE	VERO BEACH	INDIAN RIVER	32966		27	38	3	80	33	4	Active	28-Nov-01	27-Nov-06
FLR05F367	FLIGHTSAFETY ACADEMY	3530 CHEROKEE DRIVE	VERO BEACH	INDIAN RIVER	32960		27	40	51	80	24	51	Active	17-Oct-01	16-Oct-06
FLR05E296	TURBINE SUPPORT INC	2550 2560 AND 2510 AIRPORT N DR	VERO BEACH	INDIAN RIVER	32906		27	40	51	80	24	51	Active	10-Aug-01	09-Aug-06
FLR05B082	JOHANNSEN BOAT WORKS INC	690 4TH PL	VERO BEACH	INDIAN RIVER	32962		27	36	30	80	23		Active	04-Jun-01	03-Jun-06
FLR05E219	VERO MARINE CENTER INC	12 ROYAL PALM BLVD	VERO BEACH	INDIAN RIVER	32960		27	38	0.9	80	22	59.6	Active	19-May-01	18-May-06
FLR05B210	OCEAN SPRAY CRANBERRIES INC	925 74TH AVE SW	VERO BEACH	INDIAN RIVER	32968	9702	27	35	0	80	29	39	Active	24-Feb-01	23-Feb-06
FLR05C138	SEBASTIAN MUNICIPAL AIRPORT	1225 MAIN ST	SEBASTIAN	INDIAN RIVER	32958		27	48	46	80	29	44	Active	12-May-01	11-May-06
FLR05E147	SUN AVIATION	3350 CHEROKEE DR	VERO BEACH	INDIAN RIVER	32960		27	40	51	80	24	51	Active	01-May-01	30-Apr-06
FLR05B861	UNITED PARCEL SERVICE INC	4555 41ST ST	VERO BEACH	INDIAN RIVER	32967		27	40	3	80	26	0	Active	24-May-01	23-May-06
FLR05C532	THE NEW PIPER AIRCRAFT INC	2926 PIPER DRIVE	VERO BEACH	INDIAN RIVER	32960	1955	27	39	10	80	24	30	Active	13-Feb-01	12-Feb-06
FLR05C570	PIONEER CONCRETE TILE, INC	13000 FLORA AVENUE	HOBE SOUND	MARTIN	33455		27	2	31	80	8	30	Active	16-Feb-01	15-Feb-06
FLR05A476	WHITICAR BOAT WORKS INC	3636 SE OLD ST LUCIE BLVD	STUART	MARTIN	34996		27	10	12	80	12	24	Active	25-Feb-01	24-Feb-06
FLR05B337	BAYLEY PRODUCTS D/B/A SAILFISH MARINA	3565 SE ST LUCIE BLVD	STUART	MARTIN	34997		27	9	0.67	80	11	0.71	Active	11-Mar-01	10-Mar-06
FLR05B625	INDIANTOWN GENERATING PLANT	13303 SW SILVER FOX LANE	INDIANTOWN	MARTIN	34956		27	2	20	80	31	0	Active	24-Feb-01	23-Feb-06
FLR05A737	WITHAM FIELD	1871 SE AIRPORT RD	STUART	MARTIN	34996		27	10	0.9	80	13	0.27	Active	03-Jun-01	02-Jun-06
FLR05C015	INDIANTOWN AIRPORT	13301 S W CITRUS BLVD	INIDANTOWN	MARTIN	34956		27	2	10	80	26	25	Active	23-Mar-01	22-Mar-06
FLR05B520	SEAGATE MARINA	18753 SE FEDERAL HWY	TEQUESTA	MARTIN	33469		26	58	0.577	80	5	0.251	Active	26-Feb-01	25-Feb-06
FLR05A739	GALAXY AVIATION OF STUART	2555 SE DIXIE HWY	STUART	MARTIN	34996		27	10	0	80	13	27	Active	17-Feb-01	16-Feb-06
FLR05A767	STUART YACHT BUILDERS INC	450 SW SALERNO RD	STUART	MARTIN	34997		27	7	30	80	15	40	Active	11-Mar-01	10-Mar-06
FLR05A281	ARMELLINI EXPRESS LINES INC	3446 SW ARMELLINI AVE	PALM CITY	MARTIN	34990		27	9	50	80	18	18	Active	15-Mar-01	14-Mar-06
FLR05B684	JIM SMITH BOATS INC	2980 SE DOMINICA TERR	STUART	MARTIN	34997	5711	27	9	1.26	80	12	47.4	Active	08-Feb-01	07-Feb-06
FLR05F446	MARINEMAX OF SOUTHEAST FLORIDA, INC	2370 PALM CITY ROAD	STUART	MARTIN	34994		27	17	0.6229	80	25	0.7303	Active	01-Mar-02	28-Feb-07
FLR05F391	TURBOCOMBUSTOR TECHNOLOGY, INC	3651 SE COMMERCE AVENUE	STUART	MARTIN	34997		27	9	4	80	13	9	Active	02-Feb-02	01-Feb-07
FLR05F342	CAULKINS INDIANTOWN CITRUS CO	19100 SW WARFIELD BOULEVARD	INDIANTOWN	MARTIN	34956		27	2	30	80	31	10	Active	26-Aug-01	25-Aug-06
FLR05A742	STUART JET CENTER LTD	2501 SE AVIATION WAY	STUART	MARTIN	34996		27	11	0.505	80	13	0.114	Active	14-Oct-01	13-Oct-06
FLR05B468	PALM CITY II LANDFILL	9101 BUSCH ST	PALM CITY	MARTIN	34990		27	10	45	80	22	15	Active	29-Jul-01	28-Jul-06
FLR05E303	VOUGHT AIRCRAFT INDUSTRIES INC	1801 SE AIRPORT ROAD	STUART	MARTIN	34997		27	10	41	80	13	58	Active	20-Jun-01	19-Jun-06
FLR05C113	RECYCLE AMERICA	9001 SW BUSCH ST	PALM CITY	MARTIN	34990		27	11	0	80	22	3	Active	24-Feb-01	23-Feb-06

Appendix B.2.a. Industrial Facilities, Stormwater Permit Holders, Active and Inactive (cont.)

FACILITY ID	FACILITY NAME	ADDRESS_1	CITY	COUNTY	ZIP5	ZIP4	LAT_DD	LAT_MM	LAT_SS	LONG_DD	LONG_MM	LONG_SS	PERMIT STATUS	ISSUE_DATE	EXPIRE DATE
FLR05B960	NICHOLS SANITATION	7700 SE BRIDGE RD	HOBE SOUND	MARTIN	33455		27	2	49	80	9	15	Active	02-Feb-01	01-Feb-06
FLR05D014	FINEST KIND MARINA	3585 SE ST LUCIE BLVD	STUART	MARTIN	34997	5433	27	9	0.36	80	11	0.45	Active	30-Nov-00	29-Nov-05
FLR05D013	NORTHSIDE YACHT CLUB AND MARINA	400 NW ALICE AVENUE	STUART	MARTIN	34994	1008	27	12	30	80	15	40	Active	02-Dec-00	01-Dec-05
FLR05C489	NORTHSIDE SERVICE CENTER	272 N FLAGLER	STUART	MARTIN	34994	1008	27	12	25	80	15	42	Active	02-Dec-00	01-Dec-05
FLR05C303	AMERICAN CUSTOM YACHTS INC	6800 SW JACK JAMES DR	STUART	MARTIN	34997		27	7	29	80	16	17	Active	11-Feb-01	10-Feb-06
FLR05B677	SOUTH HUTCHINSON ISLAND WWTP	7601 S OCEAN DR	JENSEN BEACH	MARTIN	34957		27	29	28	80	8	5	Active	04-Mar-01	03-Mar-06
FLR05B677	SOUTH HUTCHINSON ISLAND WWTP	7601 S OCEAN DR	JENSEN BEACH	MARTIN	34957		27	29	28	80	8	5	Active	04-Mar-01	03-Mar-06
FLR05A118	FLORIDA EAST COAST RAILWAY CO	353 FLORIDA AVE	FT PIERCE	ST. LUCIE	33450	4362	27	26	2	80	19	16	Active	10-Feb-01	09-Feb-06
FLR05F452	FRS ST. LUCIE / FT PIERCE	4100 SEVITZ ROAD	FT PIERCE	ST. LUCIE	34981		27	23	27	80	21	57	Active	02-Mar-02	01-Mar-07
FLR05C129	SOUTHEAST PAPER RECYCLING CO	4205 METZGAR RD	FT PIERCE	ST. LUCIE	34947		27	27	15	80	22	0	Active	04-Aug-01	03-Aug-06
FLR05E185	RANGER CONSTRUCTION INDS INC FT PIERCE ASPHALT	4510 GLADES CUT OFF RD	FT PIERCE	ST. LUCIE	34981		27	23	41	80	22	19	Active	28-Feb-01	27-Feb-06
FLR05E155	FT PIERCE PORT ST LUCIE SATELLITE VMF	2275 MIDPORT ROAD	PORT ST LUCIE	ST. LUCIE	34952	4872	27	16	22	80	17	44	Active	12-May-01	11-May-06
FLR05B431	FAIRWINDS GOLF COURSE	4400 FAIRWINDS DR	FT PIERCE	ST. LUCIE	34946		27	0	0	80	21	30	Active	10-May-01	09-May-06
FLR05D099	WASTE MANAGEMENT, INC OF FLORIDA	3898 SELVITZ ROAD	FORT PIERCE	ST. LUCIE	34981		27	23	43	80	21	58	Active	21-Feb-01	20-Feb-06
FLR05A560	TROPICANA PRODUCTS INC	6500 GLADES CUT OFF RD	FT PIERCE	ST. LUCIE	34981		27	22	35	80	23	0	Active	18-Feb-01	17-Feb-06
FLR05F532	SECOND CHANCE SALVAGE, INC.	1303 ANGLE ROAD	FORT PIERCE	ST. LUCIE	34947		27	27	43	80	22	14	Active	20-Jul-02	19-Jul-07
FLR05B469	GLADES CUTOFF RD LANDFILL	6120 GLADES CUTOFF RD	FORT PIERCE	ST. LUCIE	34981		27	31	27	80	23	44	Active	28-Feb-01	27-Feb-06
FLR05D048	SOUTHERN CULVERT-FORT PIERCE	1031 DIGIORGIO ROAD	FORT PIERCE	ST. LUCIE	34982		27	24	50	81	20	20	Active	21-Feb-01	20-Feb-06
FLR05A689	FEDERAL EXPRESS CORP FPRA	480 NW ENTERPRISE	PORT ST LUCIE	ST. LUCIE	34986		27	19	17	80	24	41	Active	04-Mar-01	03-Mar-06
FLR05C396	FREEDOM PLASTICS INC	3206 ENTERPRISE RD	FT PIERCE	ST. LUCIE	34982		27	24		80	20		Active	03-Feb-01	02-Feb-06
FLR05A307	HARBORTOWN MARINA/BOAT YARD	1936 HARBORTOWN BOATYARD	FT PIERCE	ST. LUCIE	34946		27	28	13	80	19	33	Active	01-Feb-01	31-Jan-06
FLR05C139	DICKERSON FLORDIA INC PLANT 14	3760 SELVITZ RD	FT PIERCE	ST. LUCIE	34982		27	24	45	80	21	50	Active	01-Feb-01	31-Jan-06
FLR05F515	SHORT LOAD CONCRETE, INC.	3825 SELVITZ ROAD	FT. PIERCE	ST. LUCIE	34981		27	23	42	80	21	59	Active	26-Jun-02	25-Jun-07
FLR05B023	CORONADO PAINT CO	308 OLD COUNTY ROAD	EDGEWATER	VOLUSIA	32132	0308	28	59	16	80	54	41	Active	04-May-01	03-May-06
FLR05A119	FLORIDA EAST COAST RAILWAY CO	507 S MYRTLE AVE	NEW SMYRNA BEACH	VOLUSIA	32170	0279	29	0	43	80	15	29	Active	15-Mar-01	14-Mar-06
FLR05E324	HIBISCUS USED AUTO AND TRUCK PARTS	128 N OLD COUNTY RD	EDGEWATER	VOLUSIA	32132		28	59	28	80	54	41	Active	21-Oct-01	20-Oct-06
FLR05C333	WATER RECLAMATION FACILITY	3019 W SR 44	NEW SMYRNA BEACH	VOLUSIA	32168		29	1	12	80	59	43	Active	04-Feb-01	03-Feb-06
FLR05F329	LIGHTHOUSE/VIP PRODUCTS INC	703 SOUTH STREET	NEW SMYRNA BEACH	VOLUSIA	32168		29	3	36	80	57	8	Active	23-Aug-01	22-Aug-06

Appendix B.2.b. Industrial Facility Wastewater Discharge Permit Holders in the Indian River Lagoon Basin

Permit No.	NAME	ADDRESS	CITY	STATUS	NPDES	DESIGN CAP	PLANUNIT	Water Use Class
NPDES Permits – surface water discharge								
FL0000680	RELIANT ENERGY (FORMERLY OUC/INDIAN RIVER)	U.S. HWY #1 AND KING'S HIGHWAY	TITUSVILLE	A	Y	820.0000	North Indian River Lagoon Unit	3
FL0001473	FPL CAPE CANAVERAL PLANT	6000 N US HWY 1	COCOA	A	Y	800.0000	North Indian River Lagoon Unit	3
FL0002984	VERO BEACH MUNICIPAL POWER PLANT	17TH STREET AND INDIAN RIVER	VERO BEACH	A	Y	181.0000	South Central Indian River Lag	2
FL0037770	IRCUD/LANDFILL NPDES (IW)	1325 74TH AVENUE SW	VERO BEACH	A	Y		South Central Indian River Lag	3
FL0037940	IRCUD/SOUTH COUNTY REVERSE OSMOSIS WATER TRTMT. FAC.	1550 SOUTHWEST 9TH AVENUE	VERO BCH.	A	Y	1.5000	South Central Indian River Lag	3
FL0042005	MORTON SALT NPDES (IW)	450 CARGO ROAD	PORT CANAVERAL	A	Y	0.0840	Banana River Unit	3M
FL0042544	VERO BEACH REVERSE OSMOSIS WATER TRTMT FAC.	3225 NORTH U S HIGHWAY 1	VERO BEACH	A	Y	1.5000	South Central Indian River Lag	3
FL0044334	NASA/ SEA WATER IMMERSION FACILITY	SECTION 13, T 22 S, R 37 E	KENNEDY SPACE CENTER	A	Y	0.0300	Banana River Unit	3M
FL0166511	IRCUD/HOBART PARK REVERSE OSMOSIS WATER TRTMT.PLANT	NW CORNER 58TH AVENUE @ 77TH ST.	VERO BEACH	A	Y	0.7500	South Central Indian River Lag	3
FL0176231	BLUEPOINTS FISHERIES SCALLOP RINSATE DISCHARGE	727 SCALLOP DRIVE	CAPE CANAVERAL	A	Y	0.1600	Banana River Unit	3M
Ground water permits								
FLA010288	NASA/SRB RECOVERY FAC (IW)	HANGAR ROAD	CAPE CANAVERAL AFB	A	N	0.0135	Banana River Unit	3
FLA010299	NASA/LC 39B COMBINED (IW)	28TH STREET S.E. (KSC)	KENNEDY SPACE CEN	A	N	0.5000	Banana River Unit	3
FLA010302	CAPE CANAVERAL AFS/COMPLEX 40	CONTRACTOR RD SOUTH OF VAB	KENNEDY SPACE CENTER	A	N	0.3500	Banana River Unit	3
FLA010306	CCAS/COMPLEX 36A	CAPE CANAVERAL AIR STATION	PATRICK AIR FORCE BASE	A	N		Banana River Unit	3M
FLA010307	NASA/LC 39A COMBINED PERMITS (IW)	28TH STREET S.E. (KSC)	KENNEDY SPACE CENTER	A	N	0.5000	Banana River Unit	3
FLA010309	CCAS/LC 17B	CCAS/MULTIPLE LAUNCH COMPLEXES	CAPE CANAVERAL AFS	A	N	0.1120	Banana River Unit	3M
FLA010313	NASA/SPACEPORT BUS WASH RECYCLE SYSTEM	SPACEPORT USA	KENNEDY SPACE CNTR	A	N	0.0050	North Indian River Lagoon Unit	3
FLA010379	RINKER MATERIALS/PORT CANAVERAL CONCRETE BATCH PLANT	209 GEORGE KING	PORT CANAVERAL	A	N	0.0060	Banana River Unit	3
FLA010380	RINKER MATERIALS/TITUSVILLE CONCRETE BATCH PLANT	511 GARDEN ST	TITUSVILLE	A	N	0.0020	North Indian River Lagoon Unit	3
FLA010389	SOUTH BREVARD WATER COOP (IW)	41 MOHICAN WAY	MELBOURNE BEACH	A	N	0.0360	North Central Indian River Lag	2
FLA010392	BIG THREE INDUSTRIAL GAS	STATE ROAD # 3, NASA GATE #3	MERRITT ISLAND	A	N	0.0142	North Indian River Lagoon Unit	3
FLA010393	NEVINS FRUIT COMPANY, INC	2900 PARRISH RD @ US 1	TITUSVILLE	A	N	0.0250	North Indian River Lagoon Unit	2
FLA010398	RAINBOW (BAY WASH OF MELBOURNE) CAR WASH/WICKHAM RD	745 S. WICKHAM ROAD	WEST MELBOURNE	A	N		North Central Indian River Lag	3
FLA010414	WINGATE RESERVES REVERSE OSMOSIS (IW)	106 SIGNATURE DR	S MELBOURNE BEACH	A	N	0.0070	North Central Indian River Lag	2
FLA010415	HARRIS MALABAR FACILITY	2800 JORDAN BLVD.	MALABAR	A	N	0.0940	North Central Indian River Lag	3
FLA010445	LEROY E SMITH'S & SONS, INC CITRUS PACKER	SR-5A NORTH OF SO GIFFORD RD	GIFFORD	C	N	0.0080	South Central Indian River Lag	3
FLA010446	HALE INDIAN RIVER GROVES INC	9255 US HIGHWAY 1	WABASSO	A	N	0.0050	South Central Indian River Lag	2
FLA010448	IMG CITRUS (AKA BLUE GOOSE DBA/DOLE CITRUS PACKER)(IW)	2600 45TH STREET	VERO BEACH	A	N	0.0170	South Central Indian River Lag	3
FLA010449	GRAVES BROTHERS/UNIT 3	US 1 BETWEEN S.R.510 AND 87TH STREET	WABASSO	A	N	0.0220	South Central Indian River Lag	3
FLA010450	UNITED INDIAN RIVER PACKERS, INC	STATE RD. 5A & HOBART RD.	WABASSO	A	N	0.0150	South Central Indian River Lag	3
FLA010451	GRACEWOOD FRUIT COMPANY INC	1626 90TH AVENUE	VERO BEACH	A	N	0.0480	South Central Indian River Lag	3
FLA010452	HOGAN & SONS CITRUS PACKERS	US 1 NORTH OF 27TH ST.	VERO BEACH	A	N	0.0080	South Central Indian River Lag	3
FLA010453	VERO BEACH CITRUS PACKERS	601 US HIGHWAY # 1	VERO BEACH	A	N	0.0500	South Central Indian River Lag	2
FLA010454	GRAVES BROTHERS/UNIT 1	CORNER RD 510 & OLD US 1	WABASSO	A	N	0.0120	South Central Indian River Lag	3
FLA010457	OSLO CITRUS GROWER CITRUS PACKING	695 SOUTHWEST U.S. HIGHWAY 1, OSLO	VERO BEACH	A	N	0.0210	South Central Indian River Lag	2
FLA010458	INDIAN RIVER EXCHANGE PACKERS	7355 S.W. 9TH STREET	VERO BEACH	A	N	0.0150	South Central Indian River Lag	3
FLA010461	COUNTRYSIDE NORTH MOBILE HOME PARK (IW)	8775 20TH STREET	VERO BEACH	A	N	0.0770	South Central Indian River Lag	3
FLA010474	CIBA-GEIGY/PWDS	7145 58TH AVENUE	VERO BEACH	A	N		South Central Indian River Lag	3
FLA010480	OCEAN SPRAY CRANBERRIES/SPRAYFIELD (IW)	925 74TH AVENUE, SW	VERO BEACH	A	N	0.3500	South Central Indian River Lag	3
FLA010482	GOLDEN RIVER FRUIT PACKERS	625 SW 66TH AVE	VERO BEACH	A	N	0.0300	South Central Indian River Lag	3
FLA010494	SUNRISE LAUNDROMAT	6375 85TH STREET	WABASSO	A	N	0.0070	South Central Indian River Lag	3
FLA011143	RINKER MATERIALS/NEW SMYRNA BEACH CONCRETE PLANT	SOUTH DIXIE AND SMITH STREET	NEW SMYRNA BEACH	A	N	0.0030	Mosquito Lagoon Unit	2
FLA011189	TARMAC/EDGEWATER CONCRETE BATCH PLANT	200 NORTH FLAGLER AVENUE	EDGEWATER	A	N	0.0450	Mosquito Lagoon Unit	2
FLA012882	TRACTOR SUPPLY CO (IW)	3660 W NEW HAVEN AVE	MELBOURNE	N	N		North Central Indian River Lag	3
FLA016237	HURRICANE CAR WASH II RECYCLE SYSTEM (IW)	4630 BABCOCK STREET NORTHEAST	PALM BAY	A	N		North Central Indian River Lag	3
FLA016267	VCUD/SOUTHEAST BARN EQUIPT. & TRUCK WASH RECYCLE SYS.	US1 @ WAYNE AVENUE	NEW SMYRNA BEACH	A	N		Mosquito Lagoon Unit	2
FLA016525	GREENE RIVER CITRUS PACKING - WEST	1015 90TH AVENUE	VERO BEACH	A	N	0.0450	South Central Indian River Lag	3
FLA016537	OSMAN LINCOLN MERCURY VEHICLE WASH RECYCLE SYSTEM	625 EAST NASA BOULEVARD	MELBOURNE	A	N	0.0028	North Central Indian River Lag	3
FLA017160	NASA/ K6-1696 RECYCLE SYSTEM	CRCA FACILITY, CONTRACTORS ROAD	KENNEDY SPACE CENTER	A	N	0.0230	Banana River Unit	3
FLA017257	HARRIS SANITATION RECYCLE SYSTEM	7382 TALONA DRIVE	WEST MELBOURNE	A	N	0.0100	North Central Indian River Lag	3
FLA017359	SEBASTIAN CAR WASH II RECYCLE SYSTEM	US 1, NW OF SEBASTIAN CEMETERY	SEBASTIAN	A	N	0.0080	South Central Indian River Lag	2
FLA017470	AIR LIQUIDE AMERICAN (UNDER BIG THREE)	7007 N COURTENAY PKWY	MERRITT ISLAND	A	N		North Indian River Lagoon Unit	3
FLA103641	PRAXAIR/MIMS PERCOLATION PONDS	2801 HAMMOCK ROAD	MIMS	A	N	0.1000	North Indian River Lagoon Unit	2
FLA104221	INTERSIL CORPORATION/MELBOURNE FACILITY	2401 PALM BAY ROAD	PALM BAY	A	N	1.8000	North Central Indian River Lag	3
FLA104477	GREEN RIVER CITRUS PACKING/ EAST	6920 US HWY 1	VERO BEACH	A	N	0.0180	South Central Indian River Lag	3
FLA165387	MACASPHALT VEHICLE WASH (IW)	6210 N. US HWY 1	MELBOURNE	A	N	0.0230	North Indian River Lagoon Unit	2
FLA171701	HAMMOND GROVES CITRUS PACKING RECYCLE SYSTEM	3885 41ST STREET	VERO BEACH	A	N	0.0090	South Central Indian River Lag	3
FLA176893	NASA/FOIL SHOP RECYCLE SYSTEM (BUILDING K6-1996)	FOIL SHOP-CONTRACTORS ROAD	KENNEDY SPACE CENTER	A	N	0.0001	Banana River Unit	3
FLA178543	OAK MARSH II DBA COLLEGE CAR WASH	3720 WICKHAM RD.	MELBOURNE	A	N		North Indian River Lagoon Unit	2
FLA179639	BAKER CONCRETE CONSTRUCTION	PAD 37A	CAPE CANAVERAL AS	N	N		Banana River Unit	3
FLA179825	CCAS/LC 17A	LIGHTHOUSE RD	CCAS	A	N		Banana River Unit	3M
FLA179884	CCAS/LC 36B	CENTRAL CONTROL RD	CCAS	A	N		Banana River Unit	3M
FLA180211	INLAND MARINA INC	582 S BANANA RIVER DR	MERRITT ISLAND	N	N		Banana River Unit	3
FLA180351	VICTORY GROVES CITRUS PROCESSING FACILITY	375 COMMERCE PKWY	ROCKLEDGE	A	N		North Indian River Lagoon Unit	2
FLA183725	CCAS/LC 37B	BEACH RD	CCAS	A	N		Banana River Unit	3
FLA187968	NASA/PAYLOAD TRANSPORT CANISTER WASH SYSTEM (IW)	KSC INDUSTRIAL AREA FACILITY M7-777	KENNEDY SPACE CENTER	A	N		Banana River Unit	3
FLA188522	LEXUS/TOYOTA OF MELBOURNE CAR WASH RECYCLE SYSTEM (IW)	24 NORTH HARBOR CITY BLVD	MELBOURNE	A	N		North Central Indian River Lag	3
FLA190080	TRADEMARK METALS RECYCLING (IW)	490 ANSIN RD	ROCKLEDGE	A	N		North Indian River Lagoon Unit	2
FLA271870	MICRO TECHNOLOGY INC (IW)	255 WEST DR	MELBOURNE	N	N		North Central Indian River Lag	3
FLA272680	FLORIDA RIVER PKG HOUSE/CITRUS PACKERS (IW)	OSLO RD.	VERO BEACH	A	N	0.0030	South Central Indian River Lag	3
FLA272698	ORMANTINE USA WAREHOUSE (IW)	1740 CONVAIR ST	PALM BAY	N	N		North Central Indian River Lag	3
FLA272701	EPIK COMMUNICATIONS (IW)	PARISH RD	TITUSVILLE	N	N		North Indian River Lagoon Unit	2
FLA276553	NASA/COMPLEX 34 (IW)	JOHN F KENNEDY SPACE CENTER	KENNEDY SPACE CENTER	N	N		Banana River Unit	3
FLA277631	VERO BEACH RESEARCH FARM (IW)	5690 58TH AVE	VERO BEACH	N	N		South Central Indian River Lag	3
FLA280097	AMERICAN AIR & HEAT (IW)	225 YELLOW PLACE	ROCKLEDGE	N	N		North Indian River Lagoon Unit	2
FLA281140	MC MILLWORKS (IW)	345 WEST DR.	MELBOURNE	N	N		North Central Indian River Lag	3
FLA284114	CORNWELL PROJECT (IW)	374 WEST DR.	MELBOURNE	N	N		North Central Indian River Lag	3
FLA286583	SPACE COAST VETERNARY HOSPITAL (IW)	4750 N. COURTNEY PARKWAY	MERRITT ISLAND	N	N		Banana River Unit	3
FLA287695	GRAND RENTAL STATION/MELBOURNE (IW)	3730 W HWY 192	MELBOURNE	N	N		North Central Indian River Lag	3

Source: FDEP Permit Files

Indian River Lagoon

Surface Water Improvement & Management (SWIM) Plan

2002 Update

Issued in compliance with the
Surface Water Improvement and Management Act
(Chapter 373.451 – 373.4595, Florida Statutes)
and
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Florida Department of Environmental Protection
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Prepared by:

St. Johns River Water Management District
Joel Steward
Ron Brockmeyer
Robert Virnstein

South Florida Water Management District
Pat Gostel
Patti Sime
Joel VanArman

With Major Contributions From:

SJRWMD
Ed Carter
Robert Day
Whitney Green
Jan Miller
Fred Morris
Lori Morris
Wendy Tweedale
&
Gilbert Sigua
(currently with USDA)

SFWMD
Barbara Brown
Gina Colonna
Celia Conrad
Dan Crean
Corki Ettinger
Cynthia Gefvert
Patty Goodman
Boyd Gunsalus
Dan Haunert
Gordon Hu
Kim Jacobs
Steve Krupa
Kim O'Dell
Becky Robbins
Dawn Rose
Yongshan Wan
Barbara Welch

FDEP
Fred Calder
Wayne Magley
Mary Paulic

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