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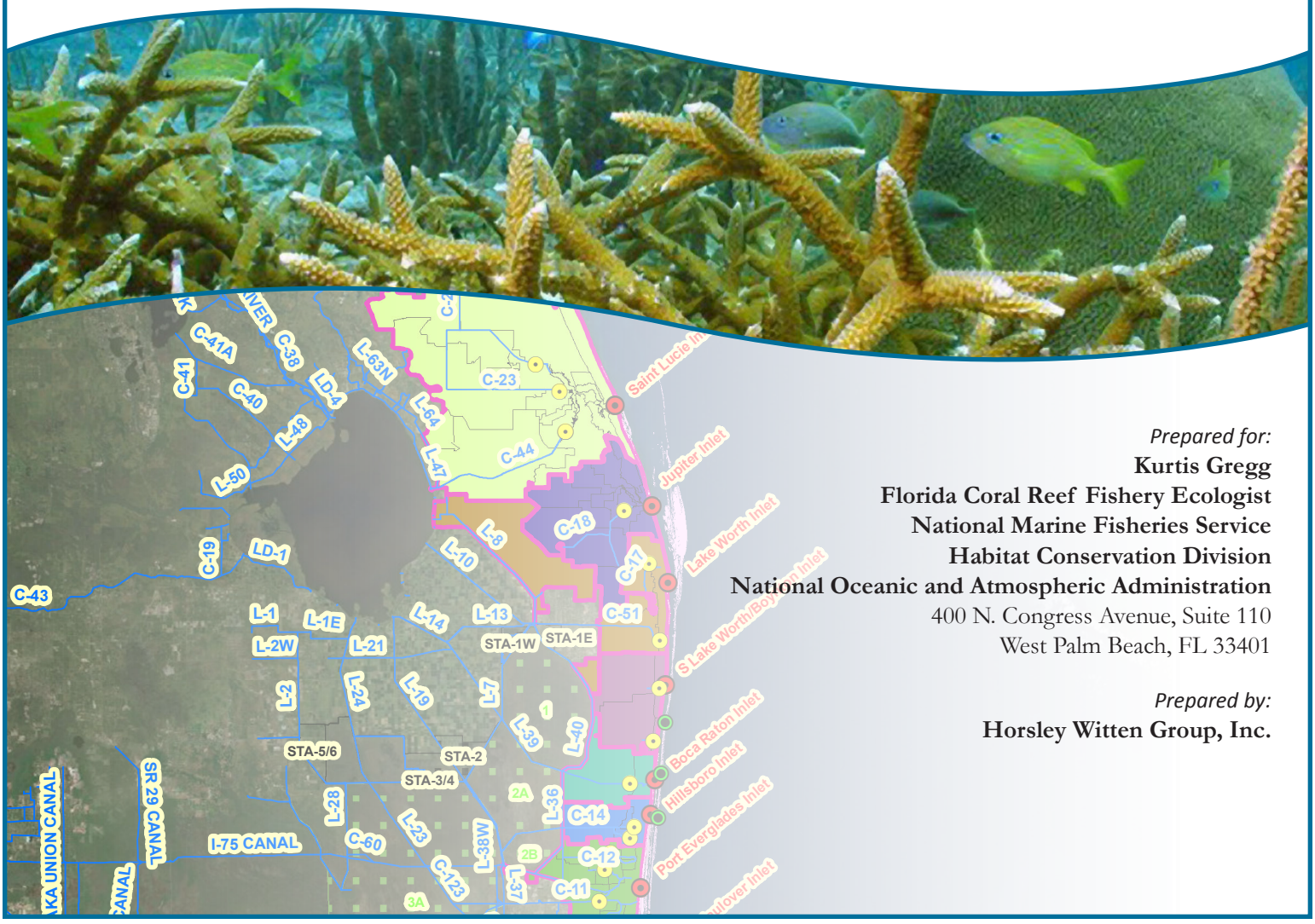
Meeting Summary Report

Watershed Scale Planning to Reduce LBSP for the Protection of Coral Reef Ecosystems in Southeast Florida

April 17, 2015, 8:30 AM to 5:00 PM

SFWMD Headquarters Office, 3301 Gun Club Road, West Palm Beach, Florida
Lake Okeechobee Conference Room, Building B-2

May 22, 2015



Prepared for:
Kurtis Gregg
Florida Coral Reef Fishery Ecologist
National Marine Fisheries Service
Habitat Conservation Division
National Oceanic and Atmospheric Administration
400 N. Congress Avenue, Suite 110
West Palm Beach, FL 33401

Prepared by:
Horsley Witten Group, Inc.

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1. Introduction

The NOAA Coral Reef Conservation Program has been working as an integral partner in the Southeast Florida Coral Reef Initiative (SEFCRI) to improve the understanding, management and protection of the southeast Florida coral reef tract. As part of this effort, the SEFCRI partnership has focused on the issue of land based sources of pollution (LBSP)[1] and has been interested in broadening the discussion of coral reef protection to include the management of the watersheds that contribute pollutant loads to the coral reef ecosystem. In this context, it is important to consider that the coral reef ecosystem is inclusive of the coral reefs themselves, as well as the variety of habitats that support the fish and other marine and estuarine organisms that are interdependent upon the coral. NOAA contracted with the Horsley Witten Group, Inc. (HW) to delineate the land areas contributing water to each of the nine inlets along the southeast Florida coastline that discharge in the vicinity of the coral reef tract (see Figure 1), and to then compile and organize a significant body of information about LBSP in southeast Florida within the framework of the nine Inlet Contributing Areas (ICAs). This work is compiled in the document *Watershed Scale Planning to Reduce Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida, An Overview and Data Gap Assessment* (January, 2015) (The LBSP Report), is available through NOAA's Coral Reef Information System[2]. NOAA then contracted with HW to facilitate a workshop among SEFCRI representatives and related practitioners to present the document and identify a geographic focus area for next steps. This meeting summary report presents a summary of the discussions and outcomes of that meeting.

[1] The SEFCRI LBSP Focus Team is comprised of representatives from 13 organizations: Broward County Environmental Protection Department*; Cry of the Water; Florida Department of Environmental Protection, Beaches and Coastal Resources; Florida Department of Environmental Protection, Southeast District Office; Florida Fish and Wildlife Conservation Commission; Florida Atlantic University, Harbor Branch Oceanographic Institute; National Coral Reef Institute; The Nature Conservancy*; Nova Southeastern University; Palm Beach County Department of Environmental Resource Management; South Florida Water Management District; US Department of Agriculture/Nature Resources Conservation Service; US Environmental Protection Agency*. An asterisk (*) identifies the primary points of contact for the team.

[2] http://www.coris.noaa.gov/activities/projects/watershed/

2. Meeting overview

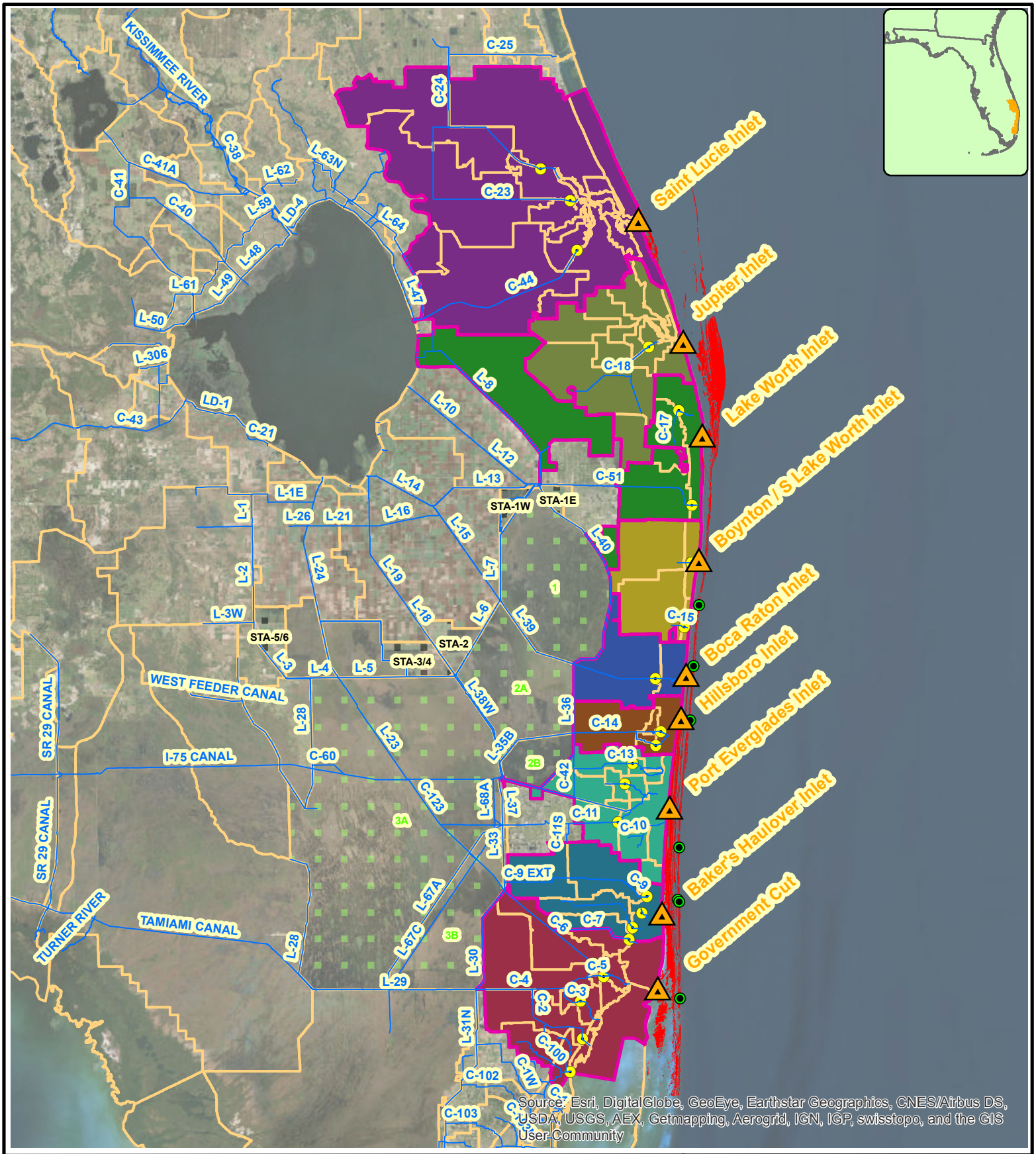
A meeting of invited participants took place on April 17, 2015 at the South Florida Water Management District (SFWMD) Headquarters office[3]. The goal of the meeting was to:

> *Prioritize the nine Inlet Contributing Areas (ICAs) and identify one ICA where the NOAA Coral Reef Conservation Program and partners will focus efforts in the near future to develop and implement a management plan to reduce LBSP impacts to the coral reef tract of southeast Florida.*

The meeting was organized and hosted by NOAA's Coral Reef Conservation Program, and was managed by Kurtis Gregg, a contractor with ECS-Federal, Inc. in support of NOAA Fisheries Service, Habitat Conservation Division. Invitees to the meeting represented various state agencies, three of the four counties and local researchers, most of whom are directly involved in the Southeast Florida Conservation of Reefs Initiative (SEFCRI). A list of attendees is provided in Appendix A. Facilitation as well as technical presentations were provided by Elizabeth Baker, Senior Environmental Planner, and Nigel Pickering, Senior Water Resources Engineer, both with the Horsley Witten Group (HW) under contract to NOAA.

The agenda for the day is provided in Appendix B. The agenda for the meeting included a welcome by Dana Wusinich-Mendez, Atlantic and Caribbean Team Lead for NOAA's Coral Reef Conservation Program, and several presentations in the morning by Kurtis Gregg, Elizabeth Baker and Nigel Pickering, along with two discussion sessions in the afternoon to achieve the meeting goals. Kurtis presented an overview of a literature review he prepared in 2013 describing how typical pollutants from Land-Based Sources of Pollution (LBSP) are known to impact coral reef ecosystem habitats, including seagrass, mangroves, oysters and hard bottom, as well as the coral reef tract offshore of southeast Florida. Elizabeth presented an overview of watershed-based assessment, planning and management, drawing on the 9 elements of watershed plans promoted by the Environmental Protection Agency (EPA). She also presented a basic overview of the boundaries of the 9 inlet contributing areas (ICAs) delineated by HW (Figure 1), as well as a basic introduction to the LBSP report. Nigel then presented a detailed overview of the data and assessment in the LBSP report, including a number of comparisons among the 9 ICA's. The afternoon consisted of a discussion session to identify what criteria the group would use to prioritize ICAs, and then a second discussion session to apply those criteria in order to prioritize the ICAs. A set of handouts providing a 2-page overview of each of the ICAs was distributed to the participants to assist in the discussion. These discussions and their outcomes are presented in more detail in Sections 3 and 4 of this summary report. The PowerPoint© presentations are included in Appendix C. The handouts summarizing the information for each ICA are included in Appendix D.

[3] The SFWMD headquarters office is a central location where several staff members from the Florida DEP Coral Reef Conservation Program are also housed.



Legend

- Inlets
- Domestic Wastewater Outfalls
- Salinity Control Structures
- Canals
- SW Treatment Areas
- Conservation Areas
- Watersheds
- Inlet Contributing Areas
- Coral Reefs

N

0 4 8 16 Miles

Path: C:\Shared\Projects\13107 TO 4.7 Southeast Florida LBSP\GIS\Maps\150501_ICAs_Overall_Small_13107.mxd

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Inlet Contributing Areas in SE Florida

Date: 5/1/2015

Figure 1

3. Discussions

Prioritization Criteria

The working group discussions were organized into two phases. First, the group was tasked with identifying criteria that would be used to prioritize the ICAs. The prioritized list of ICAs would then guide the order in which the nine ICAs would be ranked by NOAA and SEFCRI partners for future efforts to develop and implement watershed-based plans. The purpose of the plan is to reduce LBSP for the protection of the southeast Florida coral reef ecosystem, including estuarine and marine habitats.

The meeting participants divided into two breakout groups for a 40 minute discussion, and then reported out on their recommended criteria. Both groups developed very similar lists of criteria, and then engaged in a detailed discussion to narrow the list to a final set of agreed-upon criteria. The initial set of criteria is presented in Table 1.

Table 1. Initial Set of Criteria

Initial Criteria
1. Availability of data and information in the ICA and adjacent to the inlet
2. Ability to detect change in the coral reef habitat in the ICA and adjacent to the inlet
3. The quality and quantity of existing habitat in the ICA and adjacent to the inlet
4. The manageability or complexity of the ICA
5. The size of the flow and pollutant load in the ICA
6. Partnerships (politics, finances, capacity) in the ICA

The group felt that some criteria held more weight than others, but did not completely overshadow the importance of all the remaining criteria. As a result, the group agreed to a set of weighted criteria, presented in Table 2.

Table 2. Revised Set of Weighted Criteria

Criteria	Weighting Factor
1. Availability of data and information in the ICA and adjacent to the inlet	X 3
2. Ability to detect measurable change in the coral reef habitat in the ICA and adjacent to the inlet	X 3
3. The quality and quantity of existing habitat in the ICA and adjacent to the inlet	X 2
4. The manageability or complexity of the ICA	X 2
5. The size of the flow and pollutant load in the ICA	X 2
6. Partners (politics, finances, capacity) in the ICA	X 1

The group also agreed to apply these criteria using rankings of high, medium and low, rather than trying to prioritize all nine ICAs in order from 1 through 9 of each criterion. This approach was considered to be simpler and would account for the fact that there would be some level of uncertainty in the rankings and that specific number rankings could be misleading. In this method, high = 3 points, medium = 2 points, and low = 1 point.

Once the prioritization process was initiated and the group began to apply the criteria to individual ICAs, it encountered some difficulty in applying certain criteria and clarifying the definitions of some criteria. For example, the group agreed that the criterion of “Ability to detect measurable change in the coral

reef habitat in the ICA and adjacent to the inlet" was too difficult to use given the lack of information about existing conditions and specific links between LBSP and coral ecosystem species, as well as the confusion among the group as to the exact intention of that criterion. In addition, the group agreed to split apart one criterion (Number 3 in Table 2 above) to assess separately the coral reef habitat and estuary habitat, since some ICAs may receive different ranking scores for each habitat type.

Overwhelmingly, the group agreed that the availability of data and information about the existing conditions in the ICA was the most important criterion for prioritization. Table 3 presents the final set of weighted criteria that were used in prioritizing the ICAs.

Prioritization Process

Using a matrix to organize the discussion, the group worked through a discussion of each of the criteria and assigned rankings of High, Medium and Low to each ICA. The nature of the succession and ranking was somewhat subjective in that there were no hard and fast parameters by which the group determined these rankings. Instead, the participants volunteered their own knowledge and expertise regarding each ICA and each criterion. Each ranking was agreed upon by the full group and participants had the opportunity to voice their observations and experiences in each of the ICAs.

During the ranking discussion, there were two terms that the group was using that required additional clarification and discussion among the participants. These terms and the basic definition discussed by the group are described below:

- **Coral reef ecosystem**. This includes the reefs themselves and all other habitats and biota that support and depend on the coral reefs, including back reef areas, hard-bottom areas and the estuaries within the Intracoastal Waterway upstream to the SFWMD salinity control structures.

- **Measurable change**. The ability to measure change (positive or negative) in the biological health of the coral reef stand. Several members of the group felt strongly that this change should be measured in the biology itself. Others suggested that it might be very difficult to measure changes in the biology itself, and that changes may not become evident for a long period of time; therefore, they suggested that it would be appropriate to measure that change using surrogate parameters, such as water quality at the reef, inlet or estuary.

An initial ranking resulted in three ICAs that have total weighted scores of 26, followed by two ICAs with similar scores of 25 and 24. The group initially asked the facilitators to hide the final scores and simply group the top three scores as high priority, the middle three scores as medium priority and the lowest three scores as low priority. However, when the facilitators revealed that there were actually 5 scores grouped at the top of the ranking, the group asked to rank them all as high priority. The final ranking is presented in Table 4.

Following the ranking process, the group agreed to have a subjective discussion of each of the top five 'High priority" ICAs to identify which ICA to pursue as a pilot project. The group reached unanimous consensus relatively quickly and selected Boynton ICA. Boynton ICA was considered to have the least complex hydrologic network, making it presumably simpler to understand. It has a significant body of available data and information about potential LBSP, water quality, inlet dynamics, and coral reef habitat. In addition, the Boynton ICA appears to have a ready network of partners to provide technical and organizational support to the development of a watershed-based management plan.

Table 3. Final Set of Weighted Criteria

Criteria	Weight Factor
1. Availability of data and information in the ICA and adjacent to the inlet. Data and information is needed to assess the existing conditions in an ICA so that LBSP sources can be identified, management measures can be identified, and impacts of the management measures can be tracked. An ICA with a wealth of existing data and information is ripe for the development of a management plan, while an ICA in which little is known could benefit from templates and lessons learned from a pilot watershed plan in another watershed. ICAs that have a greater availability of data and information receive a higher score.	X 3
2. The quality and quantity of existing coral reef habitat adjacent to the inlet. Some ICAs have more coral reef habitat and better quality coral reef habitat than other ICAs. Admittedly, the group agreed that this criterion is slightly flawed in that quality and quantity do not always go hand in hand, and coral reef quality is somewhat of a subjective evaluation. However, the group agreed that, in voting on this criterion, each would do their best to consider both quality and quantity in their ranking. ICAs that have a greater quality and quantity of existing coral reef habitat receive a higher score.	X 1
3. The quality and quantity of existing estuary habitat in the ICA. Some ICAs have more estuarine habitat and better quality estuarine habitat than other ICAs. Admittedly, the group agreed that this criterion is slightly flawed in that quality and quantity do not always go hand in hand, and estuarine quality is somewhat of a subjective evaluation. However, the group agreed that, in voting on this criterion, each would do their best to consider both quality and quantity in their ranking. ICAs that have a greater quality and quantity of existing estuarine habitat receive a higher score.	X 1
4. The manageability or complexity of the ICA. Southeast Florida has a highly managed water system, with an intricate network of primary, secondary and tertiary canals through which water is conveyed and pumped for a variety of competing uses (general drainage, flood control, water supply, and ecosystem needs). Some ICAs contain significantly more or fewer canals as well as flood storage facilities, varieties of wastewater treatment facilities, and varieties of land uses. As a result, the ICAs have varying levels of complexity in the manageability of the LBSP in the ICA. The less complex the ICA, generally the more manageable it is. ICAs that are less complex and more manageable receive a higher score.	X 2
5. The size of the flow and pollutant load in the ICA. Clearly the different ICAs each have varying levels of pollutants loads from LBSP. The LBSP Report prepared in advance of this meeting provides a basic estimate of land-based nutrient loads in each ICA, for purposes of comparison. Total flows into the ICAs are also influenced by the sheer size of the ICA. ICAs that have a greater flow and larger pollutant load receive a higher score.	X 2
6. Partners (politics, finances, capacity) in the ICA. ICAs that have a more established network of partners to assist with and provide political support, financing options and technical and management capacity receive a higher score.	X 1

Table 4. Final Prioritization of the ICAs Based on the Selected Weighted Criteria

ICA Name	1. Data Availability	2. Coral Reef Habitat Quantity and Quality	3. Estuary Habitat Quantity and Quality	4. Manageability / Complexity	5. Flow and Loads	6. Partners	Weighted Total	Rank	
Weighting Factor	3	1	1	2	2	1			
Jupiter Inlet	3	3	3	3	1	3	26	3	High
Boynton Inlet	**3**	**2**	**2**	**3**	**2**	**3**	**26**	3	High
Government Cut	3	3	3	1	3	3	26	3	High
Lake Worth Inlet	3	2	3	2	2	3	25	3	High
St Lucie Inlet	3	1	3	1	3	3	24	3	High
Port Everglades Inlet	3	3	2	1	2	2	22	2	Medium
Boca Raton Inlet	2	2	1	3	1	1	18	1	Low
Baker's Haulover Inlet	1	3	2	2	2	2	18	1	Low
Hillsboro Inlet	1	3	1	3	1	2	17	1	Low

4. Outcome

Prioritization of the Nine ICAs

The group succeeded in achieving the goal of the meeting. Recognizing that NOAA and the SEFCRI partners have limited resources and must be selective in focusing these resources, the group prioritized the nine ICAs by categorizing them in groups of high, medium and low priority. The group stressed that the entire region is important and that this prioritization process is a matter of pragmatism. The final prioritization is a guide; it does not identify which ICA is most likely to be successfully improved, or which ICA is most heavily impacted and in need of remediation. As a result, this prioritization process does not override the group's support for ongoing research, monitoring and remediation in all of the ICAs in the SEFCRI region. The final prioritized list of ICA's is presented in Table 5.

Table 5. Final Prioritized List of ICAs

ICA	Prioritization Ranking
Boynton ICA	High (Pilot)
Jupiter ICA	High
Government Cut ICA	High
Lake Worth ICA	High
St. Lucie ICA	High
Port Everglades ICA	Medium
Boca Raton ICA	Low
Baker's Haulover ICA	Low
Hillsboro ICA	Low

Selection of a Pilot ICA

The group also reached a unanimous agreement in support of selecting the **Boynton ICA** as the pilot ICA to work toward developing a "Watershed-Based Plan to Reduce LBSP Impacts to the Coral Reef Ecosystem in Southeastern Florida."

5. Next Steps

The NOAA Coral Reef Conservation Program aims to work with its partners in the SEFCRI region to develop and implement the pilot watershed-based plan for the Boynton ICA, and to use that work as a pilot project to demonstrate this approach, learn from the process, and apply a similar process across each of the other ICAs within the SEFCRI Region. A schedule for this work has not yet been discussed. NOAA and its partners will work together and within their own agencies to identify and secure funding opportunities to continue this collaborative effort to reduce LBSP for the protection of the coral reef ecosystem in southeast Florida.

Appendix A. List of Attendees at the April 17, 2105 Meeting

NAME	AFFILIATION
Jack Stamates	NOAA Atlantic Oceanographic and Meteorological Laboratory
Jeff Beal	Florida Fish and Wildlife Conservation Commission
John Fauth	University of Central Florida
Nancy Craig	Broward County
Brian Walker	Nova Southeastern University-Oceanographic Center
Ken Banks	Broward County
Troy Craig	Broward County (formerly DEP Coral Program)
Kathy Fitzpatrick	Martin County
Dianne Hughes	Martin County
Leanne Welch	Palm Beach County
Paul Davis	Retired (formerly Palm Beach County)
Jamie Monty	Florida DEP Coral Reef Conservation Program, Manager
Lauren Waters	Florida DEP Coral Reef Conservation Program, Assistant Manager
Joanna Walczak	Florida DEP, SE Regional Administrator
Jenny Baez	Florida DEP Coral Reef Conservation Program, LBSP Coordinator
Kevin Carter	South Florida Water Management District
Teresa Coley	South Florida Water Management District
Dana Wusinich-Mendez	NOAA Coral Reef Conservation Program
Rob Ferguson	NOAA Coral Reef Conservation Program (contractor) (by phone)
Kurtis Gregg	NOAA Fisheries Service (contractor)
Jocelyn Karazsia	NOAA Fisheries Service
Ellie Baker	Horsley Witten Group, Facilitator
Nigel Pickering	Horsley Witten Group, Facilitator

Appendix B. Meeting Agenda

Watershed Scale Planning to Reduce LBSP for the Protection of Coral Reef Ecosystems in Southeast Florida

April 17, 2015, 8:30 AM to 5:00 PM

Registration and Check-in at 8:30 AM, Building B-1 Security desk

SFWMD Headquarters Office, 3301 Gun Club Road, West Palm Beach, Florida
Lake Okeechobee Conference Room, South end of Building B-2, Third Floor.

AGENDA

8:30 am	**Check-in: B-1 Security; Meeting room is the Lake Okeechobee Conference Room in B-2**
9:00 am	**1. Introductions** *The Primary Purpose of the meeting is to:* *Prioritize the nine Inlet Contributing Areas (ICAs) and identify one ICA where the NOAA Coral Reef Conservation program and partners will focus effort in the near future to develop and implement a management plan to reduce LBSP impacts to the coral reef tract of southeast Florida*
9:10 am	**2. Overview of the Issues – LBSP impacts on the Coral Reef Ecosystem in SE Florida**
9:40 am	**3. What are Watershed-Based Assessment, Planning and Management?**
10:10 am	**Coffee Break**
10:25 am	**5. LBSP in the ICAs**
11:30 am	**6. Introduction to the Afternoon Discussion**
11:45 pm	**Lunch**
12:45 pm	**7. Discussions: Criteria for Selecting a Pilot ICA** • Purpose: Consensus on criteria for selecting an ICA to develop and implement a pilot Watershed-Based Plan to Reduce LBSP for the Protection of the Coral Reef Ecosystem
2:15 pm	**Coffee Break**
2:30 pm	**8. Applying the Criteria to Select a Pilot ICA**
4:30 pm	**9. Concluding Discussion: Where do we go from here?**
5:00 pm	**Meeting Concludes**

Appendix C. Meeting Presentations

1. **Overview of the Issues – LBSP impacts on the Coral Reef Ecosystem in SE Florida (Kurtis Gregg)**
2. **What are Watershed-Based Assessment, Planning and Management? (Elizabeth Baker)**
3. **Land-Based Sources of Pollution (LBSPs) in the Inlet Contributing Areas (ICAs) (Nigel Pickering)**

Science, Service, Stewardship

Coral Reef Connections: Land-Based Sources of Pollution, Fisheries Habitats and the Florida Coral Reef Tract

Kurtis Gregg, M.S.
ECS-Federal, Inc. supporting:
NOAA Fisheries Service
Southeast Region
Habitat Conservation Division

NOAA FISHERIES SERVICE

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Magnuson-Stevens Act and the Essential Fish Habitat (EFH) Rule

- Congress defined EFH in the Magnuson-Stevens Act as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" [16 U.S.C. 1802(10)]

- Consultation requirements for federal agencies when an *adverse* affect to EFH is proposed [50 CFR Part 600]

- EFH is described and identified for each federally-managed fishery through regional Fishery Management Councils

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Fisheries Habitat Connections

Sustainable coral reef ecosystems require functional back-reef habitats (e.g. seagrass, mangrove, soft bottom, coastal inlets and nearshore hardbottom) to provide nursery, shelter and foraging opportunities for reef fish and the other organisms in coral reef and associated habitats.

Photo: Google Earth 2013

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EFH and the Southeast Florida Coral Reef Ecosystem

Marine and estuarine habitats are designated as EFH for species managed under fishery management plans for Spiny Lobster; Shrimp; Coral, Coral Reef, and Hardbottom and Snapper/Grouper Complex, including:

Seagrass

Photo: NOAA 2013

NOAA FISHERIES SERVICE

EFH and the Southeast Florida Coral Reef Ecosystem

Mangroves

Photo: NOAA 2012

Hardbottom

Photo: Pinnacle Group International 2011

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EFH and the Southeast Florida Coral Reef Ecosystem

Oyster reefs

Photo: Palm Beach County ERM (2013)
http://www.pbcgov.com/erm/lakes/estuarine/oysters/

Unconsolidated sediments

e.g. tidal flats, unvegetated bottom

Photo: Pinnacle Group International 2011

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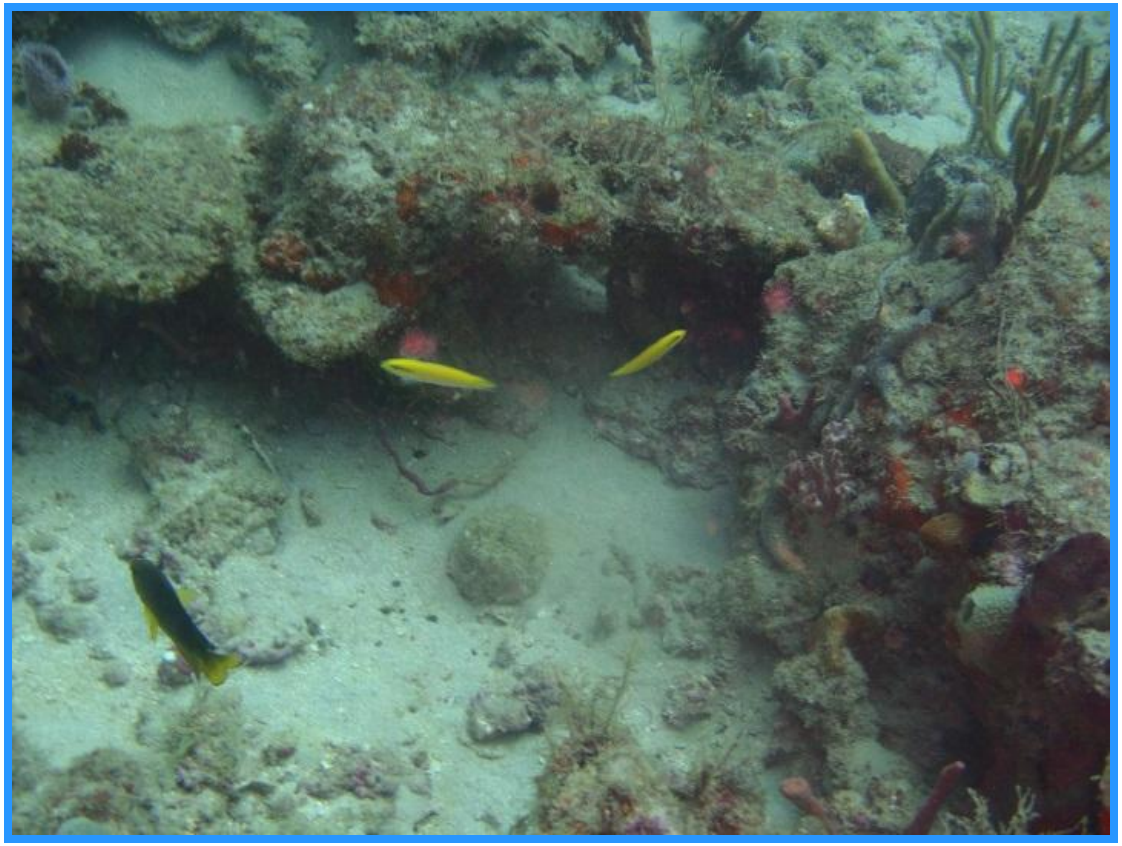
EFH and the Southeast Florida Coral Reef Ecosystem

Nearshore hardbottom



Photos: NOAA 2013

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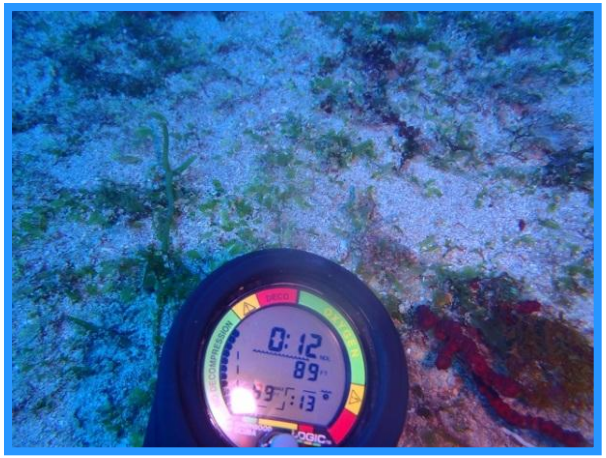
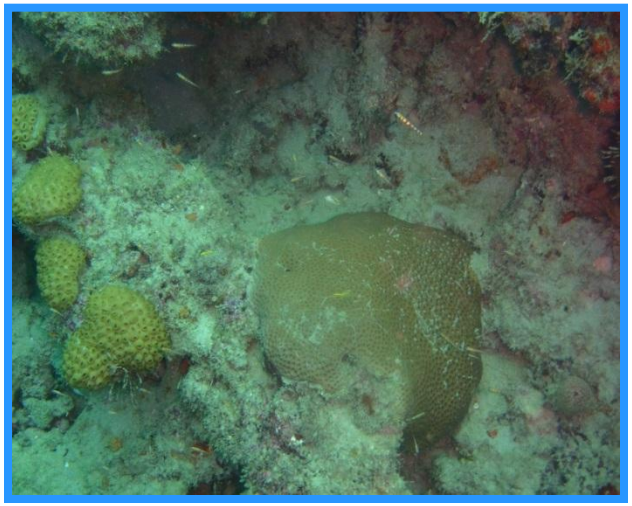
EFH Outside Florida's Inlets

Seagrass



Photos: NOAA 2012

Coral,
coral reefs
and hardbottom



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Pollutants Affecting Fisheries Habitats in Southeast Florida

- Nutrients-Nitrogen and Phosphorus
- Biocides-Pesticides, Herbicides and Fungicides
- Sedimentation
- Turbidity
- Freshwater/Rapid salinity changes
- Hydrocarbons and other organic compounds
- Heavy metals-Arsenic, Zinc, Copper, Lead, Mercury, etc.
- Pharmaceuticals and personal care products

NOAA FISHERIES SERVICE

LBSP Affecting the Coral Reef Ecosystem

Excessive nitrogen and phosphorus can result in adverse changes to estuarine and marine ecosystems. Increases in dissolved inorganic nutrients have been shown to promote the growth of macroalgae and cyanobacteria that compete for space on reefs with benthic animals.

Biocides and their degradation compounds can be highly toxic to corals, crustaceans, and other benthic fauna at very low concentrations.

Photo: Dave Gilliam

Photo: Sailing Buzzards Bay
http://sailingbuzzardsbay.frankgerry.com/?p=118

NOAA FISHERIES SERVICE

LBSP Affecting the Coral Reef Ecosystem

Sedimentation can kill filter feeding animals such as corals, sponges and oysters by smothering burial or inhibiting feeding and can adversely affect seagrass and other estuarine habitats by direct burial.

Sedimentation also contributes to **turbidity** that decreases light penetration and reduces photosynthetic production by seagrass, algae and coral zooxanthellae in coastal waters.

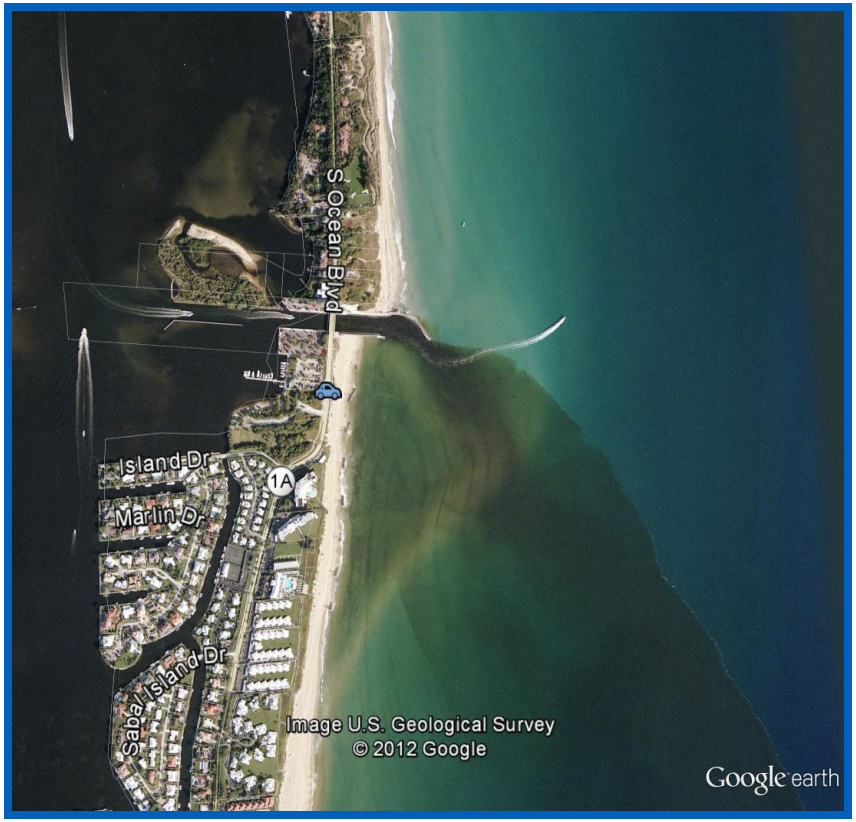

Photo: Google Earth 2012

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LBSP Affecting the Coral Reef Ecosystem

Organic pollution occurs when **hydrocarbons** are released into the environment via sewage effluent, stormwater runoff or oil spills. Petroleum products released by oil spills remaining near the surface of the water may not contact reefs or other sub-tidal habitats; however, these compounds may affect developing larvae that float at the surface. Intertidal habitats are particularly vulnerable to hydrocarbon pollution.

Photo: NY Daily News 2010

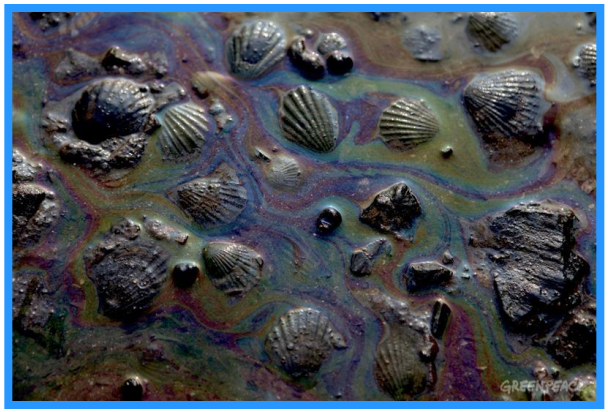
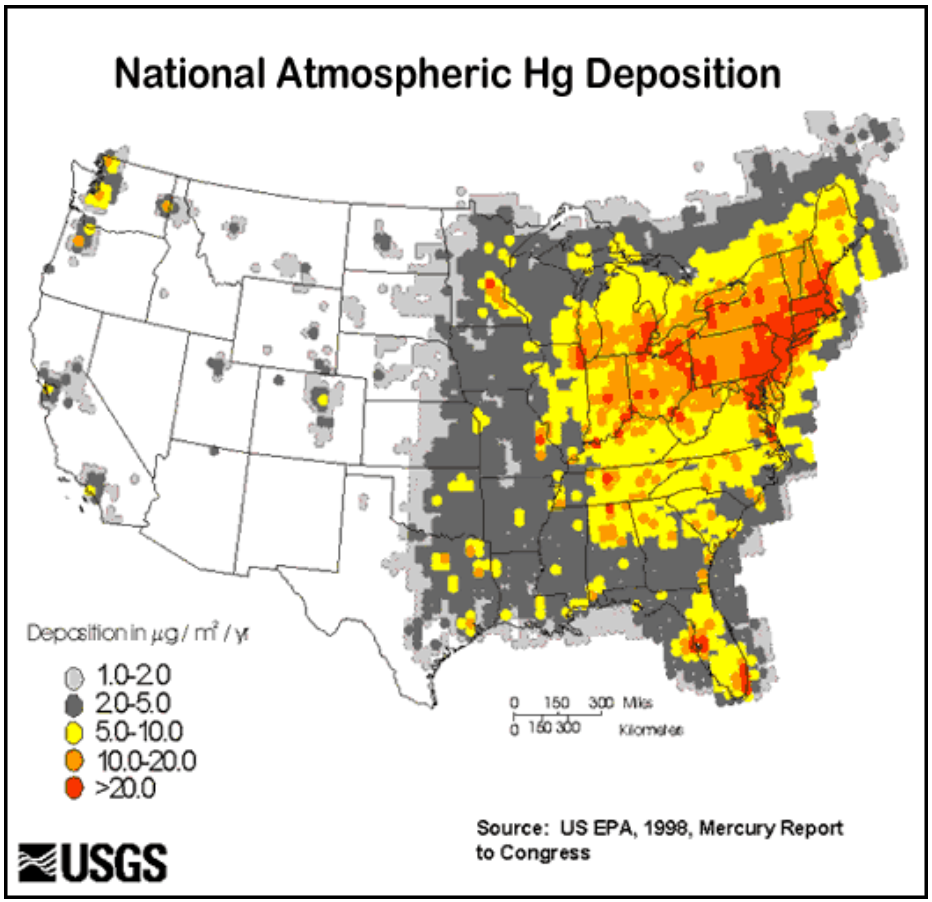


Photo: Greenpeace 2010

NOAA FISHERIES SERVICE

Land-Based Pollutants Affecting the Coral Reef Ecosystem

Heavy metals are known to have lethal and sub-lethal effects on marine fauna such as corals, mollusks, and crustaceans.



Graphic: US EPA Mercury Report 1998

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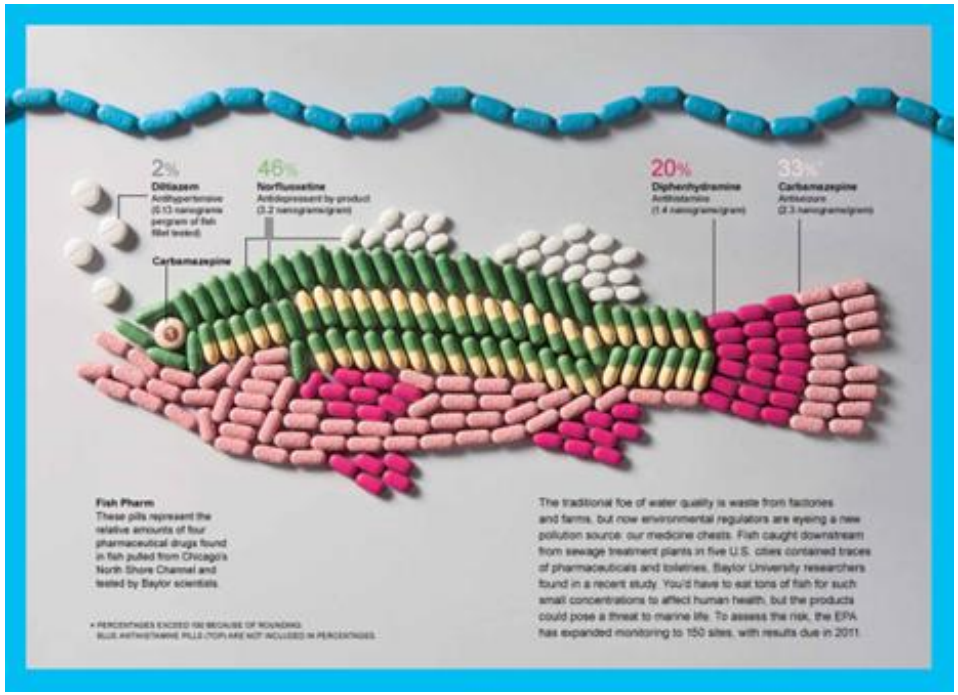
LBSP Affecting the Coral Reef Ecosystem

Pharmaceuticals (medications and hormones) and **Personal care products**, (e.g., lotions, fragrances, insect repellent), end up in estuarine and marine environments of southeast Florida.



Art: Alejandro Ramirez, Baylor University 2010
http://ngm.nationalgeographic.com/2010/04/pollution/fish-pharm

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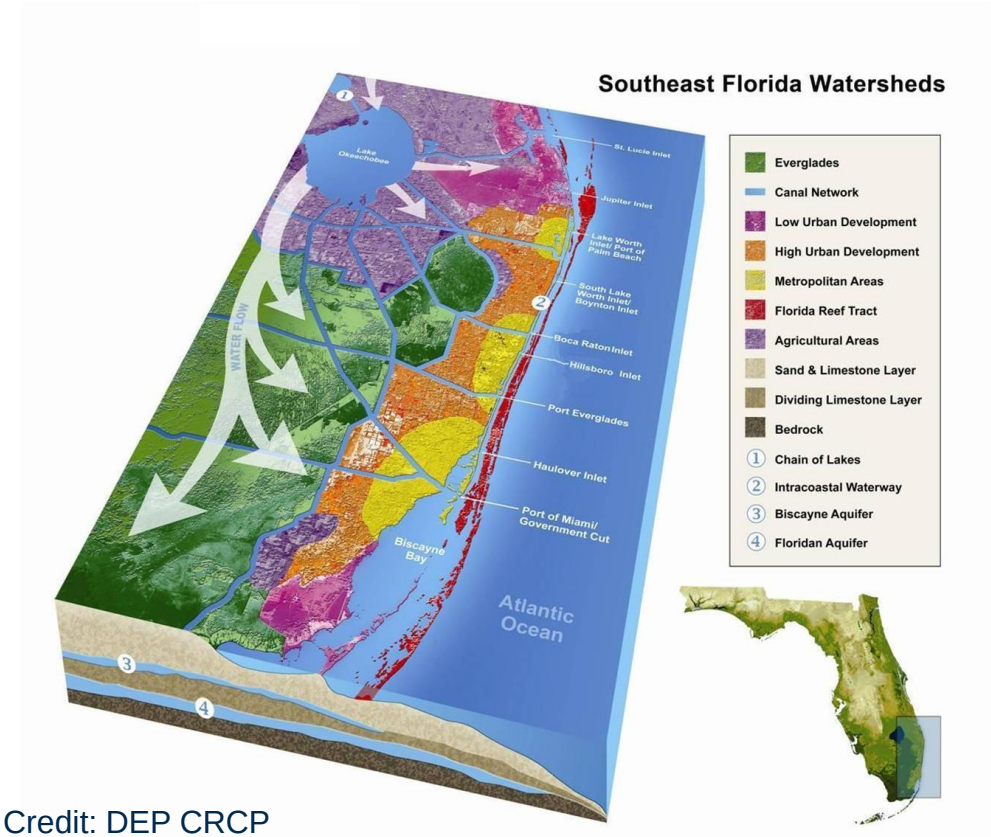
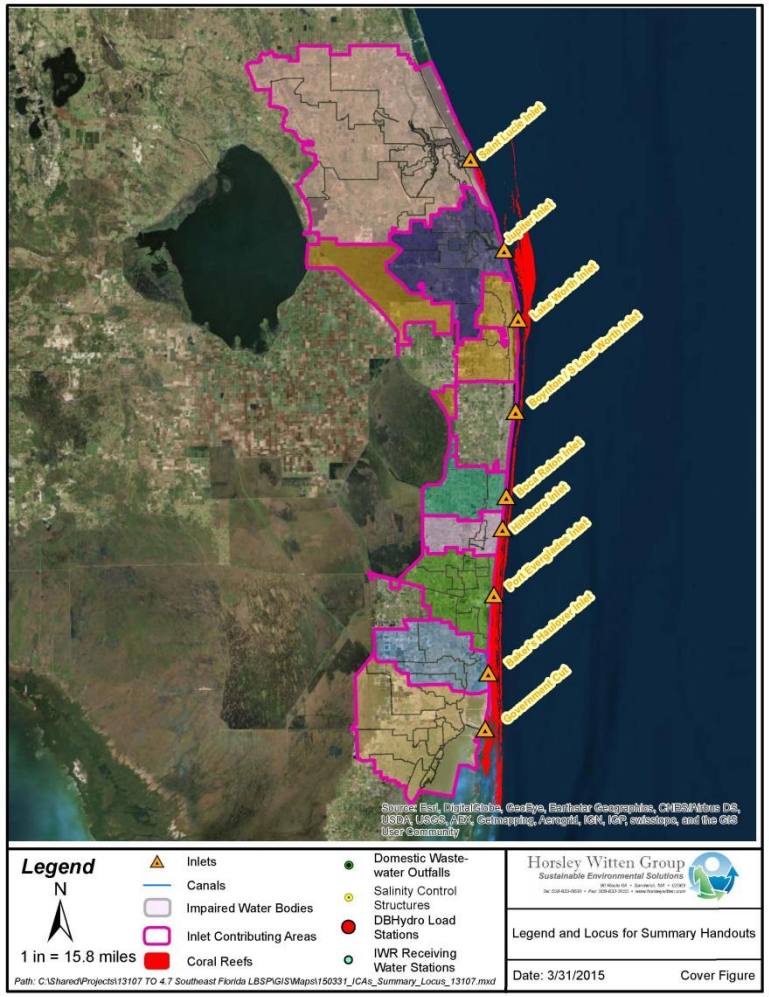
Then



Credit: DEP CRCP

Now



NOAA FISHERIES SERVICE

Water Management in Southeast Florida

Stormwater is routed through southeast Florida canals before being discharged to estuarine waters, like Lake Worth Lagoon.

Photo: Google Earth 2013

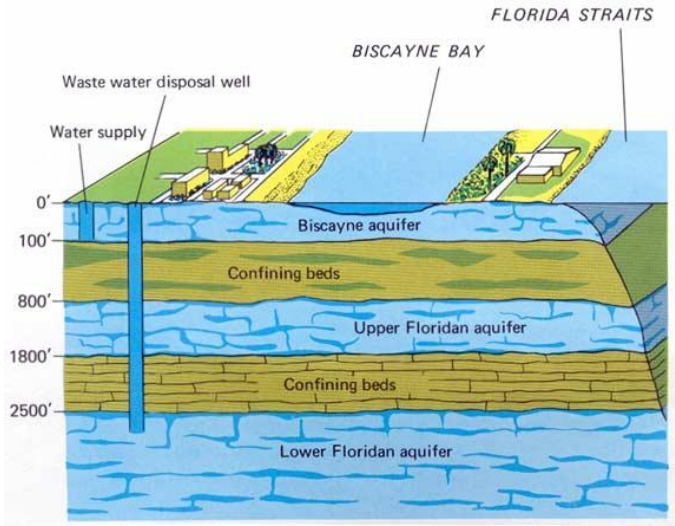
NOAA FISHERIES SERVICE

Water Management in Southeast Florida

The methods of **wastewater** effluent disposal in southeast Florida include:

- ocean outfalls
- surface discharges
- reuse
- deep well injection
- on-site septic systems

Photo: Palm Beach Post 2010



Graphic: USGS 2013

NOAA FISHERIES SERVICE

Sources of Pollutants

Source	Nutrients	Sediments	Turbidity	Biocides	Metals	Hydrocarbons	Pharmaceuticals
Stormwater	X	X	X	X	X	X	
Treated Wastewater	X		X	X			X
Untreated Wastewater	X		X	X		X	X
Ocean Outfalls	X		X	X			X
Submarine Groundwater Discharge	X					X	X

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LBSP and Affected Habitats

Habitats:	Mangroves	Seagrass	Oysters	Soft-Bottom	Nearshore Hardbottom and Worm Reef	Coral, Coral Reef and Offshore Hardbottom
Pollutants ↓						
Nutrients: N and P	Nutrients-Mostly P, but also N	Nutrients-Mostly N		Nutrients-N	Nutrients-Mostly N	Nutrients-Mostly N
Sedimentation	Fine sediments and silt can clog pneumatophores on prop roots	Burial can kill seagrass	Burial and sublethal stress affect oysters	Burial and changes in sediment composition can stress benthic organisms.	Burial and sublethal stress affects benthic organisms.	Burial and sublethal stress affects benthic organisms.
Turbidity		Water clarity is the primary factor for seagrass distribution		Resuspension of fine sediments reduces water clarity	Adversely affects symbionts in corals and sponges	Adversely affects symbionts in corals and sponges
Rapid Salinity Changes-Freshwater inflows		Salinity range is the primary driver of seagrass abundance	Osmotic regulation stress from rapid salinity changes can cause sublethal stress and mortality	Rapid salinity changes coupled with freshwater inflows contributes to eutrophication	Salinity changes may interact synergistically with other coral stressors	Salinity changes may interact synergistically with other coral stressors

NOAA FISHERIES SERVICE

LBSP and Affected Habitats

Habitats:	Mangroves	Seagrass	Oyster	Soft-Bottom	Nearshore Hardbottom and Worm Reef	Coral, Coral Reef and Offshore Hardbottom
Pollutants↓						
Organics and other hydrocarbons	Prop roots are vulnerable to organics and hydrocarbons	Intertidal beds are at risk of organic and hydrocarbon pollution	Intertidal oysters are at risk of organic and hydrocarbon pollution		Intertidal hardbottom and worm reef is at risk from organic and hydrocarbon pollution	
Low Dissolved Oxygen			Respiratory stress and mortality	Results from algal bloom and die off		
Pharmaceuticals and personal care products					Adversely affect corals and other benthic animals	Adversely affect corals and other benthic animals
Heavy metals			Zinc and copper affect oyster at all life stages		Zinc, copper and other metals affect corals and other animals	Zinc, copper and other metals affect corals and other animals
Biocides			Biocides affect oysters at all life stages		Biocides affect corals and other animals at all life stages	Biocides affect corals and other animals at all life stages
Pathogens					Human sewage linked to coral disease	Human sewage linked to coral disease

NOAA FISHERIES SERVICE

Key Recommendations

- **Reduce nutrient loading** from all anthropogenic sources and pathways, including surface water management systems, coastal inlets, submarine groundwater discharge, and ocean outfall discharge, to improve conditions for estuarine and marine habitats.
- Use an **ecosystem-based perspective to inform current water quality improvement planning and water management activities** in southeast Florida to reduce LBSP impacts to estuarine and marine EFH. The ecosystem-based management approach considers the physical, chemical and biological components and connections between species and between habitats.
- **Support implementation of numeric nutrient water quality criteria for nitrogen and phosphorus** that are in the process of being developed by the state of Florida
- **Support construction of additional water storage reservoirs, stormwater treatment areas and use of appropriate technologies to reduce nutrient levels** before release of water to southeast Florida estuaries and to modulate salinity changes in those estuaries.
- **Modify beach nourishment activities to minimize burial, sedimentation and turbidity impacts** to nearshore hardbottom, including worm reef, and other offshore habitats.

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Thank You!

Kurtis.Gregg@noaa.gov

Watershed-Based Planning

Meeting hosted by:

NOAA

Coral Reef Conservation Program

April 17, 2015

SFWMD Headquarters

West Palm Beach, Florida

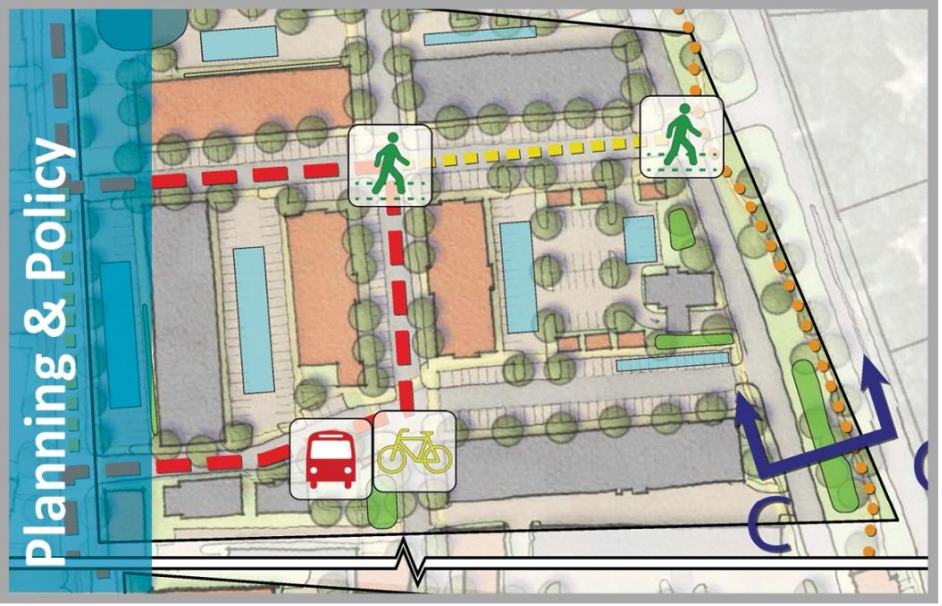
Elizabeth Baker, Senior Environmental Planner

Nigel Pickering, Senior Water Resources Engineer

April 17, 2015

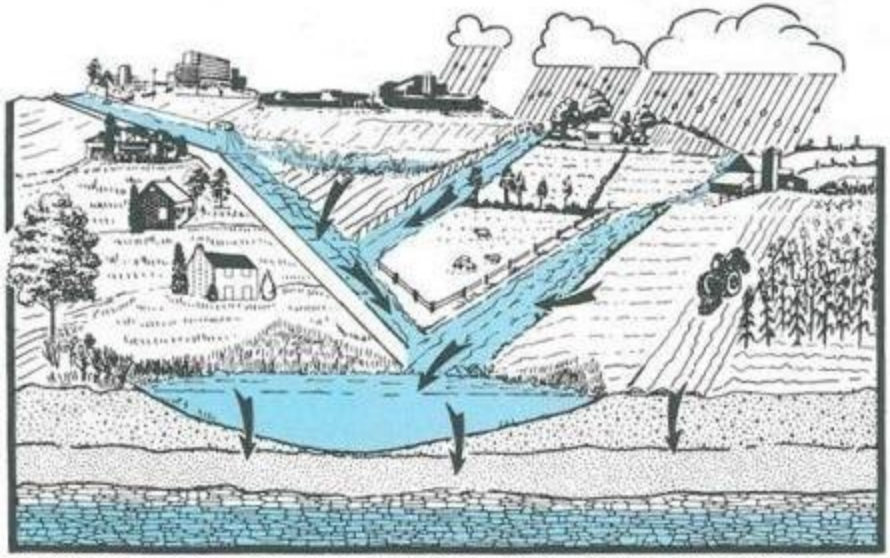
SFWMD Headquarters, West Palm Beach, Florida

Horsley Witten Group



Offices in Massachusetts, Rhode Island and Georgia

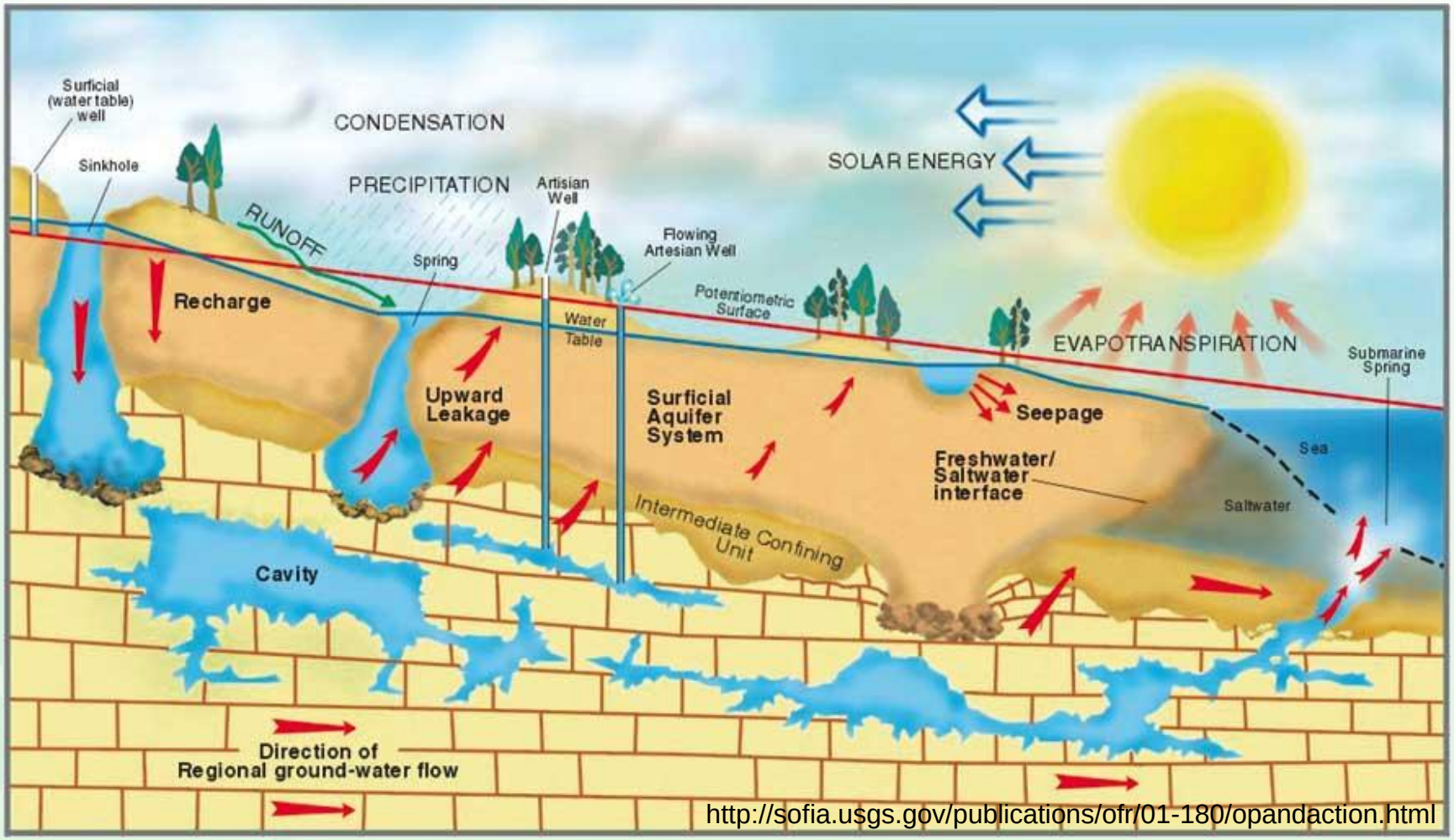
What is a Watershed?



Water flows downhill across parking lots, farms, and yards into reservoirs including ground water aquifers.
Image credit: Northwest Florida Water Management District

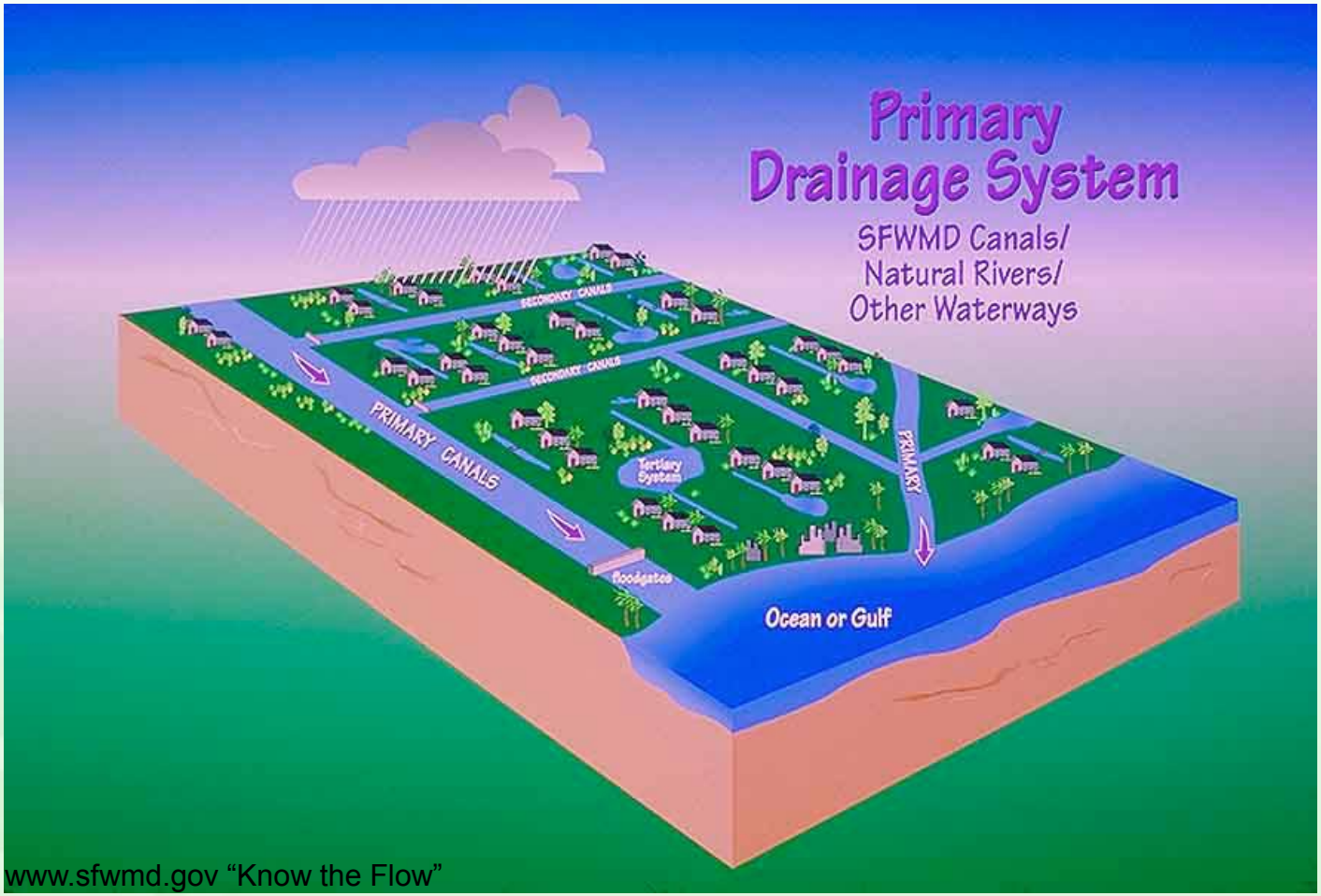
A **watershed** is the area of land where all of the water that is under it or drains off of it goes into the same place." - EPA

Surface Water – Groundwater Interactions



Conceptual illustration of a generalized cross-section through the Florida peninsula, showing karstic features and the hydrologic cycle.

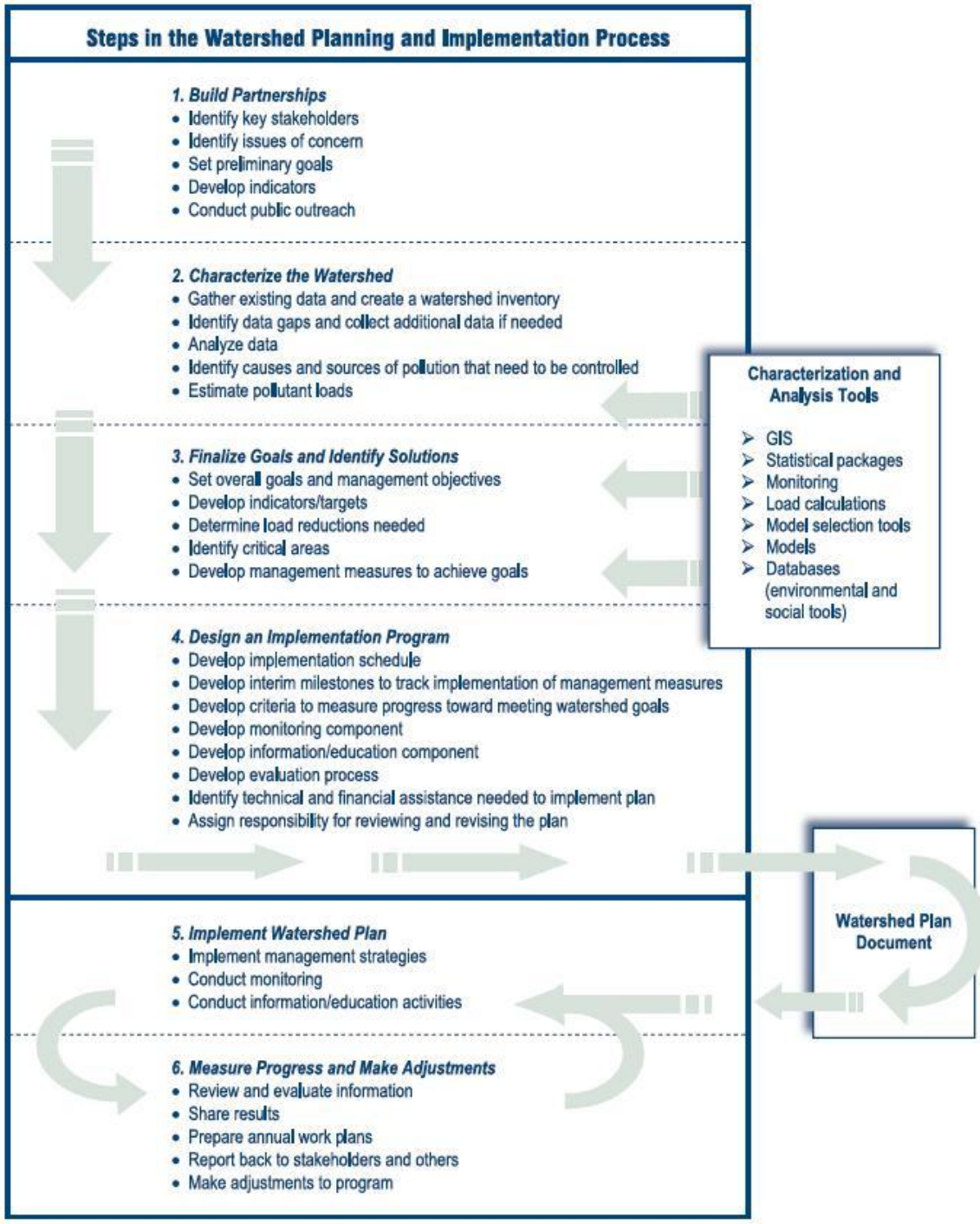
Highly Managed Watersheds



www.sfwmd.gov “Know the Flow”

Watershed-Based Management Approach

1. Build Partnerships
2. Characterize the Watershed
3. Finalize Goals and Identify Solutions
4. Design an Implementation Program
5. Implement Watershed Plan
6. Measure Progress and Make Adjustments



- EPA's Handbook for Developing Watershed Plans to Restore and Protect our Waters (2008)

9 Elements of a Watershed Plan

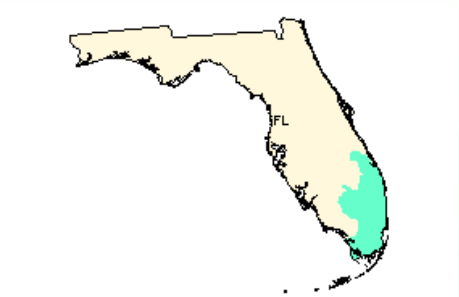
a. Identify the **causes** of water body impairment and **sources** of pollution.
b. Estimate **pollutant loads** and expected **load reductions** from management efforts.
c. Describe the **management measures** that will achieve reductions.
d. Estimate **funding and technical assistance needs** to implement management measures.
e. Describe the **public education** component to encourage continuous participation in the plan.
f. Define a **schedule** for implementation.
g. Describe interim **measureable milestones** to assess whether implementation is occurring.
h. Identify reasonable **criteria to evaluate improvements** in water quality and watershed health.
i. Describe a **monitoring program** to measure progress against the criteria.

- EPA's Handbook for Developing Watershed Plans to Restore and Protect our Waters (2008)

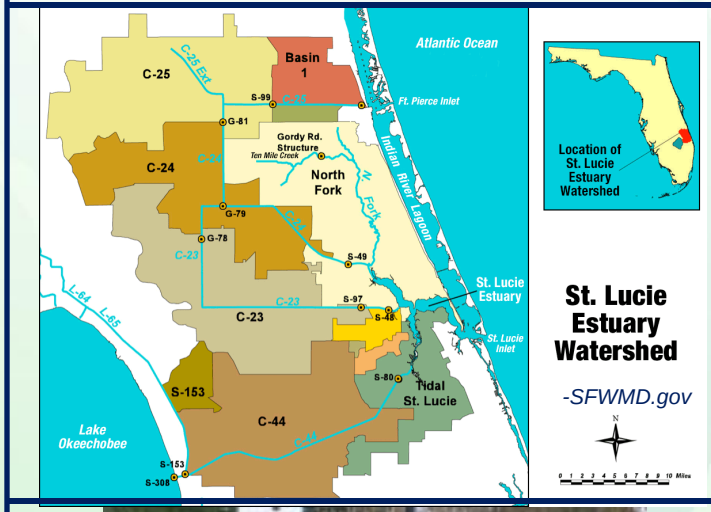
FL Watershed Restoration Framework

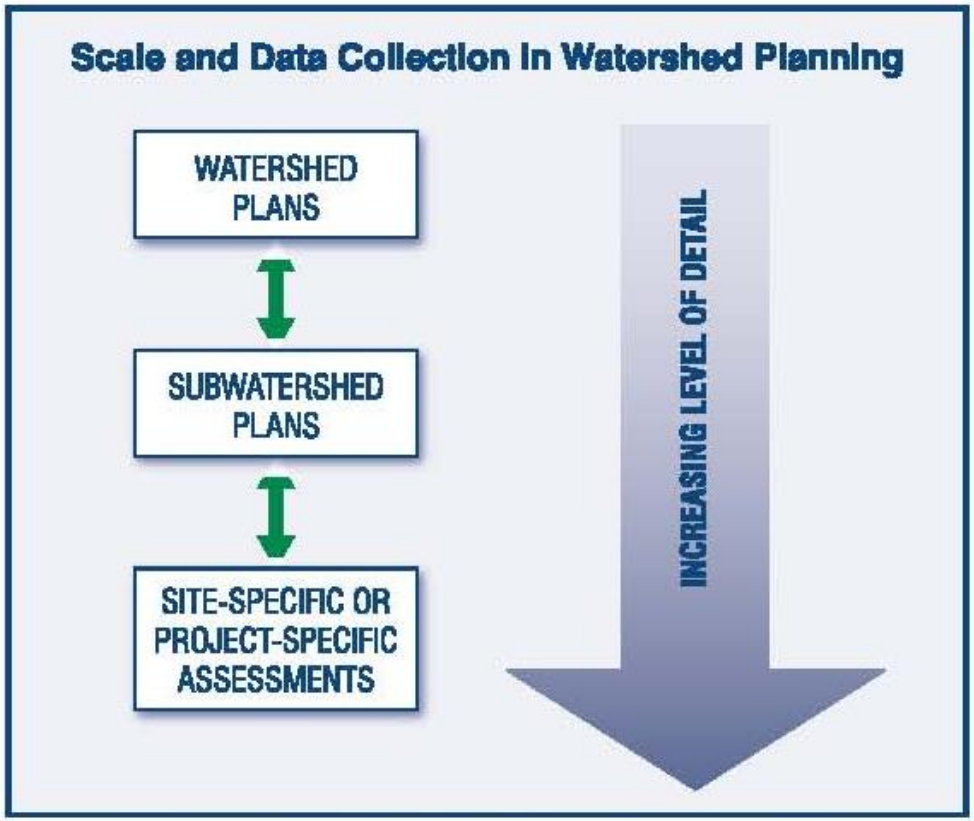
http://www.dep.state.fl.us/water/watersheds/rest-frame.htm

Scale



EPA Surf Your Watershed - Everglades Watershed

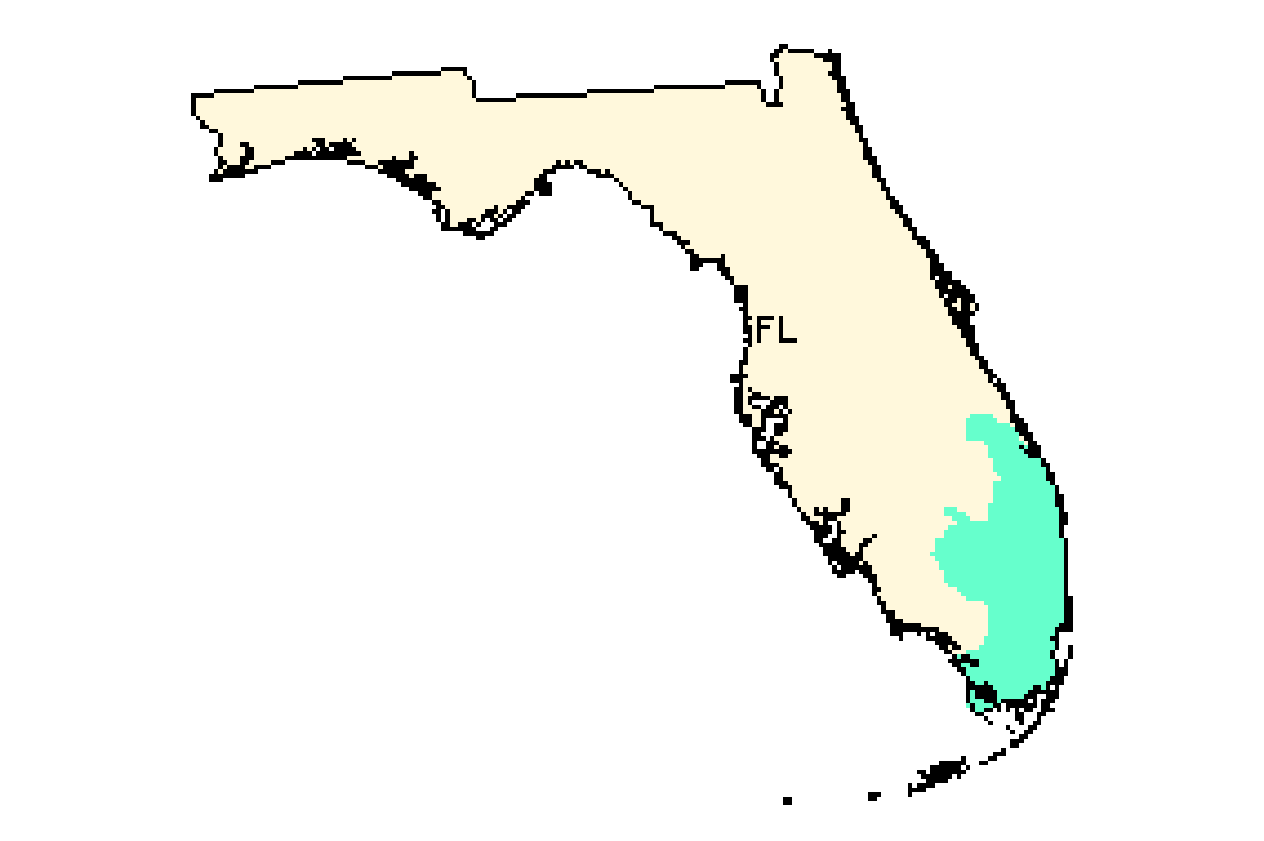




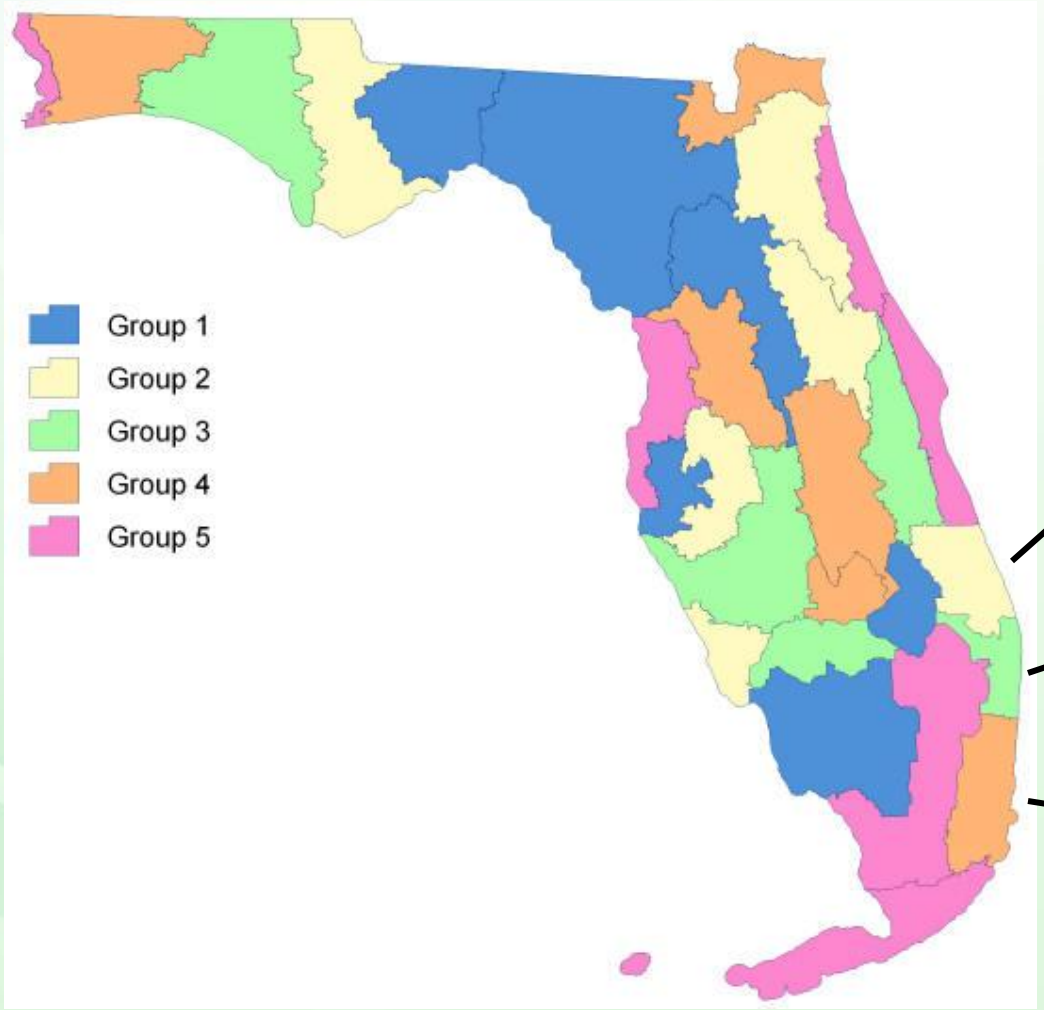
- EPA's Handbook for Developing Watershed Plans to Restore and Protect our Waters (2008)

Horsley Witten Group, Inc.

EPA Surf Your Watershed: Everglades Watershed



DEP Watershed Monitoring Basins



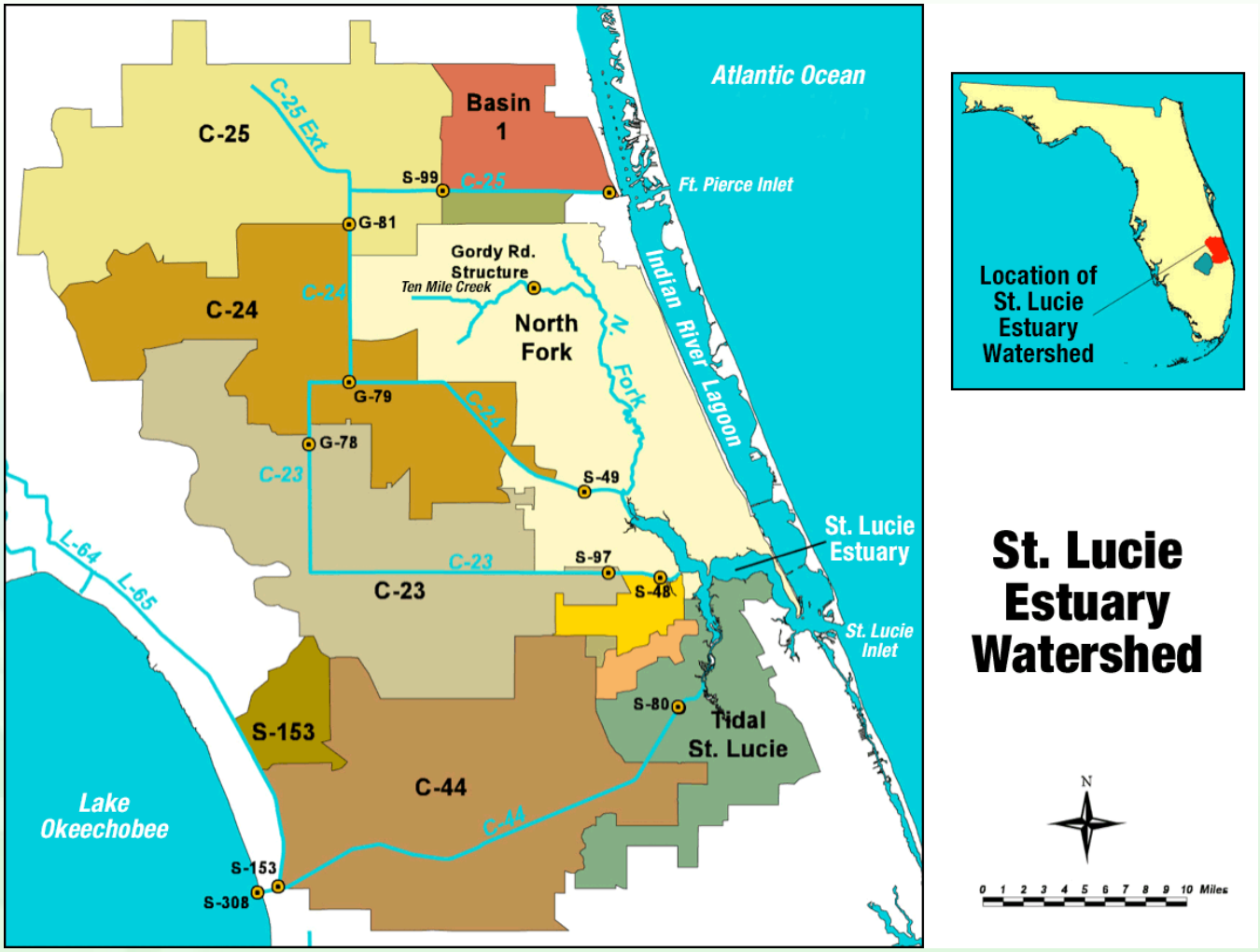
- **Large Scale**
- **Multiple Inlets/Basin**

St. Lucie –
Loxahatchee Basin

Lake Worth Lagoon –
Palm Beach Coast Basin

Southeast Coast –
Biscayne Bay Basin

St. Lucie Estuary Watershed



-SFWMD.gov

Tools

Common watershed assessment and analysis tools:

- Watershed Treatment Model (Center for Watershed Protection)
- BASINS - Better Assessment Science Integrating Point and Non-Point Sources (EPA)
- WAM - Watershed Assessment Model (EPA)
- SWMM - Stormwater Management Model (EPA)
- WARMF - Watershed Analysis Risk Management Framework (EPA)
- NSPECT - Nonpoint Source Pollution and Erosion Comparison Tool (NOAA)
- MapShed – Map version of Generalized Watershed Loading Function (GWLF) model (PennState)

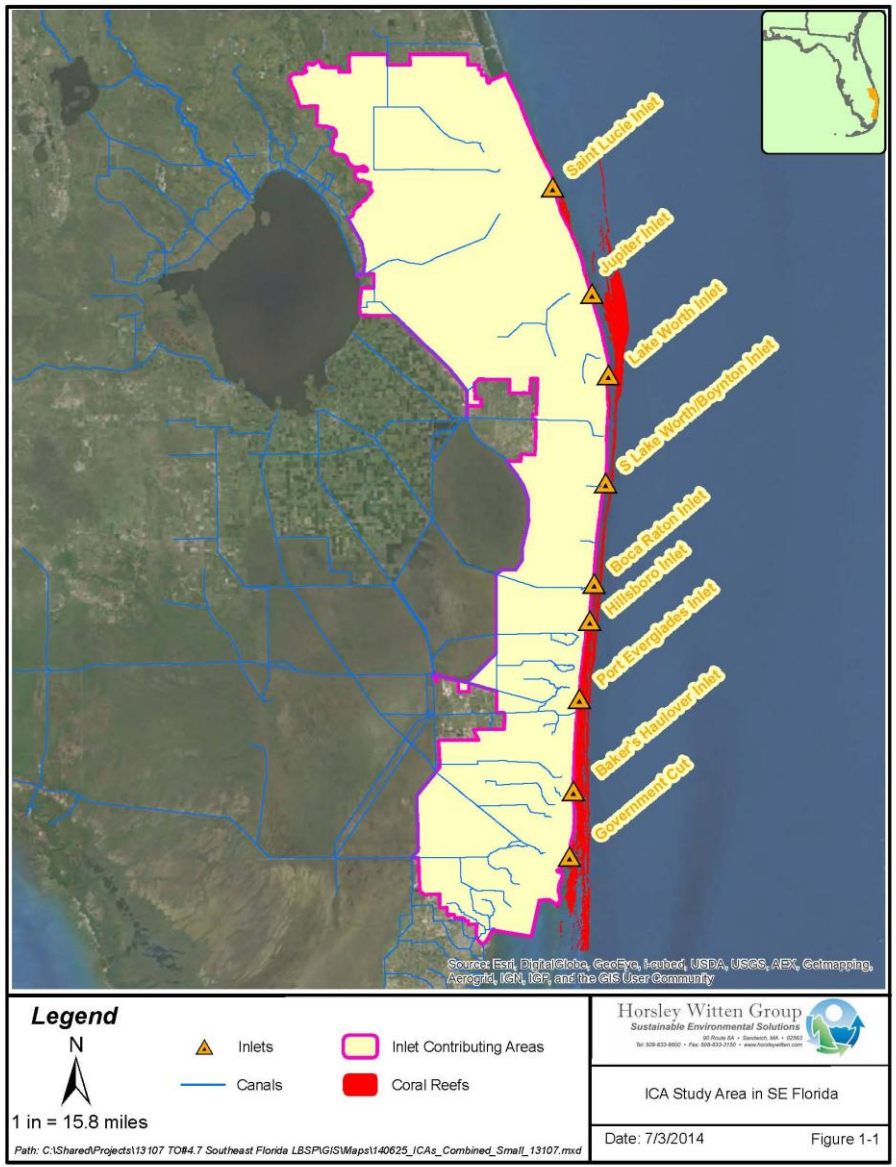
Data Needs

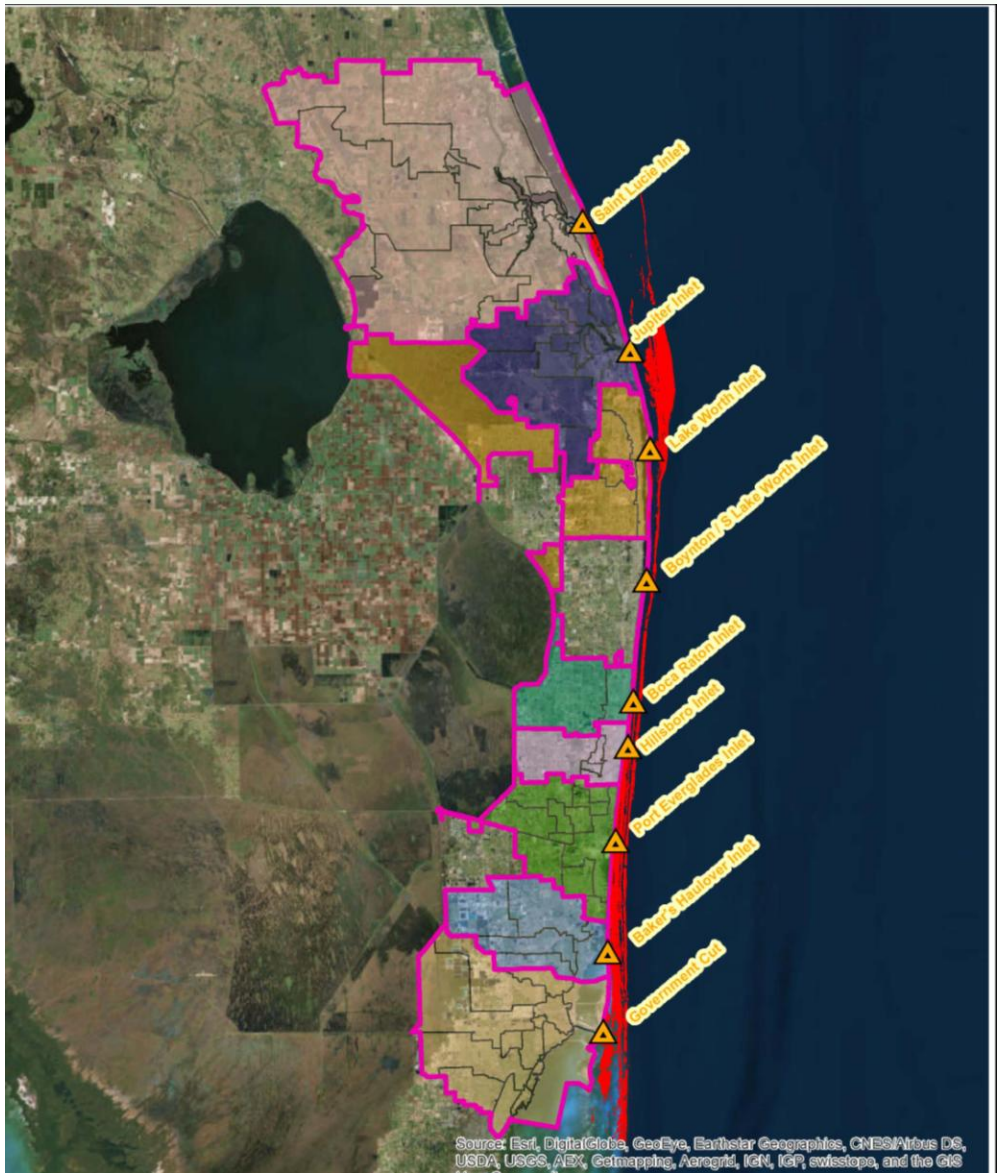
- Geographic Information
- Water Quality Data
- Flow Data
- Watershed Mechanics
  - Hydrology
  - Geology
  - Natural resources

Delineating the SE Florida Watersheds

- Goal: Reduction and management of LBSPs affecting **coral reef** ecosystem health
- Scale – different than other agencies/purposes
- Inlets as focal points
- Terminology: Inlet Contributing Area (ICA)
- Used flow data from canal management
- 'Average' condition
- Salinity control structures = upper limit of receiving waters

Inlet Contributing Areas (ICAs)

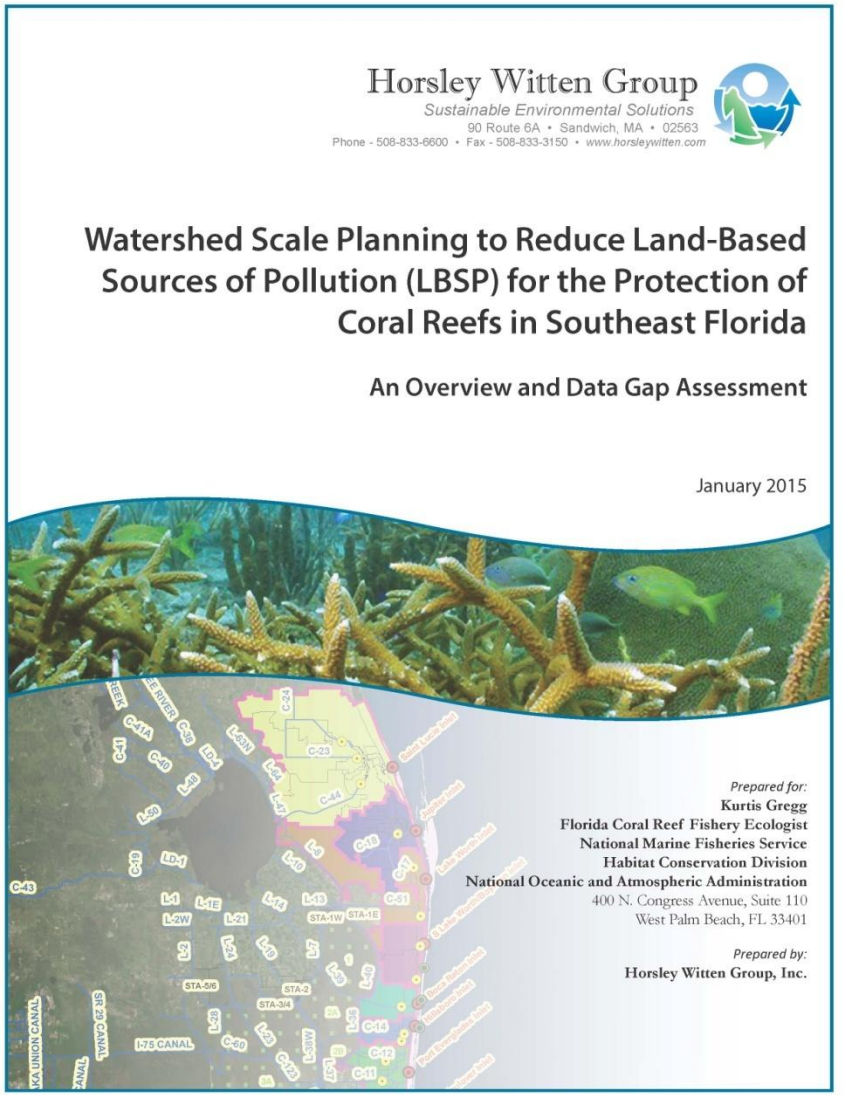




Overview of the LBSP Report

Purpose/Scope:

- Compiling existing information
- Organizing it for watershed-based approach
- Begin to assess, understand and prioritize
- For the protection of coral reef ecosystem



Organization of the LBSP Report

1. Introduction
2. Overview of Project Area
3. Water Management in Each ICA
4. Watershed Assessment and Planning Data Needs
5. Information Collection and Compilation Process
6. Documented Levels of LBSP Impacts in each ICA
7. Summary of Data and Data Gaps
8. Conclusions and Recommendations

Contacts

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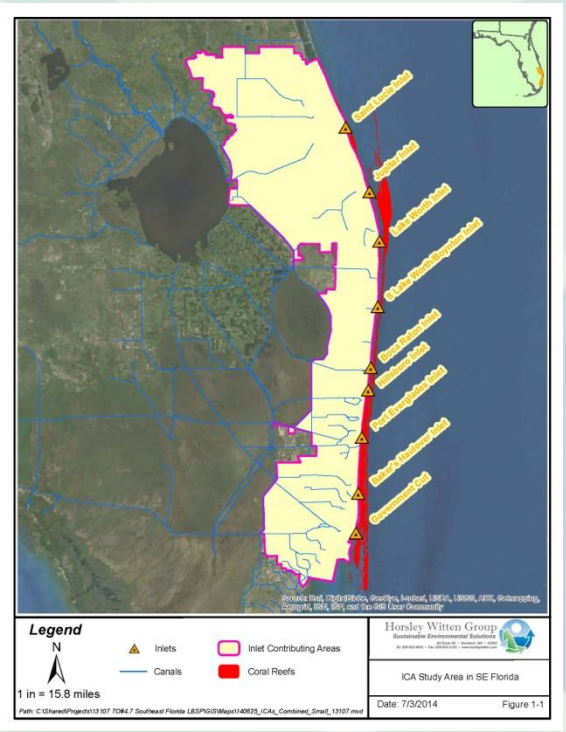
LBSPs in the ICAs in Southeast Florida



Meeting hosted by:

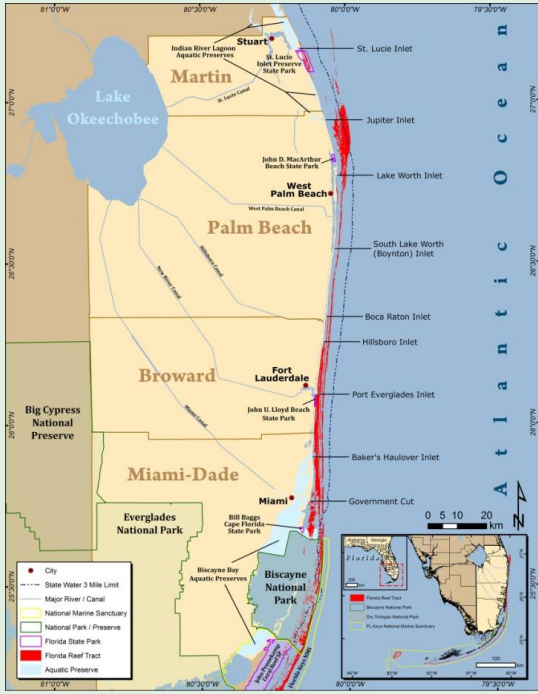
NOAA

Coral Reef Conservation Program

April 17, 2015

SFWMD Headquarters

West Palm Beach, Florida



Facilitators:

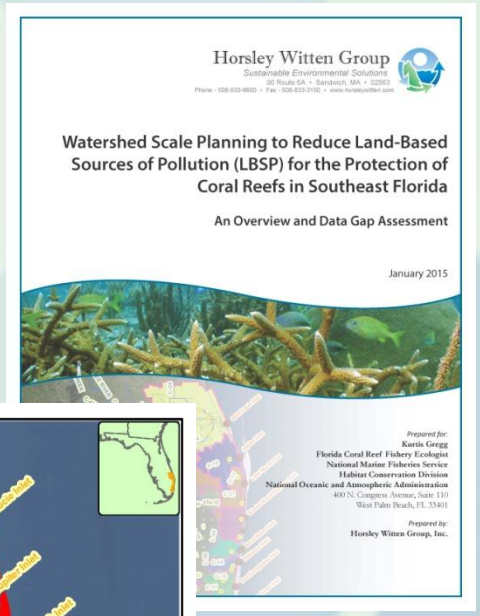
Nigel Pickering, Senior Water Resources Engineer

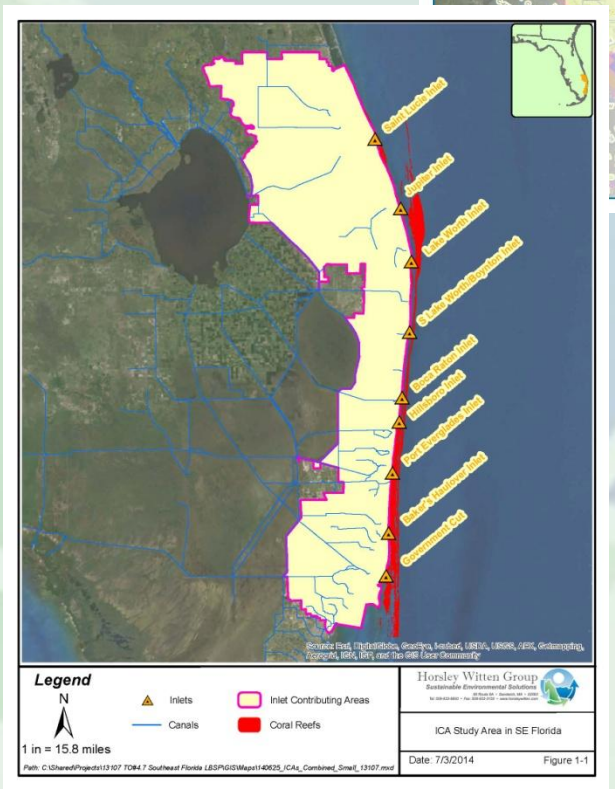
Elizabeth Baker, Senior Environmental Planner

Horsley Witten Group, Inc.

Horsley Witten Group, Inc.

Presentation Overview

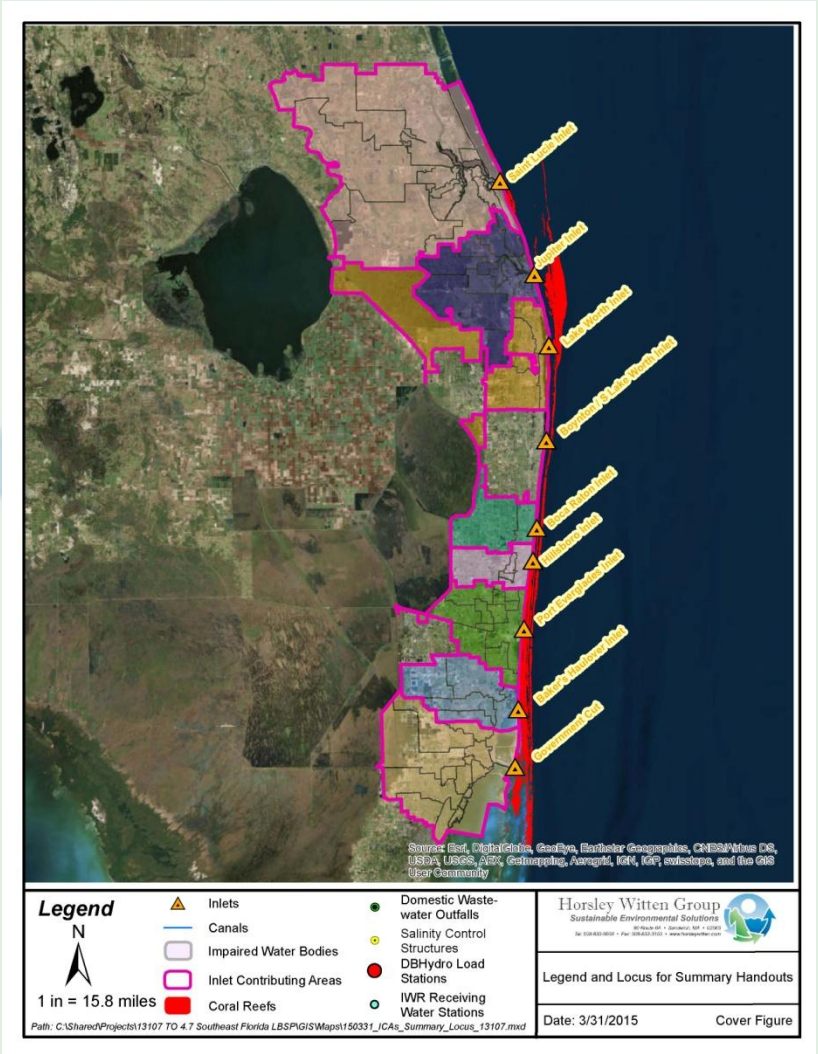




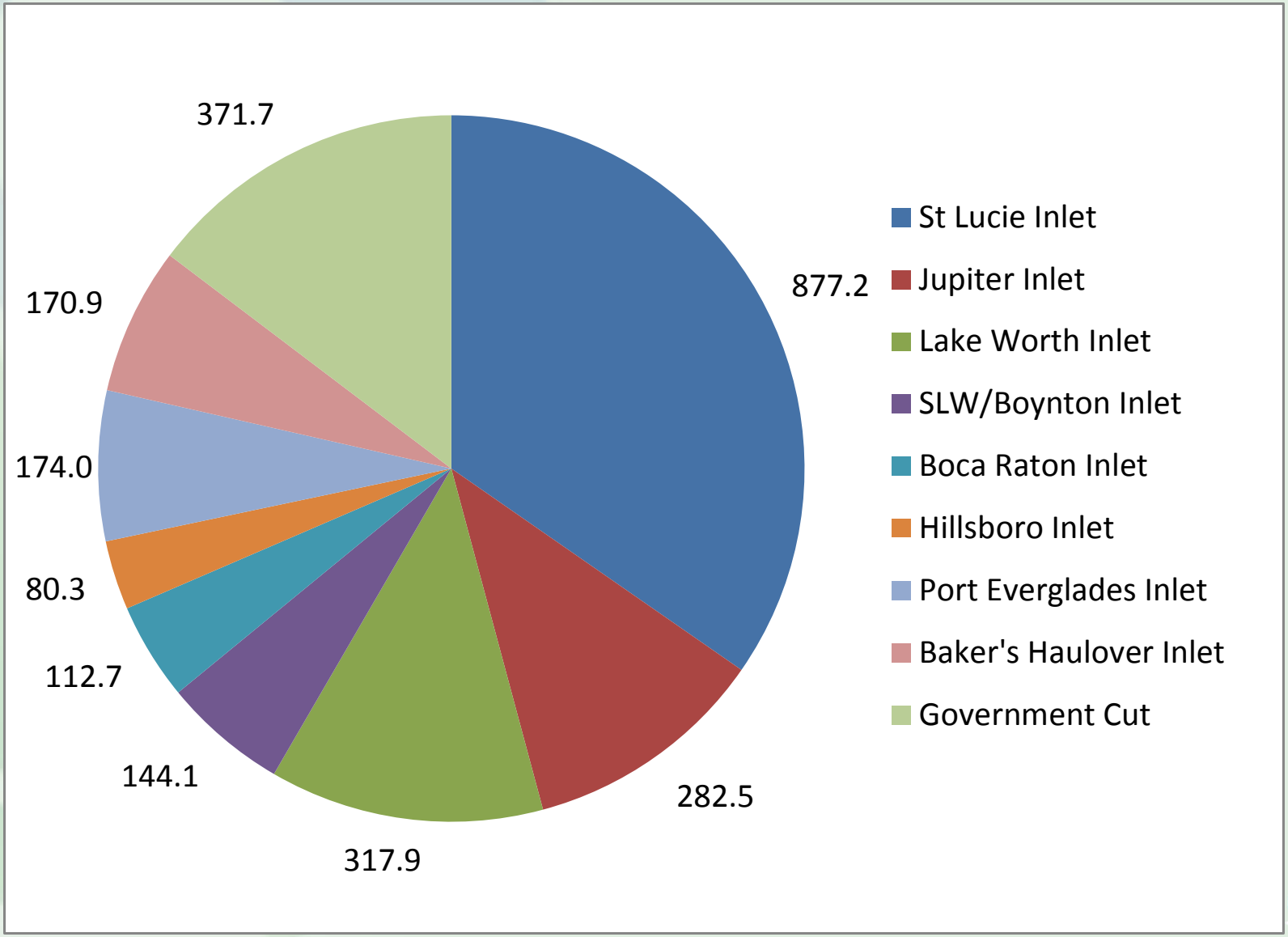
- Geographic Comparisons
- Sources of Pollution
- Water Quality Comparisons
- Assessment and Planning Efforts
- Data Limitations

Geographic Comparisons

- Watershed area
- Land use



Watershed Area (Sq Mi)



Land Use Groups

ICA Name / Landuse Group	Area (% of total)				
	Urban / Trans	Crop Agric	Animal Agric	Water / Wetlands	Open / Forest
St Lucie Inlet	20.1	49.1	0.4	19.1	11.4
Jupiter Inlet	24.5	9.6	0.1	41.8	23.9
Lake Worth Inlet	45.1	8.6	0.5	29.9	15.9
SLW/Boynton Inlet	75.0	10.1	0.8	11.6	2.6
Boca Raton Inlet	75.2	5.9	0.4	12.9	5.6
Hillsboro Inlet	88.9	0.0	0.0	9.1	1.9
Port Everglades Inlet	85.5	0.6	0.1	10.8	3.1
Baker's Haulover Inlet	77.3	0.9	0.0	18.7	3.1
Government Cut	60.4	1.1	0.0	35.3	3.2

* Largest two land uses in each ICA are highlighted

Sources of Pollution

- Atmospheric*
  - All water bodies
- Land-based
  - stormwater
  - groundwater
- Septic systems
  - groundwater
- Ocean outfalls
  - near corals

Image: http://www.sfwmd.gov

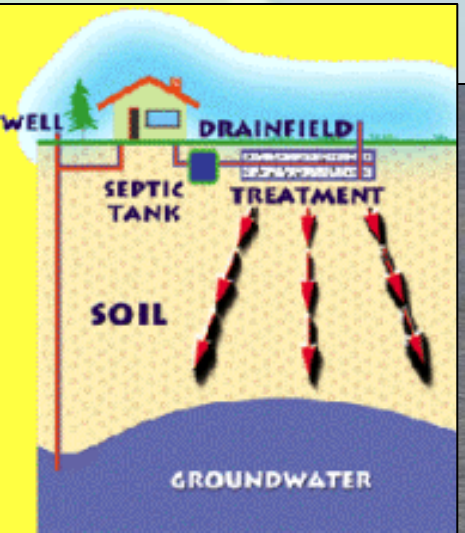
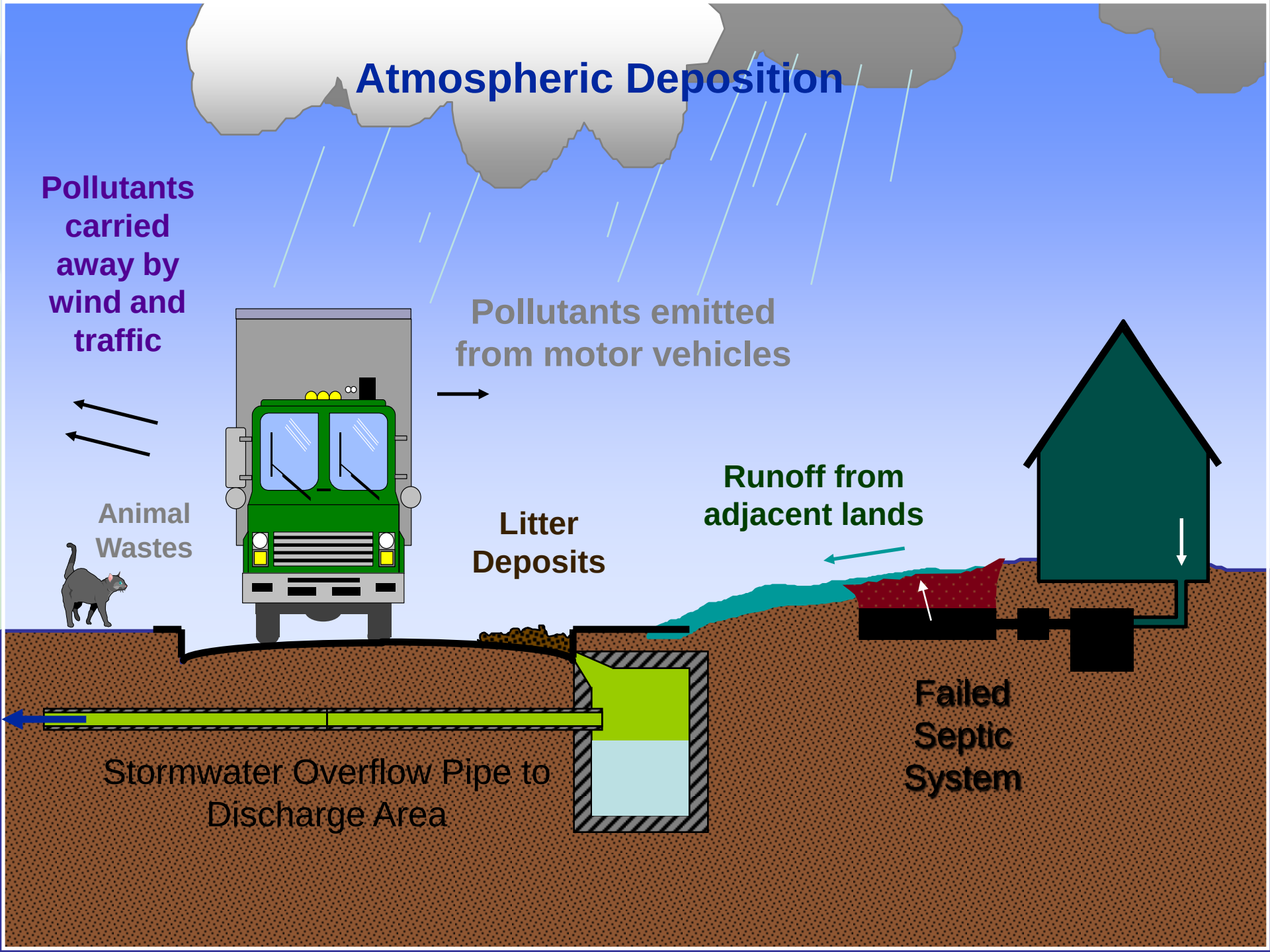


Photo: http://www.florida-stormwater.org/


Atmospheric Deposition
Pollutants carried away by wind and traffic
Pollutants emitted from motor vehicles
Animal Wastes
Litter Deposits
Runoff from adjacent lands
Failed Septic System
Stormwater Overflow Pipe to Discharge Area

LBSP – Phosphorus Loads*

ICA Name	Phosphorus Loads (lb/yr)					
	Urban / Trans	Crop Agric	Animal Agric	Water / Wetlands	Open / Forest	TOTAL
St Lucie Inlet	152,820	449,242	7,458	11,042	22,448	**643,011**
Jupiter Inlet	51,197	26,931	1,131	9,857	10,625	**99,741**
Lake Worth Inlet	122,891	17,221	2,537	7,392	7,036	**157,076**
SLW/Boynton Inlet	115,695	36,562	1,980	720	753	**155,710**
Boca Raton Inlet	89,946	14,426	574	724	1,360	**107,031**
Hillsboro Inlet	84,380	17	0	306	383	**85,087**
Port Everglades Inlet	163,014	1,707	123	803	1497	**167,143**
Baker's Haulover Inlet	139,282	2,241	0	1,695	1,114	**144,331**
Government Cut	228,868	8,714	0	7,386	2,374	**247,342**

* Estimated using land-based export coefficients from St Lucie SLRWRP model. Highest two sources highlighted.

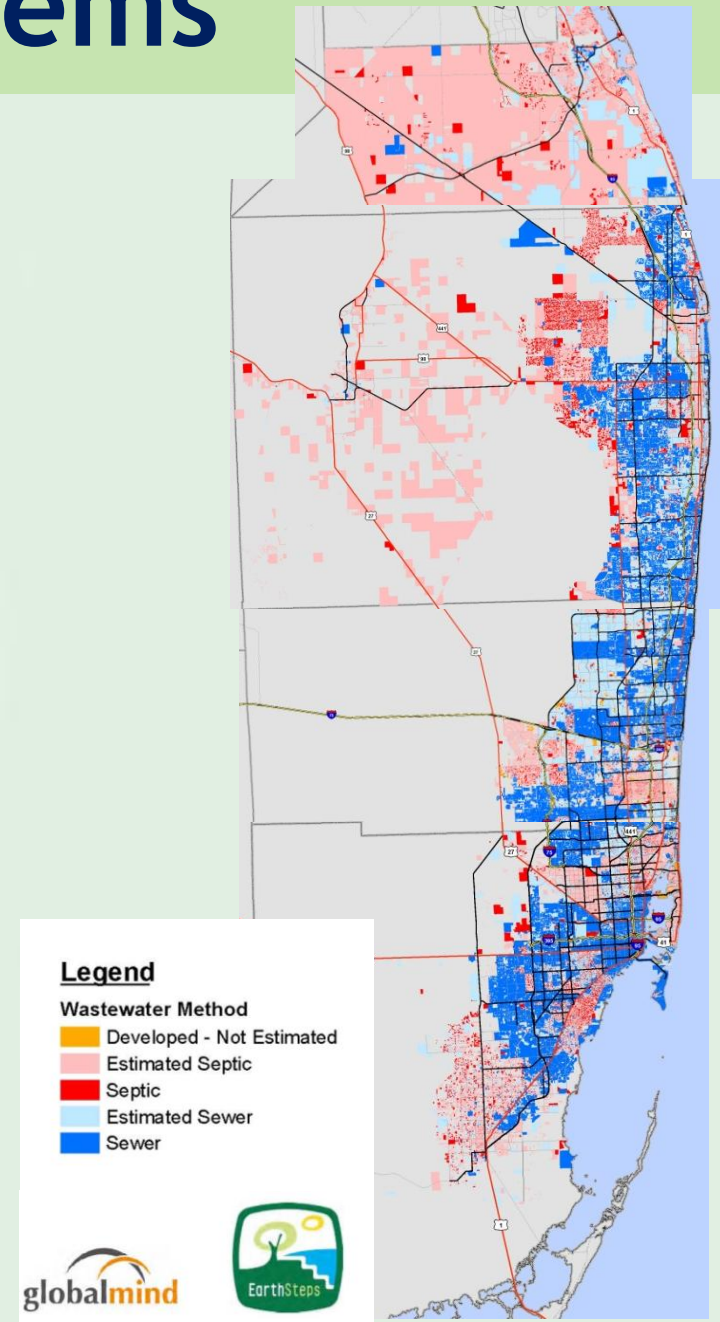
LBSP – Nitrogen Loads*

ICA Name	Nitrogen Loads (lb/yr)					
	Urban / Trans	Crop Agric	Animal Agric	Water / Wetlands	Open / Forest	TOTAL
St Lucie Inlet	679,810	1,819,762	23,623	133,752	152,259	**2,809,205**
Jupiter Inlet	243,382	105,167	3,130	115,715	85,241	**552,635**
Lake Worth Inlet	553,964	99,548	10,928	87,526	64,087	**816,053**
SLW/Boynton Inlet	469,325	98,200	8,788	9,401	6,339	**592,053**
Boca Raton Inlet	366,496	42,716	3,845	9,179	10,462	**432,698**
Hillsboro Inlet	328,222	56	0	4,021	2,890	**335,189**
Port Everglades Inlet	657,174	5,029	770	10,505	10,199	**683,677**
Baker's Haulover Inlet	571,334	8,024	0	21,263	9,395	**610,017**
Government Cut	961,622	24,422	0	91,701	20,694	**1,098,439**

* Estimated using land-based export coefficients from St Lucie SLRWRP model. Highest two sources highlighted.

Septic Systems

- More septic systems in use the northern ICAs than in the southern, more developed ICAs
- Septic systems are used throughout the region and warrant evaluation as a potential nitrogen source
- Current available data is conflicting
  - County data
  - EPA data
  - State Inventory



Ocean Outfalls

ICA Name	Ocean Outfall Name	Treatment Facility Name
SLW/Boynton	Boynton/Delray Beach	South Central Regional Wastewater Treatment Facility*
Boca Raton	Boca Raton	City of Boca Raton Wastewater Treatment/ Water Reclamation Facility
Hillsboro	Broward	Broward County North Regional Wastewater Treatment Plant
Port Everglades	Hollywood	Hollywood Southern Regional Wastewater Treatment Facility
		Cooper City Wastewater Treatment Facility
		Town of Davie Wastewater Treatment Facility
Bakers Haulover	Miami North	MDWASD North District Wastewater Treatment Plant
Government Cut	Miami Central	MDWASD Central District Wastewater Treatment Plant

* only discharges during wet weather

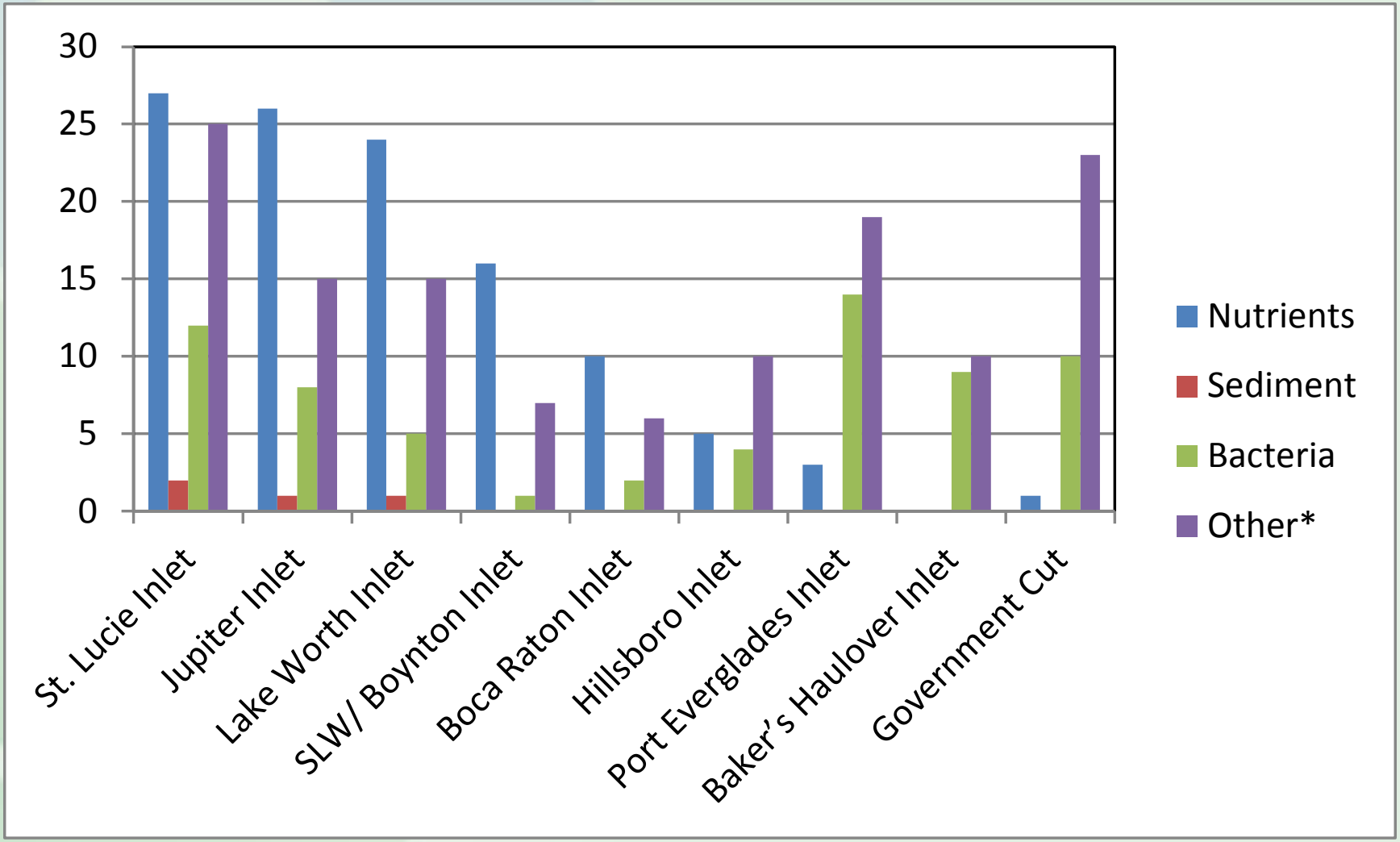
Water Quality Comparisons among the ICAs

Verified Impaired Water Bodies

ICA	Nutrients	Sediment	Bacteria	Other*
St. Lucie Inlet	27	2	12	25
Jupiter Inlet	26	1	8	15
Lake Worth Inlet	24	1	5	15
SLW/ Boynton Inlet	16	0	1	7
Boca Raton Inlet	10	0	2	6
Hillsboro Inlet	5	0	4	10
Port Everglades Inlet	3	0	14	19
Baker's Haulover Inlet	0	0	9	10
Government Cut	1	0	10	23

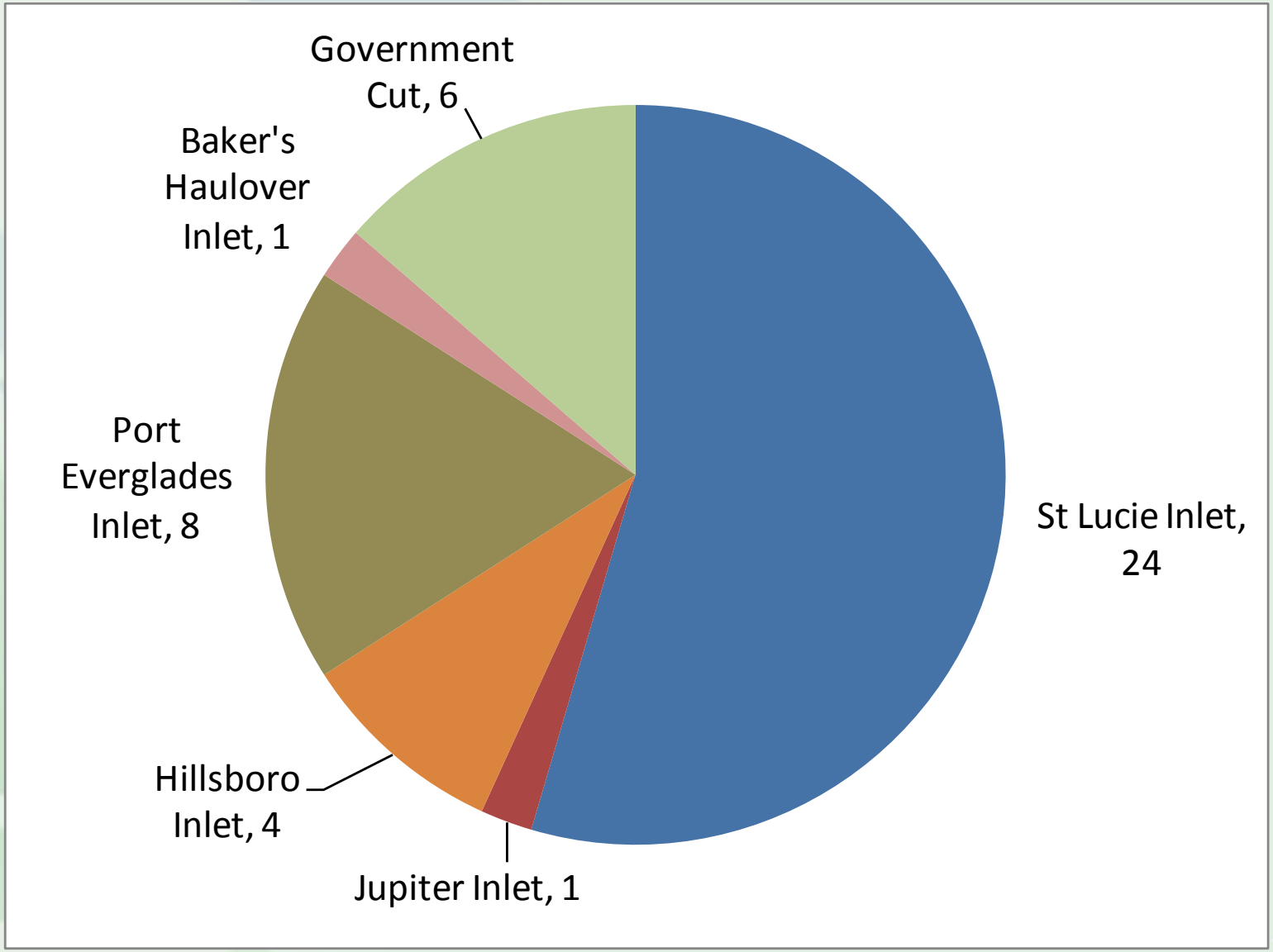
*Other = copper, dioxin, iron, and mercury

Verified Impaired Water Bodies



*Other = copper, dioxin, iron, and mercury

Number of Completed TMDLs



Types of Completed TMDLs

ICA	TMDL	Number
Saint Lucie Inlet	TN	9
Saint Lucie Inlet	TP	9
Saint Lucie Inlet	BOD	4
Saint Lucie Inlet	Fecal Coliform	2
Jupiter Inlet	Fecal Coliform	1
Hillsboro Inlet	TN	1
Hillsboro Inlet	TP	1
Hillsboro Inlet	Fecal Coliform	2
Port Everglades Inlet	Fecal Coliform	8
Baker's Haulover Inlet	Fecal Coliform	1
Government Cut	Fecal Coliform	6

Receiving Waters Monitoring

Number of Measurements

'Each month, County staff collects water samples at 87 locations along Biscayne Bay, as well as major drainage canals and tributaries leading to the Bay.'

-Website of Miami-Dade County DERM http://www.miamidade.gov/environment/surface-water-quality.asp

ICA Name	Nutrients	Conductivity / Salinity	Sediments
St Lucie Inlet	326,732	123,152	58,558
Jupiter Inlet	133,779	47,575	30,112
Lake Worth Inlet	24,597	6,883	2,641
SLW/Boynton Inlet	10,530	3,517	1,101
Boca Raton Inlet	24,825	7,297	3,088
Hillsboro Inlet	8,842	2,506	1,222
Port Everglades Inlet	117,355	42,885	15,315
Baker's Haulover Inlet	99,575	62,518	13,918
Government Cut	261,582	167,950	39,093

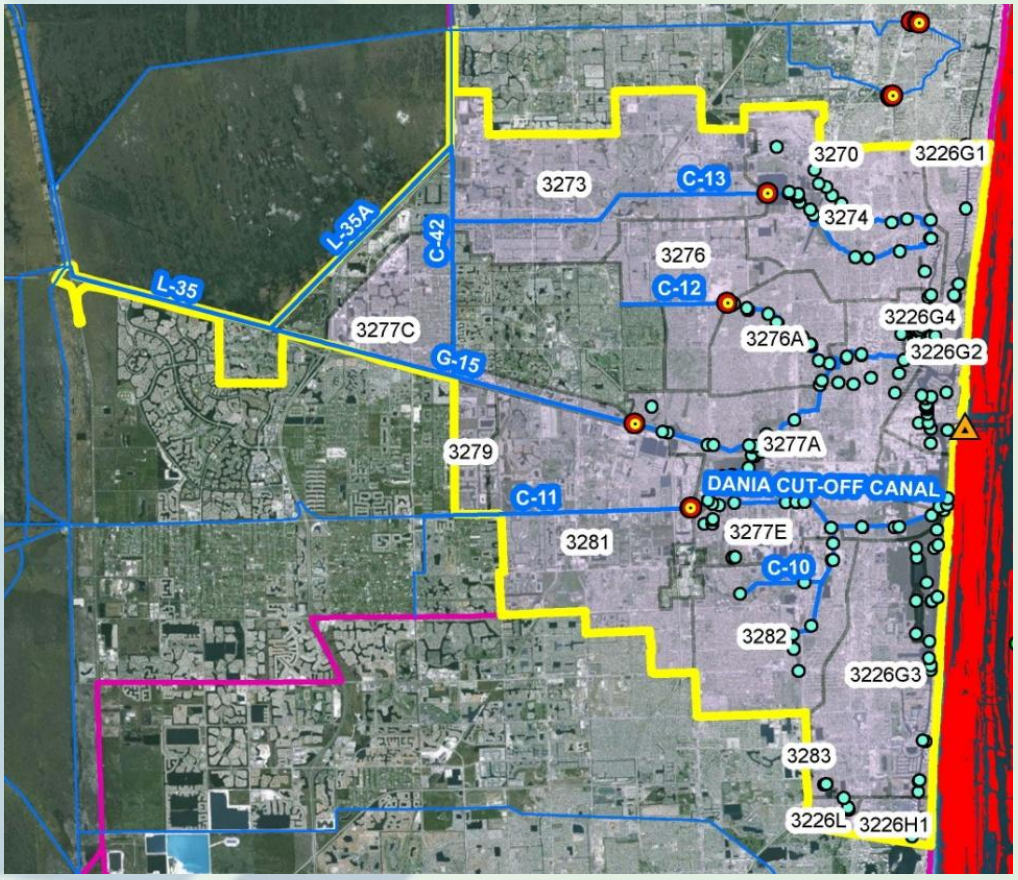
Receiving Waters Monitoring

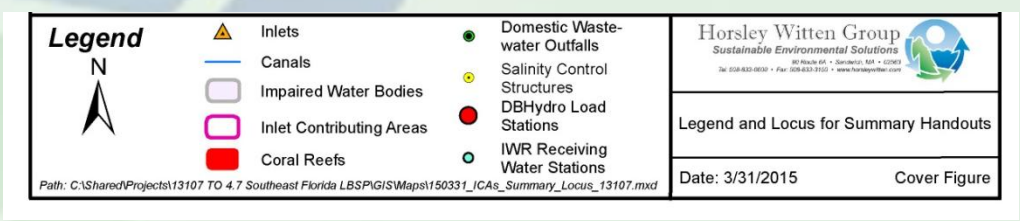
Number of Stations

ICA Name	Nutrients	Conductivity / Salinity	Sediments
St Lucie Inlet	4,552	906	1,068
Jupiter Inlet	1,997	452	428
Lake Worth Inlet	603	116	104
SLW/Boynton Inlet	336	60	56
Boca Raton Inlet	341	70	51
Hillsboro Inlet	114	23	12
Port Everglades Inlet	1,379	332	203
Baker's Haulover Inlet	424	123	90
Government Cut	1,323	385	222

* Colored cells represent possible data gap

Example: Port Everglades ICA

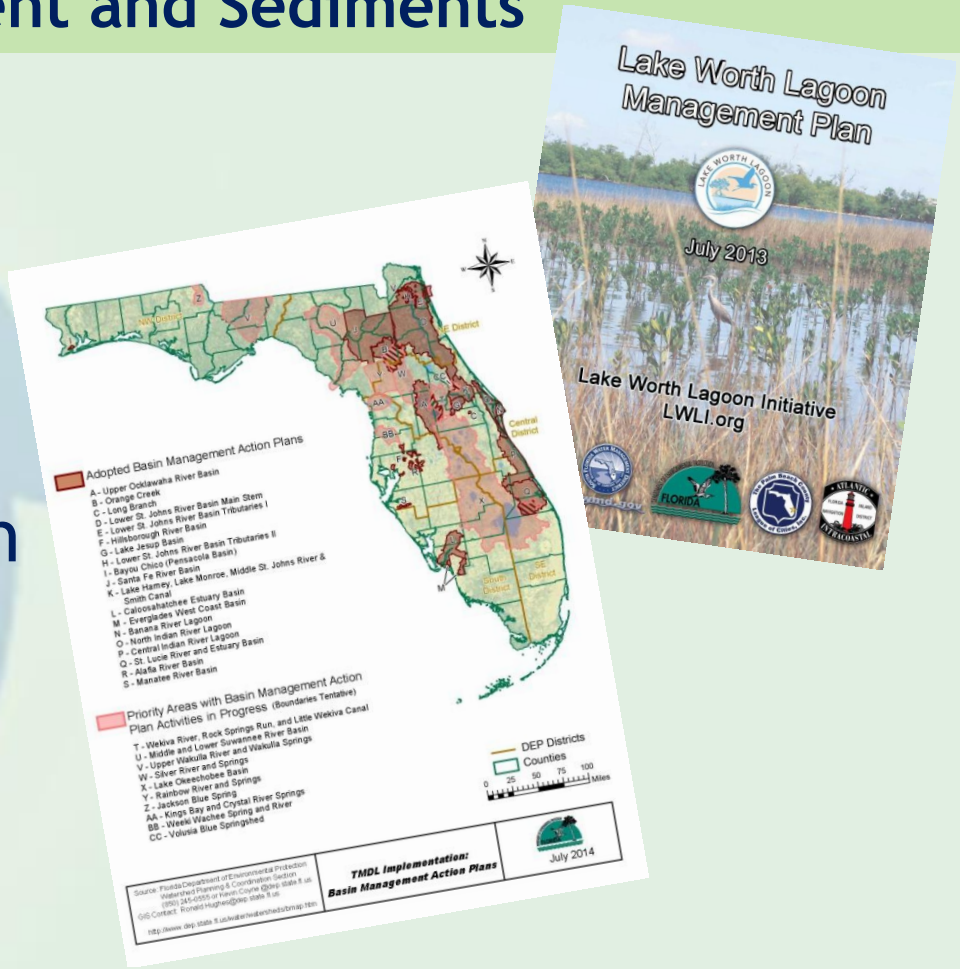




Assessment and Planning Efforts

Related to Nutrient and Sediments

- Number and topic vary greatly
- St Lucie has a high number
- Jupiter and Lake Worth ICAs have a moderate number
- Other five ICAs mostly have few studies



Number of Assessment Reports

ICA Name	Water Quality	Flow	Habitat
St Lucie Inlet	10	2	2
Jupiter Inlet	7	5	4
Lake Worth Inlet	7	5	4
SLW/Boynton Inlet	8	3	1
Boca Raton Inlet	2	1	0
Hillsboro Inlet	1	1	0
Port Everglades Inlet	1	2	0
Baker's Haulover Inlet	1	0	1
Government Cut	1	0	1

St Lucie Studies

- Nutrient and Dissolved Oxygen TMDL for the St Lucie Basin (2008)
- St Lucie River Watershed Protection Plan (SLRWPP) (2009)
- Update of St Lucie River Watershed Protection Plan (2012)
- St Lucie River and Estuary Basin Management Action Plan (BMAP) (2013)

Jupiter Studies

- Modeling Freshwater Inflows and Salinity in the Loxahatchee River and Estuary (2006)
- Restoration Plan for the Northwest Fork of the Loxahatchee River (2006)
- Loxahatchee River National Wild and Scenic River Management Plan Update (2010)
- Loxahatchee River Watershed Restoration Project (ongoing)

Lake Worth Studies

- Lake Worth Lagoon Watershed and Stormwater Loading Analysis (2009)
- Lake Worth Lagoon Management Plan (LWLMP) Revision (2013)
- Freshwater Inflows and Water Quality in Lake Worth Lagoon (2013)

Boynton Studies

- NOAA FACE Outfalls Surveys Cruise (2006)
- Palm Beach County Chain of Lakes report (2009)
- South Lake Worth (Boynton) Inlet Fact Finding Study (2009)
- Boynton-Delray Coastal Water Quality Monitoring Program Report (2011)
- Boynton Inlet Flow Measurement Study (2013)

Hillsboro, Boca, Port Everglades and Government Cut Studies

- NOAA FACE Outfalls Surveys Cruise (2006)
- Palm Beach County Chain of Lakes report (2009) (Boca only)
- Hillsboro, Boca Raton and Port Everglades Inlet Flow Measurement Studies (2013)
- Biscayne Bay Aquatic Preserves Management Plan (2013) (GC only)

Data Gaps and Limitations

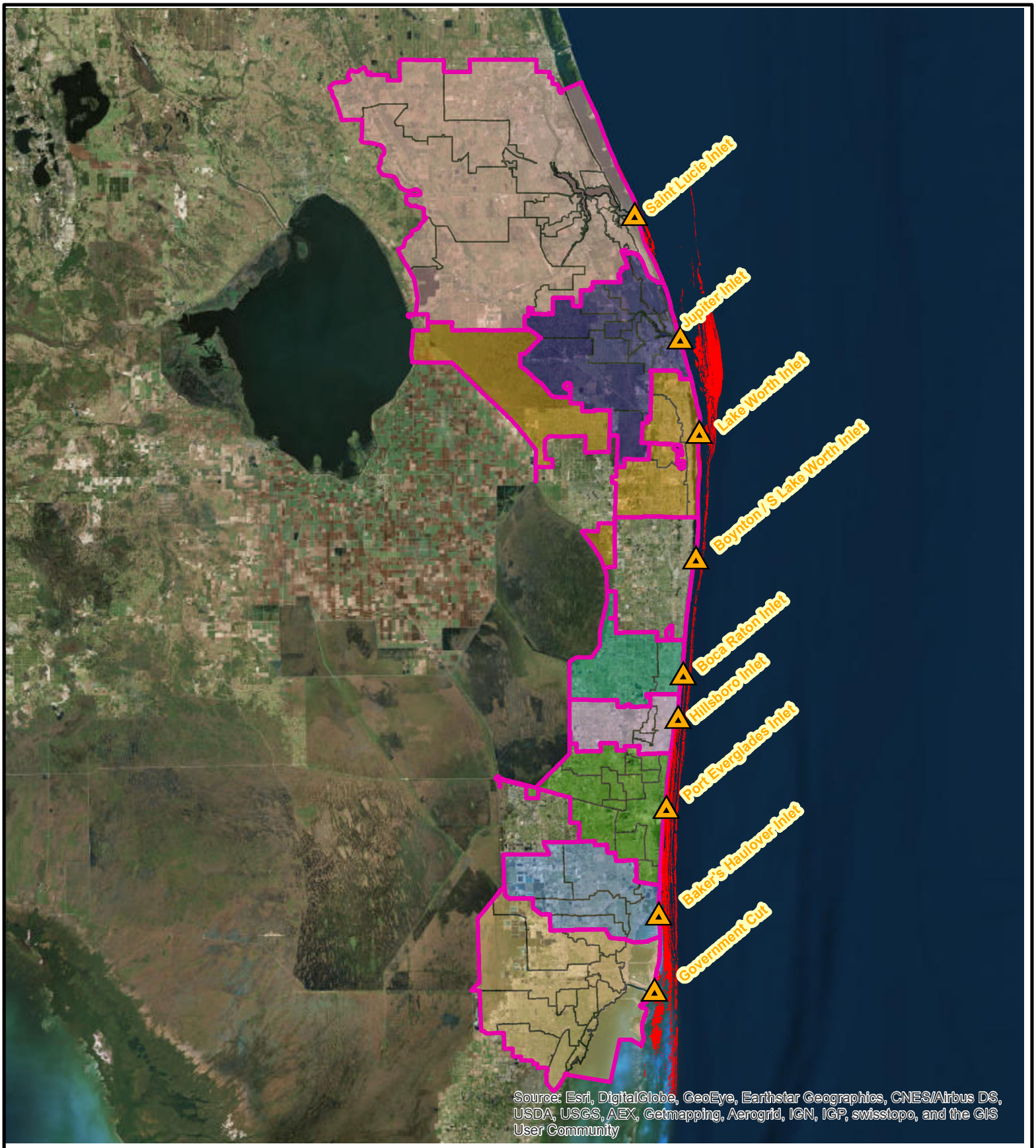
- Mapping of areas dependent on onsite wastewater systems
- Improved precision of land use based pollutant load estimates
- Flow-weighted nutrient measurements are needed for nutrient loads
- Improved density of response monitoring in the receiving waters
- Improved nutrient fluxes from inlets
- Improved understanding of offshore mixing of nutrients from ocean outfalls

Data Gaps by ICA

ICA Name	Land-based Coefficient	Nutrient Load Monitoring	Receiving Waters Monitoring	Nutrient Outflux via Inlet	Septic Mapping	Outfall Mixing
St Lucie Inlet				x	x	
Jupiter Inlet	x	x*		x	x	
Lake Worth Inlet	x	x*	x	x	x	
SLW/Boynton Inlet	x	x*	x	x	x	x
Boca Raton Inlet	x	x	x	x	x	x
Hillsboro Inlet	x	x	x	x	x	x
Port Everglades Inlet	x	x		x	x	x
Baker's Haulover Inlet	x	x		x	x	x
Government Cut	x	x		x	x	x

* crude estimates of nutrient load can be made with current grab sampling and flow measurements

Appendix D. Discussion Handouts - ICA Summaries



Legend

N

1 in = 15.8 miles

- Inlets
- Canals
- Impaired Water Bodies
- Inlet Contributing Areas
- Coral Reefs
- Domestic Wastewater Outfalls
- Salinity Control Structures
- DBHydro Load Stations
- IWR Receiving Water Stations

Path: C:\Shared\Projects\13107 TO 4.7 Southeast Florida LBSP\GIS\Maps\150331_ICAs_Summary_Locus_13107.mxd

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Legend and Locus for Summary Handouts

Date: 3/31/2015

Cover Figure

ST. LUCIE INLET CONTRIBUTING AREA (ICA)

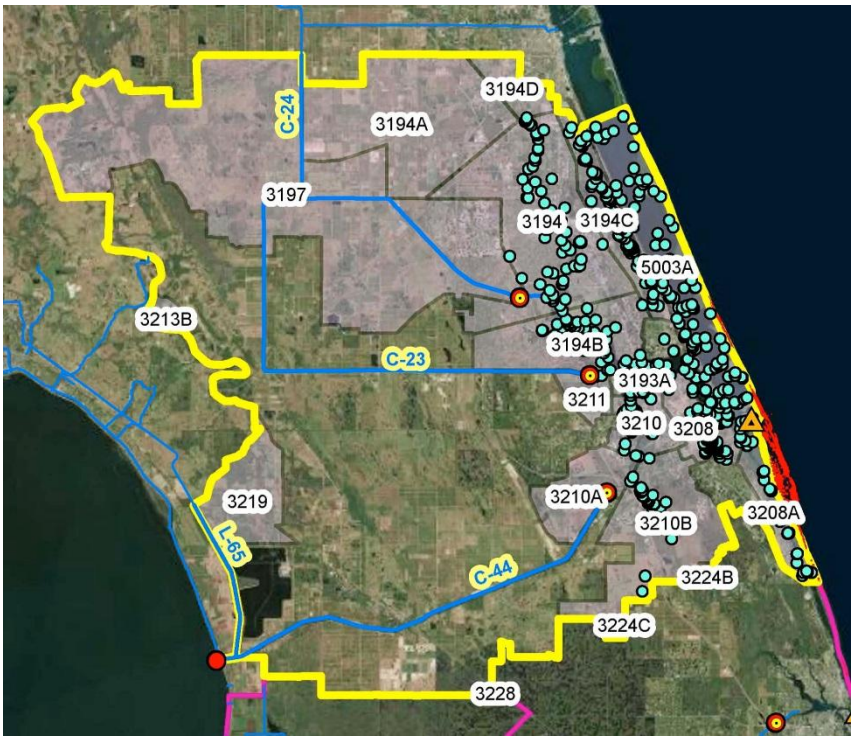
SIZE AND LAND USE

- Total Area: 877 square miles
- Crop Agriculture: 430 square miles
- Urban Land: 176 square miles
- Largest of the 9 ICAs in SE Florida

WATER MANAGEMENT

The major canals within this ICA include C-24, C-23, and C-44.

- **C-24 Canal** (Diversion Canal), is the primary canal for the St. Lucie River Basin, and drains a primarily agricultural sub-basin into the North Fork.
- **C-23 Canal** drains a combination of residential and agricultural land.
- **C-44 Canal** (St. Lucie Canal) carries excess water from Lake Okeechobee into the South Fork.



IMPAIRED WATER BODIES & TMDLS

- This ICA has 66 water bodies (WBIDs) listed as impaired:
  - Nutrients (27)
  - Sediments (2)
  - Bacteria (12)
  - Other (25)
- This ICA has 11 WBIDs with a completed Total Maximum Daily Load (TMDL) (see table on right).

WBID	WATERBODY NAME	TMDL
3197	C-24	TN, TP, and BOD
3200	C-23	TN and TP
3218	C-44	TN, TP, and BOD
3194A	TENMILE CREEK	Fecal Coliform
3194	ST LUCIE RIVER (NORTH FORK)	Fecal Coliform
3194	ST LUCIE RIVER (NORTH FORK)	TN, TP, and BOD
3210A	ST LUCIE CANAL	TN and TP
3194B	ST LUCIE RIVER (NORTH FORK)	TN, TP, and BOD
3211	BESSEY CREEK	TN and TP
3193	ST LUCIE RIVER	TN and TP
3210	ST LUCIE RIVER (SOUTH FORK)	TN and TP

ESTIMATED NUTRIENT LOADS (lbs/yr)

- This ICA has the highest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the highest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- No municipal wastewater ocean outfalls are located adjacent to this ICA.

Source	Total Phosphorus (lb/yr)	Total Nitrogen (lb/yr)
Animal Agriculture	7,458	23,623
Crop Agriculture	449,242	1,819,762
Open/Forest	22,448	152,259
Urban/Transportation	152,820	679,810
Water/Wetlands	11,042	133,752
TOTAL	**643,010**	**2,809,205**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

MONITORING LOCATIONS AND DATA AVAILABILITY

Flow and Loads to Receiving Waters

- Measured at 3 SFWMD salinity control structures:
  - Daily flow monitoring
  - Weekly composite water quality samples and periodic grab samples (nutrients, suspended solids)
- This information is sufficient to estimate nutrient and sediment loads to the receiving waters in the ICA.

Receiving Water Responses (Estuary)

- The Impaired Waters Rule (IWR) monitoring program has 508,442 data points for nutrients, conductivity/salinity, and sediments at 6,526 active monitoring stations.
- This level of information is sufficient for an adequate estimation of water body response to these loads and has been used in the existing TMDL study for the St Lucie River.

PRIOR STUDIES AND PLANNING EFFORTS

Prior studies of this ICA include 10 water quality assessment, 2 flow assessment, and 2 habitat assessment reports. Key documents include:

- **Nutrient and Dissolved Oxygen TMDL for the St. Lucie Basin (2008).** There are nine impaired water bodies for dissolved oxygen, nutrients, and biochemical oxygen demand. The TMDL identified the primary land-based sources of pollutants as agricultural and urban, water from Lake Okeechobee, and groundwater. Management of Lake Okeechobee and some watershed loads are addressed through separate plans.
- **St. Lucie River Watershed Protection Plan (SLRWPP) (2009).** This report was developed in response to state legislation, which authorized the Northern Everglades and Estuaries Protection Program (NEEPP). The intent of the protection plan is to identify strategies for addressing and better understanding local watershed influences and inflows on the health of the river and estuary. Components of the plans were:
  - Watershed Construction Project
  - Watershed Pollutant Control Program
  - Watershed Research and Water Quality Monitoring Program
- **St. Lucie River and Estuary Basin Management Action Plan (BMAP) (2013).** The BMAP includes reduction requirements for contributing land uses, with specific BMPS identified for large sources. The projects that will be implemented to meet these TN, TP and BOD load reductions include structural BMPS, nonstructural BMPs, street sweeping, public education and agricultural management BMPs.

PRIOR STUDIES AND PLANNING EFFORTS (cont.)

- **Update of St. Lucie River Watershed Protection Plan (2012).** This report highlights significant watershed improvements as they relate to management strategies for water quality improvement. The document also lists efforts to improve water quality by reducing nutrient loadings to meet the Total Phosphorus and Total Nitrogen TMDL targets. Water storage plans for 2012-2014 are also discussed briefly.

GAPS IN DATA/INFORMATION

This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

Data/information gaps include:

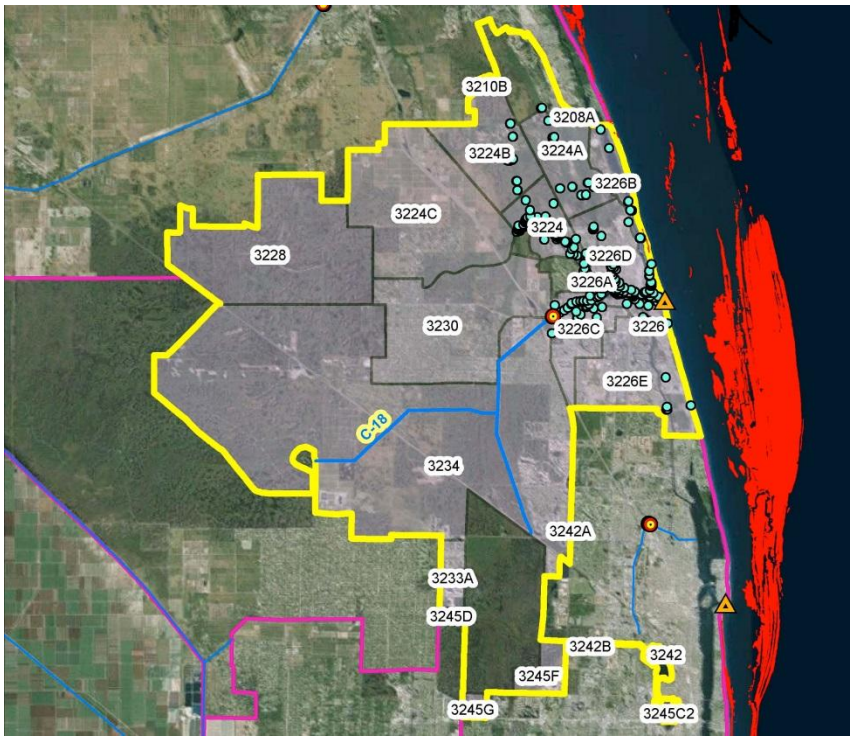
- Mapping of areas dependent on onsite wastewater systems.
- Understanding of inlet hydrodynamics and estuary flushing.

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

JUPITER INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 283 square miles
- Water/Wetlands: 118 square miles
- Urban Land: 69 square miles
- 4th largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canal within the Jupiter ICA is the C-18 canal.

- **C-18 canal** controls flow within the Jupiter ICA and the Jupiter Inlet.
- **C-18 canal** is an extension of the Southwest Fork of the Loxahatchee River
- **C-18 canal** can also augment flow in the Northwest Fork of the Loxahatchee River via the G-92 structure and the South Indian River Water Control District.

IMPAIRED WATER BODIES & TMDLS

- The Jupiter ICA has 50 water bodies (WBIDs) listed as impaired:
  - Nutrients (26)
  - Sediments (1)
  - Bacteria (8)
  - Other (15)
- The Jupiter ICA has 1 WBID with a completed Total Maximum Daily Load (TMDL) (see table on right).

WBID	WATERBODY NAME	TMDL
3226C	LOXAHATCHEE RIVER (SOUTHWEST FORK)	Fecal Coliform

ESTIMATED NUTRIENT LOADS

- This ICA has the 8th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 7th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- No municipal wastewater ocean outfalls are located adjacent to this ICA.

Source	Total Phosphorus	Total Nitrogen (lb/yr)
Animal Agriculture	1,131	3,130
Crop Agriculture	26,931	105,167
Open/Forest	10,625	85,241
Urban/Transportation	51,197	243,382
Water/Wetlands	9,857	115,715
TOTAL	**99,741**	**552,635**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

MONITORING LOCATIONS AND DATA AVAILABILITY

Flow and Loads to Receiving Waters

- Measured at one SFWMD salinity control structure:
  - Daily flow monitoring
  - Monthly water quality grab samples
- This information is **not** sufficient to accurately estimate nutrient, salinity, and sediment loads to the receiving waters in the ICA.

Receiving Water Responses (Estuary)

- The Impaired Waters Rule (IWR) monitoring program has over 211,466 data points for nutrients, conductivity/salinity, and sediments at 2,877 active monitoring stations.
- This level of information is sufficient for an adequate estimation of water body response to these loads and has been used in the existing salinity modeling study for the Loxahatchee River and Estuary.

PRIOR STUDIES AND PLANNING EFFORTS

Prior studies of this ICA include 7 water quality assessment, 5 flow assessment, and 4 habitat assessment reports. Key documents include:

- **Modeling Freshwater Inflows and Salinity in the Loxahatchee River and Estuary (2006).** This report describes the hydrologic and salinity models used in the Northwest Fork of the Loxahatchee River. The Loxahatchee Watershed (WaSh) model was developed to simulate freshwater flow from the tributaries. The Loxahatchee River Hydrodynamics/ Salinity (RMA) model was developed to simulate the influence of freshwater flows on salinity in the river and estuary.
- **Restoration Plan for the Northwest Fork of the Loxahatchee River (2006)**. This plan addresses significant saltwater encroachment in the Loxahatchee River. Reduced freshwater flows into the Northwest Fork do not push back saltwater and that adversely impacts the freshwater ecosystem. The preferred restoration flow scenario has a variable minimum flow in the dry season flow to provide sufficient flow for the downstream tributaries.
- **Loxahatchee River National Wild and Scenic River Management Plan Update (2010**). This updated plan maintains the protection and enhancement objectives from the original 1984 plan while updating the strategies and tasks to fit current conditions in the National Wild and Scenic Loxahatchee River. The managing agencies embrace adaptive management practices and recognize the need for a multi-agency approach.

PRIOR STUDIES AND PLANNING EFFORTS (CONT.)

- **Loxahatchee River Watershed Restoration Project (2015).** The Loxahatchee River Watershed Restoration Project aims to restore and sustain the overall quantity, quality, timing, and distribution of freshwaters to the federally designated "National Wild and Scenic" Northwest Fork of the Loxahatchee River for current and future generations. This project also seeks to restore, sustain, and reconnect the area's wetlands and watersheds that form the historic headwaters for the river and its tributaries. USACE and SFWMD are leading the planning process.

GAPS IN DATA/INFORMATION

This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

Data/information gaps include:

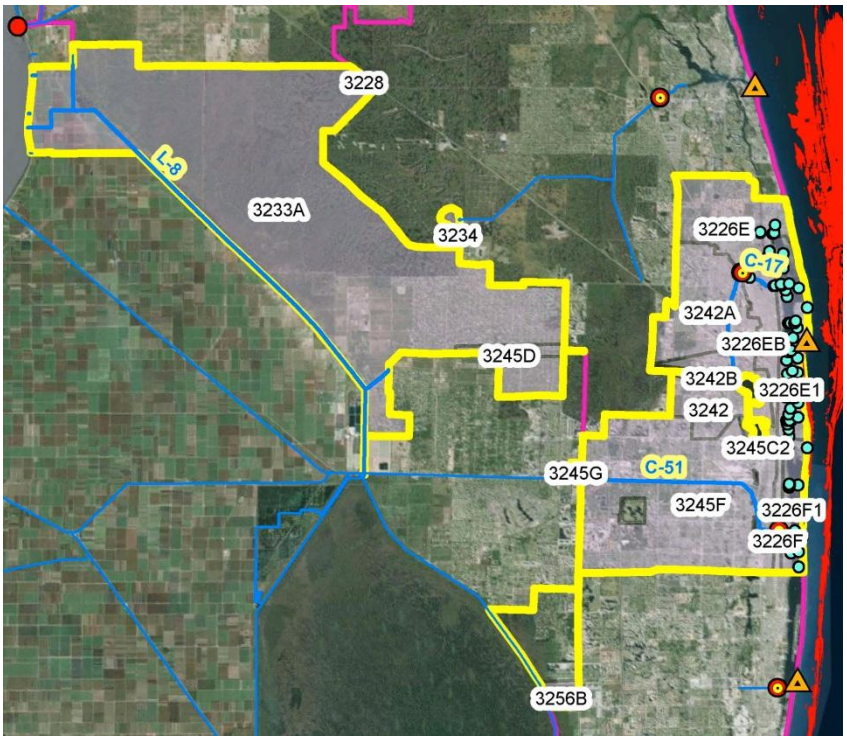
- Mapping of areas dependent on onsite wastewater systems.
- Improved precision of land use based pollutant load estimates for this ICA.
- Improved understanding of inlet hydrodynamics and estuary flushing with regard to nutrients.

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

LAKE WORTH INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 318 square miles
- Water/Wetlands: 95 square miles
- Urban Land: 143 square miles
- 3rd largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals within the Lake Worth ICA are the L-8, C-17, and C-51.

- **L-8 canal** connects Lake Okeechobee to the WCA-1. The canal is conveys excess water west to the lake or east to the coast via the C-51 and other canals.
- **C-51 Canal**, part of the West Palm Beach Canal, flows east to the Lake Worth Lagoon.
- **C-17 Canal**, part of the West Palm Beach canal, drains south to the Intracoastal Waterway.

IMPAIRED WATER BODIES & TMDLS

- The Lake Worth ICA has 45 water bodies (WBIDs) listed as impaired:
  - Nutrients (24)
  - Sediments (1)
  - Bacteria (5)
  - Other (15)
- The Lake Worth ICA has 0 WBIDs with a completed Total Maximum Daily Load (TMDL) (see table on right).

No TMDLS in this ICA

ESTIMATED NUTRIENT LOADS

- This ICA has the 4th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 3rd largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- No municipal wastewater ocean outfalls are located adjacent to this ICA.

Source	Total Phosphorus (lb/yr)	Total Nitrogen (lb/yr)
Animal Agriculture	2,537	10,928
Crop Agriculture	17,221	99,548
Open/Forest	7,036	64,087
Urban/Transportation	122,891	553,964
Water/Wetlands	7,392	87,526
TOTAL	**157,167**	**816,053**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

<table>
<tr><th colspan="2">MONITORING LOCATIONS AND DATA AVAILABILITY</th></tr>
<tr><th>Flow and Loads to Receiving Waters</th><th>Receiving Water Responses (Estuary)</th></tr>
<tr><td>Measured at two SFWMD salinity control structure:
Daily flow monitoring
Monthly water quality grab samples
This information is not sufficient to accurately estimate nutrient, salinity, and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has over 34,121 data points for nutrients, conductivity/salinity, and sediments at 823 active monitoring stations.
This level of information is not sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>Prior studies of this ICA include 7 water quality assessment, 5 flow assessment, and 4 habitat assessment reports. Key documents include:
Lake Worth Lagoon Management Plan (LWLMP) Revision (2013). The LWLMP was recently adopted in 2014. This plan summarizes progress made over the past five years towards understanding, restoring and enhancing the Lake Worth Lagoon ecosystem and charts the course for continuing improvements. Twenty-three action plans, developed by Lake Worth Lagoon Initiative Working Group participants, address water and sediment quality, habitat restoration and monitoring, and public use and outreach. Each action plan includes background information, a step-by-step implementation strategy, cost estimate, schedule, and expected benefits. More information is provided on the Lake Worth Lagoon Initiative website: http://www.pbcgov.org/erm/lwli/)
Lake Worth Lagoon Watershed and Stormwater Loading Analysis (2009). This report provides an overview of the water quality in the LWL watershed and a characterization of the types and magnitude of selected pollutant concentrations in stormwater runoff from contributing land uses. Preliminary annual loads for nitrogen, phosphorus, and sediment were developed. Additional monitoring to quantify loads was proposed and is ongoing.
Freshwater Inflows and Water Quality in Lake Worth Lagoon (2013). Presentation to Water Resources Working Group Lake Worth Lagoon Initiative. Discusses freshwater flow impacts on water quality in LWL inlets and canals using data from 3 monitoring stations.</td><td>This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

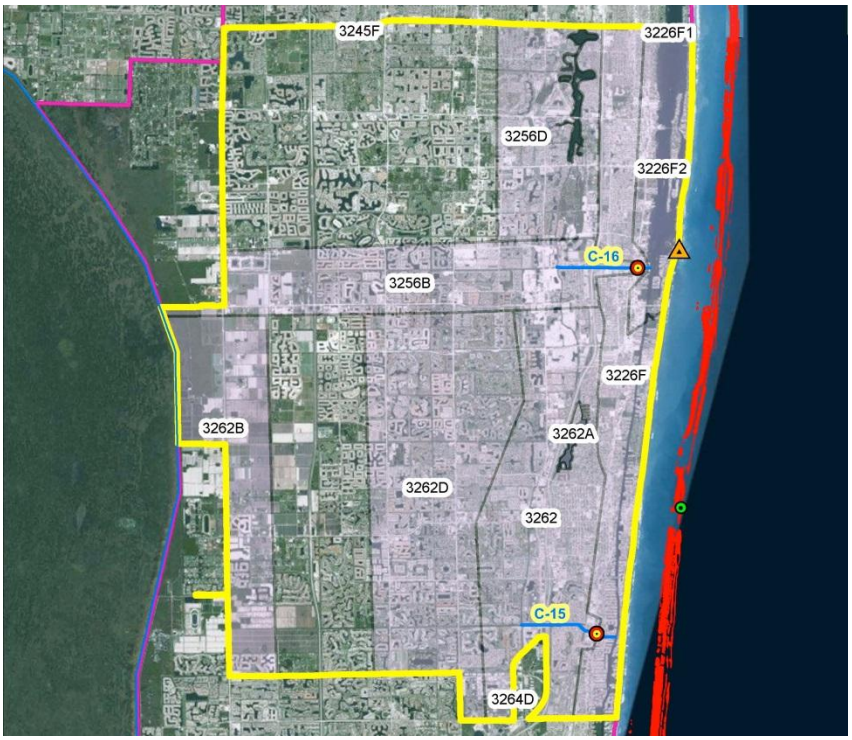
Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA (ongoing).
Improved density of response monitoring in the receiving waters for this ICA.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to nutrients.</td></tr>
</table>

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

BOYNTON/SOUTH LAKE WORTH INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 144 square miles
- Urban Land: 108 square miles
- Water/Wetlands: 17 square miles
- 7th largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals within the Boynton/South Lake Worth ICA are the C-15 and C-16 canals.

- **C-16 Canal** is an extension of the Boynton Canal in the Lake Worth Drainage District (LWDD).
- **C-15 Canal** is an extension of a LWDD lateral canal flowing west to east canal. The Boynton Canal ends and C-16 begins at the Lake Ida Canal.
- Flow in both canals is to the east to the Intracoastal Waterway.

IMPAIRED WATER BODIES & TMDLS

- The Boynton/South Lake Worth ICA has 24 water bodies (WBIDs) listed as impaired:
  - Nutrients (16)
  - Bacteria (1)
  - Other (7)
- The Boynton/South Lake Worth ICA has 0 WBIDs with a completed Total Maximum Daily Load (TMDL) (see table on right).

No TMDLS in this ICA

ESTIMATED NUTRIENT LOADS

- This ICA has the 5th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 6th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The Boynton-Delray (South Central) municipal wastewater ocean outfall is located adjacent to this ICA.

Source	Total Phosphorus (lb/yr)	Total Nitrogen (lb/yr)
Animal Agriculture	1,980	8,788
Crop Agriculture	36,562	98,200
Open/Forest	753	6,339
Urban/Transportation	115,695	469,325
Water/Wetlands	720	9,401
TOTAL	**155,710**	**592,053**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

MONITORING LOCATIONS AND DATA AVAILABILITY

Flow and Loads to Receiving Waters

- Measured at two SFWMD salinity control structure:
  - Daily flow monitoring
  - Monthly water quality grab samples
- This information is **not** sufficient to accurately estimate nutrient, salinity, and sediment loads to the receiving waters in the ICA.

Receiving Water Responses (Estuary)

- The Impaired Waters Rule (IWR) monitoring program has over 15,148 data points for nutrients, conductivity/salinity, and sediments at 452 active monitoring stations.
- This level of information is not sufficient for an adequate estimation of water body response to these loads.

PRIOR STUDIES AND PLANNING EFFORTS

Prior studies of this ICA include 8 water quality assessment, 3 flow assessment, and 1 habitat assessment reports. Key documents include:

- **NOAA FACE Outfalls Surveys Cruise (2006).** Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
- **Palm Beach County Chain of Lakes report (2009).** Reports on the nutrient status of the Chain of Lakes which are located to the west of the Atlantic Coastal Ridge in Palm Beach County. Increases in organic nitrogen concentrations were observed in all lakes, while concentrations of total phosphorus declined.
- **South Lake Worth (Boynton) Inlet Fact Finding Study (2009).** This study determines possible inlet modifications to address water quality in the Lake Worth Lagoon and critical navigation safety issues related to the current inlet configuration.
- **Boynton-Delray Coastal Water Quality Monitoring Program Report (2011).** Report from NOAA AOML that discusses a sequence of six cruises in the vicinity of the Boynton-Delray (South Central) treated-wastewater plant outfall plume, the Boynton Inlet, and the Lake Worth Lagoon. Water was sampled at 18 locations at three depths and analyzed for a variety of nutrients and related parameters.

PRIOR STUDIES AND PLANNING EFFORTS (CONT.)

- **Boynton Inlet Flow Measurement Study (2013).** Flow measurements in the Boynton Inlet were made during 2007 and 2008 to generate estimates of the channel flux at 15-minute intervals. These flux measurements were integrated over flood and ebb tidal periods to estimate the tidal prism of the inlet.

GAPS IN DATA/INFORMATION

This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

Data/information gaps include:

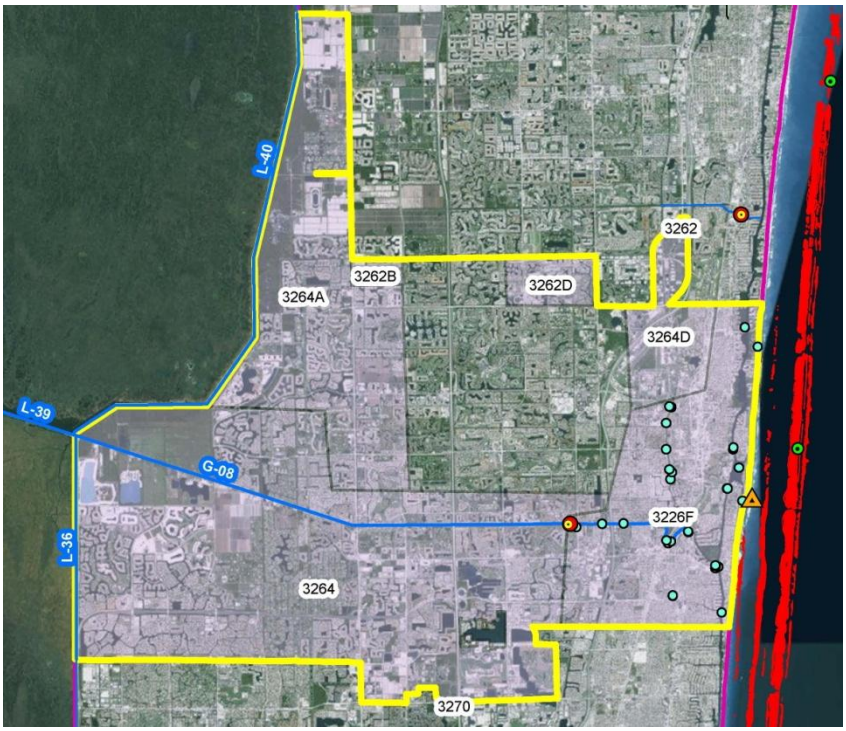
- Mapping of areas dependent on onsite wastewater systems.
- Improved precision of land use based pollutant load estimates for this ICA.
- Improved density of response monitoring in the receiving waters for this ICA.
- Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
- Improved understanding of offshore mixing and advection of nutrients discharged from the Boynton-Delray (South Central) wastewater outfall relative to nearby coral reefs.

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

BOCA RATON INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 113 square miles
- Urban Land: 85 square miles
- Water/Wetlands: 15 square miles
- 8th largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals associated with the Boca Raton ICA are the G-08, L-39, L-40, and L-36. G-08 and L-39 are part of the Boca Raton Canal.

- **G-08 Canal** splits the ICA as it flows east to the Intracoastal Waterway.
- **L-39 Canal** flows east to join G-08 at the western border of the ICA.
- **L-40 Canal** flows south along the western border to join G-08.
- **L-36 Canal** flows north along the western border to join G-08.
- **G-08 and L-39 Canals** form the Hillsboro Canal.

IMPAIRED WATER BODIES & TMDLS

- The Boca Raton ICA has 18 water bodies (WBIDs) listed as impaired:
  - Nutrients (10)
  - Bacteria (2)
  - Other (6)
- The Boca Raton ICA has 0 WBIDs with a completed Total Maximum Daily Load (TMDL) (see table on right).

No completed TMDLs in this ICA

ESTIMATED NUTRIENT LOADS

- This ICA has the 7th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 8th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The City of Boca Raton municipal wastewater ocean outfall is adjacent to this ICA.

Source	Total Phosphorus (lb/yr)	Total Nitrogen (lb/yr)
Animal Agriculture	574	3,845
Crop Agriculture	14,426	42,716
Open/Forest	1,360	10,462
Urban/Transportation	89,946	366,496
Water/Wetlands	724	9,179
TOTAL	**107,030**	**432,698**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

<table>
<tr><th colspan="2">MONITORING LOCATIONS AND DATA AVAILABILITY</th></tr>
<tr><th>Flow and Loads to Receiving Waters</th><th>Receiving Water Responses (Estuary)</th></tr>
<tr><td>Measured at one SFWMD salinity control structure:
Daily flow monitoring
Water quality grab samples inactive
This information is not sufficient to accurately estimate nutrient, salinity, and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has over 35,210 data points for nutrients, conductivity/salinity, and sediments at 462 active monitoring stations.
This level of information is not sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>Prior studies of this ICA include 2 water quality assessment, 1 flow assessment, and 0 habitat assessment reports. Key documents include:
NOAA FACE Outfalls Surveys Cruise (2006). Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
Palm Beach County Chain of Lakes report (2009). Reports on the nutrient status of the Chain of Lakes which are located to the west of the Atlantic Coastal Ridge in Palm Beach County. Increases in organic nitrogen concentrations were observed in all lakes, while concentrations of total phosphorus declined.
Boca Inlet Monitoring. NOAA has conducted a study of Boca Inlet, including four sets of intensive water quality sampling with concurrent velocity measurements and biweekly sampling of the inlet over the course of a year. These data are currently being used to provide flux estimates through these inlets into the coastal ocean.</td><td>This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

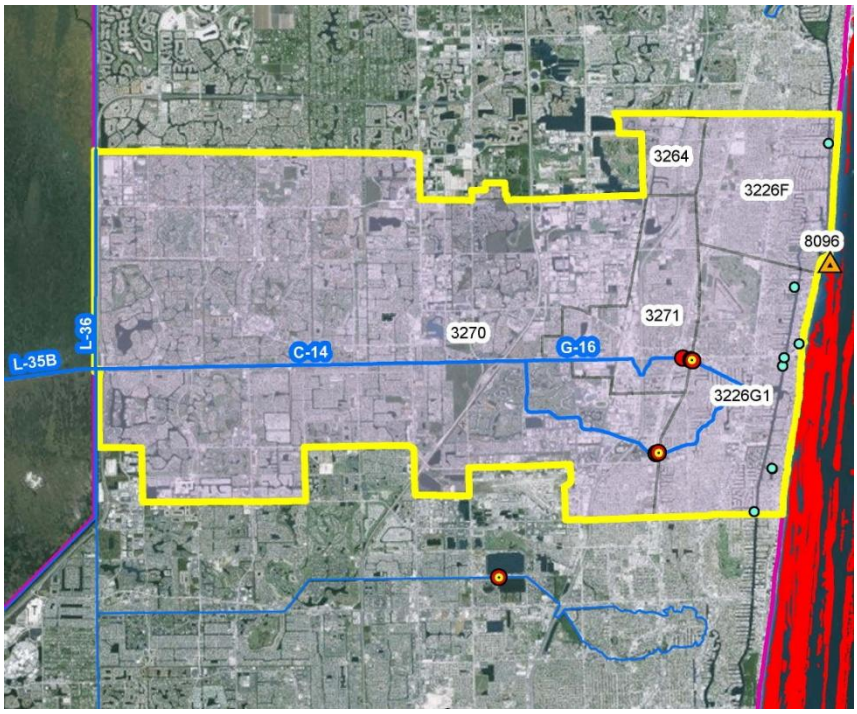
Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA.
Improved density of response monitoring in the receiving waters for this ICA.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
Improved understanding of offshore mixing and advection of nutrients discharged from the Boca Raton wastewater outfall relative to nearby coral reefs.</td></tr>
</table>

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

HILLSBORO INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total area: 80 square miles
- Urban land: 71 square miles
- Water/Wetlands: 7 square miles
- Smallest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals associated with the Hillsboro ICA are the L-35B, C-14, and G-16.

- **L-35B Canal** flows east to join C-14 at the western border of the ICA.
- **L-36 Canal** flows north along the western border of the ICA.
- **C-14 Canal** splits the western part of the ICA as it flows east to join the G-16, then continues south of G-16 to the Intracoastal Waterway.
- **G-16 Canal** splits the eastern part of the ICA as it flows east to the Intracoastal Waterway.

IMPAIRED WATER BODIES & TMDLS

- The Hillsboro ICA has 19 water bodies (WBIDs) listed as impaired:
  - Nutrients (5)
  - Bacteria (4)
  - Other (10)
- The Hillsboro ICA has 3 WBIDs with completed Total Maximum Daily Loads (TMDL) (see table on right).

WBID	WATERBODY NAME	TMDL
3271	POMPANO CANAL	TN and TP
3270	C-14 (CYPRESS CREEK CANAL / POMPANO CANAL)	Fecal Coliform
3264A	E-1 CANAL	Fecal Coliform

ESTIMATED NUTRIENT LOADS

- This ICA has the 9th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 9th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The Broward County regional municipal wastewater ocean outfall is adjacent to this ICA.

Source	Total Phosphorus (lb/yr)	Total Nitrogen (lb/yr)
Animal Agriculture	0	0
Crop Agriculture	17	56
Open/Forest	383	2,890
Urban/Transportation	84,380	328,222
Water/Wetlands	306	4,021
TOTAL	**85,086**	**335,189**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

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<tr><th>Flow and Loads to Receiving Waters</th><th>Receiving Water Responses (Estuary)</th></tr>
<tr><td>Measured at two SFWMD salinity control structure:
Daily flow monitoring
Auto logger of salinity only
This information is not sufficient to accurately estimate nutrient, salinity, and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has over 12,570 data points for nutrients, conductivity/salinity, and sediments at 149 active monitoring stations.
This level of information is not sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>Prior studies of this ICA include 1 water quality assessment, 1 flow assessment, and 0 habitat assessment reports. Key documents include:
NOAA FACE Outfalls Surveys Cruise (2006). Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
Hillsboro Inlet Monitoring. NOAA has conducted a study of Hillsboro Inlet, including four sets of intensive water quality sampling with concurrent velocity measurements and biweekly sampling of the inlet over the course of a year. These data are currently being used to provide flux estimates through these inlets into the coastal ocean.</td><td>This ICA has had considerable effort dedicated to water quality monitoring, load analyses, and planning to date.

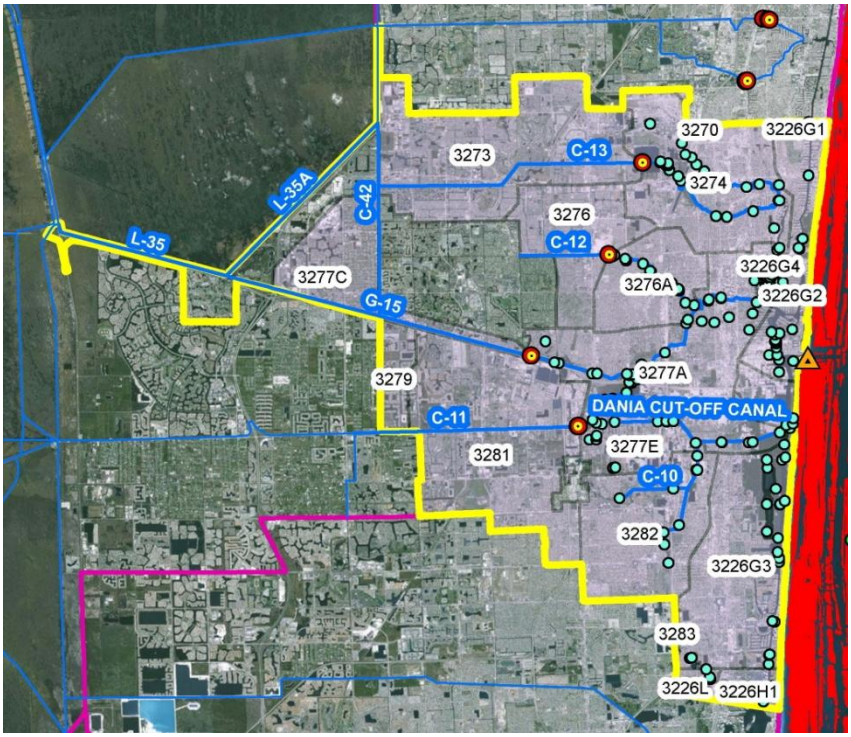
Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA.
Only salinity is measured at the 4 SFWMD salinity control structures. Nutrient measurements are needed for nutrient load calculations.
Improved density of response monitoring in the receiving waters for this ICA.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
Improved understanding of offshore mixing and advection of nutrients discharged from the Broward County North Regional Wastewater Treatment Plant outfall relative to nearby coral reefs.</td></tr>
</table>

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

PORT EVERGLADES INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 174 square miles
- Urban Land: 149 square miles
- Water/Wetlands: 19 square miles
- 5th largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals associated with the Port Everglades ICA are C-13, C-12, C-11, C-10, G-15, C-42, L-35, and L-35A.

- **Canals C-11, C-42, L-35, and L-35A** control flow into this ICA on the western border.
- **Canals C-13, C-12, G15 (the North New River Canal) and C-11** flow eastward to the Intracoastal Waterway.
- **Dania Cut-Off Canal and C-10** provide flow regulation between these east-west canals.
- **C-13 Basin** provides flood protection, supply water, and controls seepage.

IMPAIRED WATER BODIES

- This ICA has 36 water bodies (WBIDs) listed as impaired:
  - Nutrients (3)
  - Bacteria (14)
  - Other (19)
- This ICA has 8 WBIDs with completed Total Maximum Daily Loads (TMDL) (see table on right).

WBID	Name	TMDL
3277C	North New River Canal	Fecal Coliform
3274	C-13 East (Middle River Canal)	Fecal Coliform
3281	C-11 (East)	Fecal Coliform
3277A	New River Canal (South)	Fecal Coliform
3276	C-12	Fecal Coliform
3273	C-13 West (Middle River Canal)	Fecal Coliform
3277E	Dania Cutoff Canal	Fecal Coliform
3276A	New River (North Fork)	Fecal Coliform

ESTIMATED NUTRIENT LOADS (lbs/yr)

- 3rd largest land-based load of total phosphorus of all ICAs in SE Florida.
- 4th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The Hollywood municipal wastewater ocean outfall is located adjacent to this ICA.

Source	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Animal Agriculture	123	770
Crop Agriculture	1,707	5,029
Open/Forest	1,497	10,199
Urban/Transportation	163,014	657,174
Water/Wetlands	803	10,505
TOTAL	**167,144**	**678,653**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

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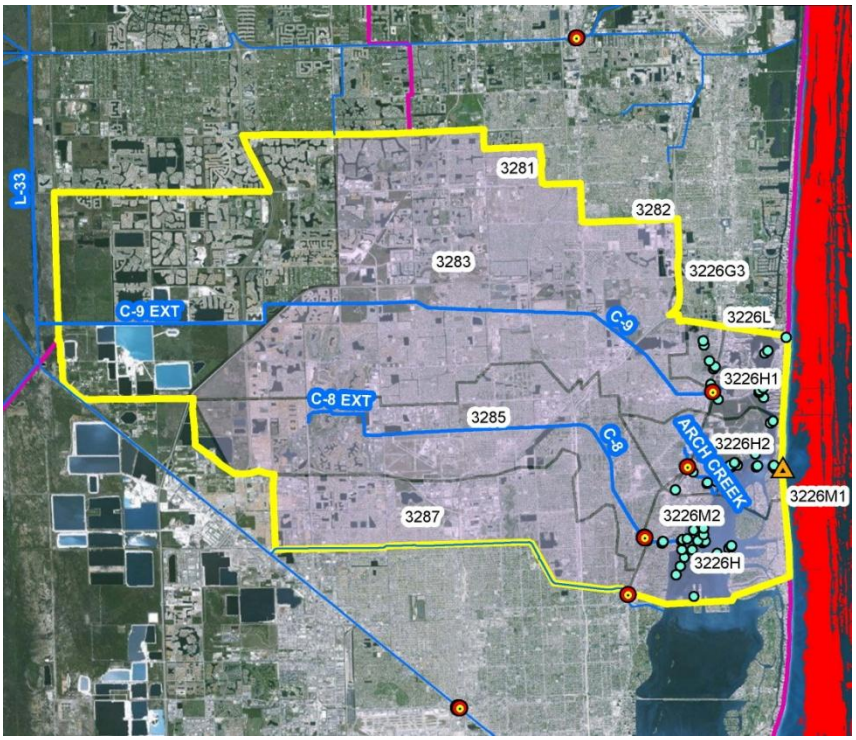
<tr><th>Flow and Loads to Receiving Waters</th><th>Receiving Water Responses (Estuary)</th></tr>
<tr><td>Measured at 4 SFWMD salinity control structures:
Daily flow monitoring
Auto logger of salinity only
This information is not sufficient to estimate nutrient and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has over 175,555 data points for nutrients, conductivity/salinity, and sediments at 1,914 active monitoring stations.
This level of information is sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>There appear to be few watershed-based water quality, flow or habitat assessments or plans in this ICA. However, this ICA has been the focus of flow monitoring and assessment. Key documents include:
NOAA FACE Outfalls Surveys Cruise (2006). Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
Port Everglades Flow Measurement Study (2013). Purpose is to calculate the mass flux through the inlet. To measure the flow through the inlet, a 300-kHz HADCP (Teledyne RD Instruments) was installed in February, 2009, on the south side of the Port Everglades inlet. In addition to the HADCP, a number of meteorological instruments have been installed on the south side of the inlet to measure: wind speed and direction, relative humidity, dew point, barometric pressure, and rain parameters. Measurements of chemical concentrations were conducted by FIU for the estimation of chemical fluxes through the inlet.</td><td>This ICA has had considerable effort dedicated to water quality monitoring at a large distribution of monitoring locations, particularly monitoring for nutrients, dissolved oxygen, and conductivity/salinity. In addition, flow has been monitored at the inlet itself. Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA.
Only salinity is measured at the 4 SFWMD salinity control structures. Nutrient measurements are needed for nutrient load calculations.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
Improved understanding of offshore mixing and advection of nutrients discharged from the Hollywood/ Cooper City/ Town of Davie Wastewater Treatment Plant outfall relative to nearby coral reefs.</td></tr>
</table>

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

BAKER'S HAULOVER INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 171 square miles
- Urban Land: 132 square miles
- Water/Wetlands: 32 square miles
- 6th largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals associated with the Baker's Haulover ICA are L-33, Arch Creek, C-8, and C-9 and their extensions.

- **L-33 Canal** control flows into the Baker's Haulover ICA on the western border.
- **Arch Creek, C-9, and C-8 Canals and their Extensions** flow eastward to the Intracoastal Waterway or the Biscayne Bay.

IMPAIRED WATER BODIES

- This ICA has 19 water bodies (WBIDs) listed as impaired:
  - Bacteria (9)
  - Other (10)
- This ICA has 1 WBID with a completed Total Maximum Daily Load (TMDL) (see table on right).

WBID	Name	TMDL
3285	C-8, Biscayne Canal	Fecal Coliform

ESTIMATED NUTRIENT LOADS (lbs/yr)

- This ICA has the 6th largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 5th largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The Miami North municipal wastewater ocean outfall is located in adjacent to this ICA.

Source	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Animal Agriculture	0	0
Crop Agriculture	2,241	8,024
Open/Forest	1,114	9,395
Urban/Transportation	139,282	571,334
Water/Wetlands	1,695	21,263
TOTAL	**144,332**	**610,016**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

<table>
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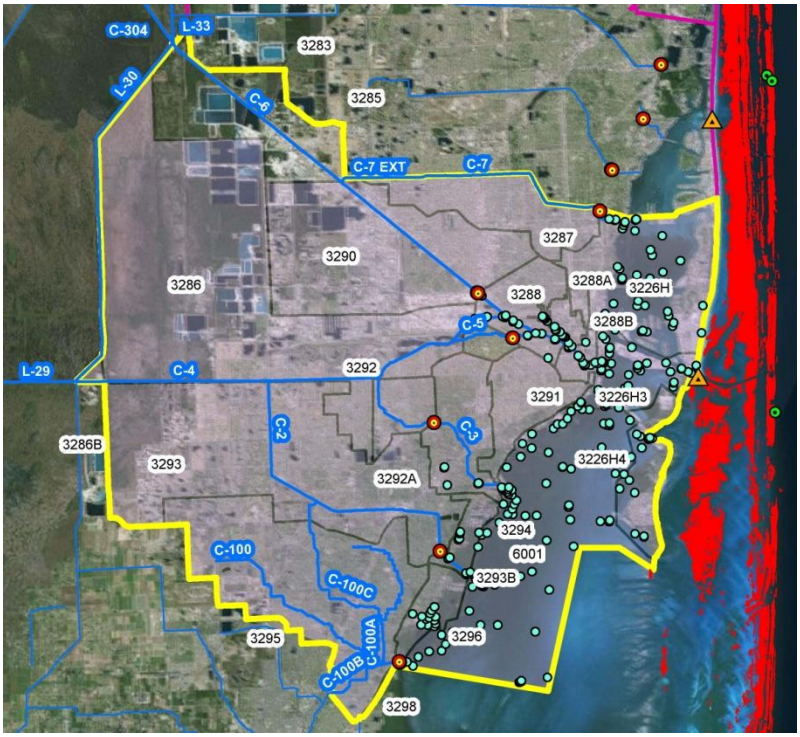
<tr><th>Flow and Loads to Receiving Waters</th><th>Receiving Water Responses (Estuary)</th></tr>
<tr><td>Measured at 3 SFWMD salinity control structures:
Daily flow monitoring
Auto logger of salinity only
This information is not sufficient to estimate nutrient and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has 176,011 data points for nutrients, conductivity/salinity, and sediments at 637 active monitoring stations.
This level of information is sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>There appear to be few watershed-based water quality, flow or habitat assessments or plans in this ICA. The Biscayne Bay Aquatic Preserves have been the focus of significant effort in this area. Key documents include:
NOAA FACE Outfalls Surveys Cruise (2006). Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
Biscayne Bay Aquatic Preserves Management Plan (2013). The Plan is an ecosystem-based management plan and describes water quality, habitat loss, obstacles in natural resource management, public access and economic uses. It also includes an administrative plan for implementation. It also includes portions of Government Cut ICA.</td><td>This ICA has had considerable effort dedicated to water quality monitoring at a large distribution of monitoring locations, particularly monitoring for nutrients, dissolved oxygen, and conductivity/salinity. Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA.
Only salinity is measured at the 3 SFWMD salinity control structures. Nutrient measurements are needed for nutrient load calculations.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
Improved understanding of offshore mixing and advection of nutrients discharged from the Miami-Dade Water and Sewer Department North District Wastewater Treatment Plant outfall relative to nearby coral reefs.</td></tr>
</table>

REFERENCE: Pickering, N. and Baker, E. 2015. Watershed Scale Planning to Reduce the Land-Based Sources of Pollution (LBSP) for the Protection of Coral Reefs in Southeast Florida. Prepared for the National Oceanographic and Atmospheric Administration. Horsley Witten Group. Sandwich, MA. 84 pp.

GOVERNMENT CUT INLET CONTRIBUTING AREA (ICA)

SIZE AND LAND USE

- Total Area: 372 square miles
- Urban land: 225 square miles
- Water/Wetlands: 131 square miles
- 2nd largest of the 9 ICAs in SE Florida



WATER MANAGEMENT

The major canals associated with this ICA include the L-33, C-304, L-30, L-29, C-7, C-7 Ext, C-6, C-5, C-4, C-3, C-2, C-100, C-100A, C-100B, and C-100C.

- **Canals L-33, C-304, L-30, and L-29** control flow into this ICA in the west.
- Canals C-7 and C-7 Ext flow east on the northern border then enter the ICA and discharge to the Biscayne Bay
- **Canal C-6 (Miami Canal)** flows southeast to the Biscayne Bay.
- **Canal C-4** flows east to join the **C-3 and C-5 Canals**, then discharges into the eastern **C-6 Canal.**
- **Canals C-100, C-100A, C-100B, and C-100C** flow north to join the **C-2 and C-4 Canals.**

IMPAIRED WATER BODIES & TMDLs

- This ICA has 34 water bodies (WBIDs) listed as impaired:
  - Nutrients (1)
  - Bacteria (10)
  - Other (23)
- This ICA has 6 WBIDs with completed Total Maximum Daily Loads (TMDL) (see table on right).

WBID	Name	TMDL
3290	C-6/Miami Canal	Fecal Coliform
3288	C-6/Miami River	Fecal Coliform
3287	C-7/ Miami River	Fecal Coliform
3288B	C-6/ Miami River (Lower Segment)	Fecal Coliform
3288A	Wagner Creek	Fecal Coliform
3226G4	Las Olas Isles Finger Canal System	Fecal Coliform

ESTIMATED NUTRIENT LOADS (lbs/yr)

- This ICA has the 2nd largest land-based load of total phosphorus of all ICAs in SE Florida.
- This ICA has the 2nd largest land-based load of total nitrogen of all ICAs in SE Florida.
- Pollutant loads from onsite wastewater systems have not been quantified.
- The Miami Central municipal wastewater ocean outfall is located adjacent to this ICA.

Source	Total Phosphorus (lbs/yr)	Total Nitrogen (lbs/yr)
Animal Agriculture	0	0
Crop Agriculture	8,714	24,422
Open/Forest	2,374	20,694
Urban/Transportation	228,868	961,622
Water/Wetlands	7,386	91,701
TOTAL	**247,342**	**1,098,439**

Relative land-based pollutant loads calculated using land-based pollutant load coefficients and the current land use areas.

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<tr><td>Measured at 4 SFWMD salinity control structures:
Daily flow monitoring
Auto logger of salinity only
This information is not sufficient to estimate nutrient and sediment loads to the receiving waters in the ICA.</td><td>The Impaired Waters Rule (IWR) monitoring program has 468,625 data points for nutrients, conductivity/salinity, and sediments at 1,930active monitoring stations.
This level of information is sufficient for an adequate estimation of water body response to these loads.</td></tr>
<tr><th>PRIOR STUDIES AND PLANNING EFFORTS</th><th>GAPS IN DATA/INFORMATION</th></tr>
<tr><td>There appear to be few watershed-based water quality, flow or habitat assessments or plans in this ICA. The Biscayne Bay Aquatic Preserves have been the focus of significant effort in this area. Key documents include:
NOAA FACE Outfalls Surveys Cruise (2006). Two data collection cruises collected chemical and biological water quality data in the vicinity of six active municipal wastewater ocean outfalls from Boynton to Government Cut Inlets. Data, including nutrients, pH, chlorophyll, and velocity, were collected from the direct outfall area as well as more distant areas.
Biscayne Bay Aquatic Preserves Management Plan (2013). The Plan is an ecosystem-based management plan and describes water quality, habitat loss, obstacles in natural resource management, public access and economic uses. It also includes an administrative plan for implementation. It also includes portions of Baker’s Haulover ICA.</td><td>This ICA has had considerable effort dedicated to water quality monitoring at a large distribution of monitoring locations, particularly monitoring for nutrients, dissolved oxygen, and conductivity/salinity. Data/information gaps include:
Mapping of areas dependent on onsite wastewater systems.
Improved precision of land use based pollutant load estimates for this ICA.
Only salinity is measured at the 4 SFWMD salinity control structures. Nutrient measurements are needed for nutrient load calculations.
Improved understanding of inlet hydrodynamics and estuary flushing with regard to long-term nutrient fluxes.
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