The Florida Senate

COMMITTEE MEETING EXPANDED AGENDA

APPROPRIATIONS SUBCOMMITTEE ON THE ENVIRONMENT AND NATURAL RESOURCES
Senator Bradley, Chair
Senator Book, Vice Chair

MEETING DATE: Wednesday, January 25, 2017
TIME: 10:00 a.m.—12:00 noon
PLACE: *Pat Thomas Committee Room,* 412 Knott Building

MEMBERS: Senator Bradley, Chair; Senator Book, Vice Chair; Senators Braynon, Hukill, Hutson, Mayfield, and Stewart

TAB	BILL NO. and INTRODUCER	BILL DESCRIPTION and SENATE COMMITTEE ACTIONS	COMMITTEE ACTION
1		Presentation by the Department of Environmental Protection	
2		Presentation by Environmental Advocates	
3		Presentation by Representatives of Agricultural Landowners in the Everglades Agricultural Area	
4		Presentation by Research Professor from Harbor Branch Oceanographic Institute	
5		The committee intends to provide 30 minutes for public comment, time permitting. Each speaker's time may be limited based on time restrictions.	
		Other Related Meeting Documents	

Florida Department of Environmental Protection

Everglades Restoration Overview

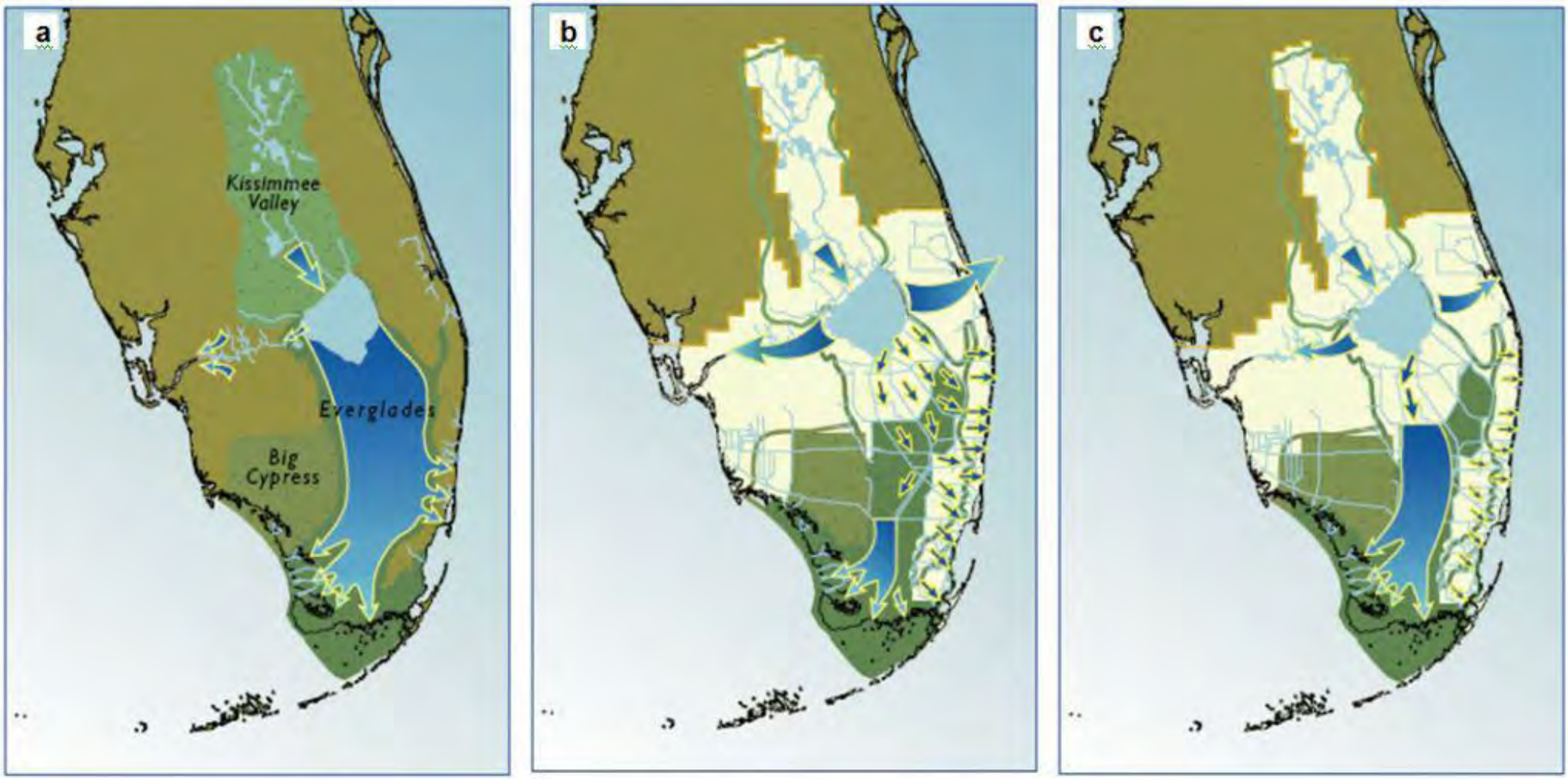
Drew Bartlett, Deputy Secretary
for Ecosystem Restoration

January 25, 2017





South Florida Ecosystem Restoration Program Overview

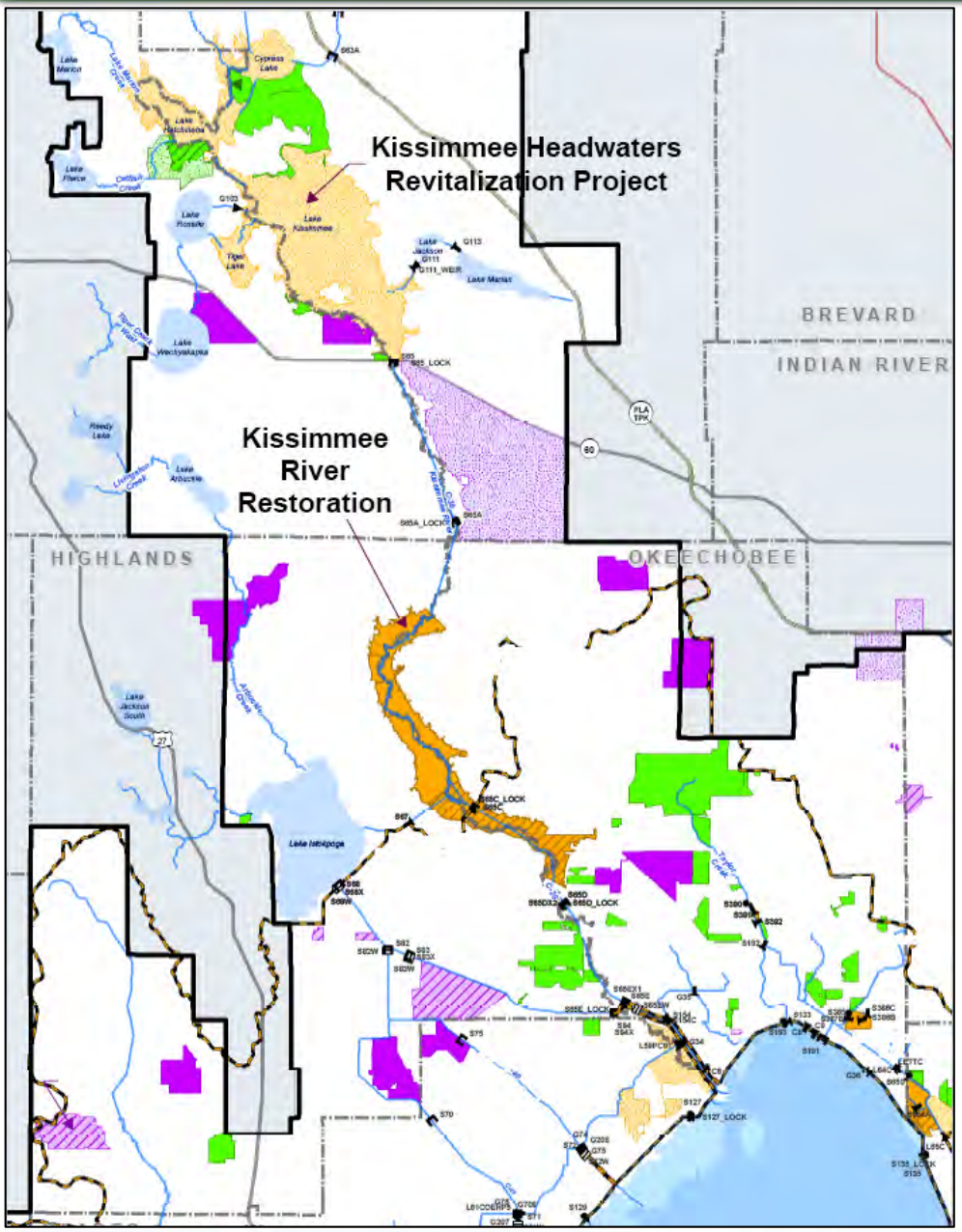


Pre-drainage Flow

Current Flow

Restored Flow

Lake Okeechobee Watershed



CERP

- Watershed Storage Planning
  - Kicked off in 2016

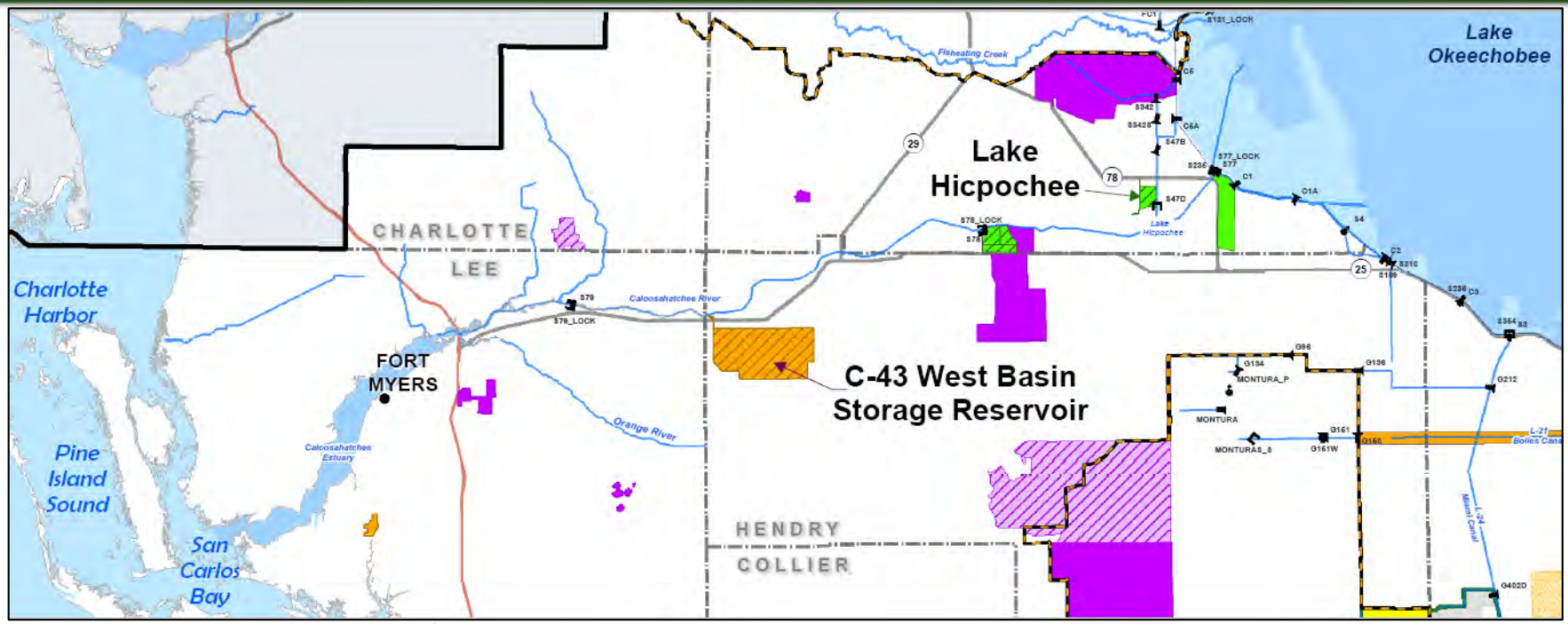
NEEPP & BMAP

- BMAP Adopted in 2014
  - 145 Metric Tons reduction in phosphorus pollution
- Dispersed Water Management
  - $53M infusion in 2016
- Agriculture BMPs

Pre-CERP

- Kissimmee River Restoration
  - Final Land Acquisition funded in 2015
- Upper Kissimmee Chain of Lakes
  - Implemented in 2016

Caloosahatchee Watershed



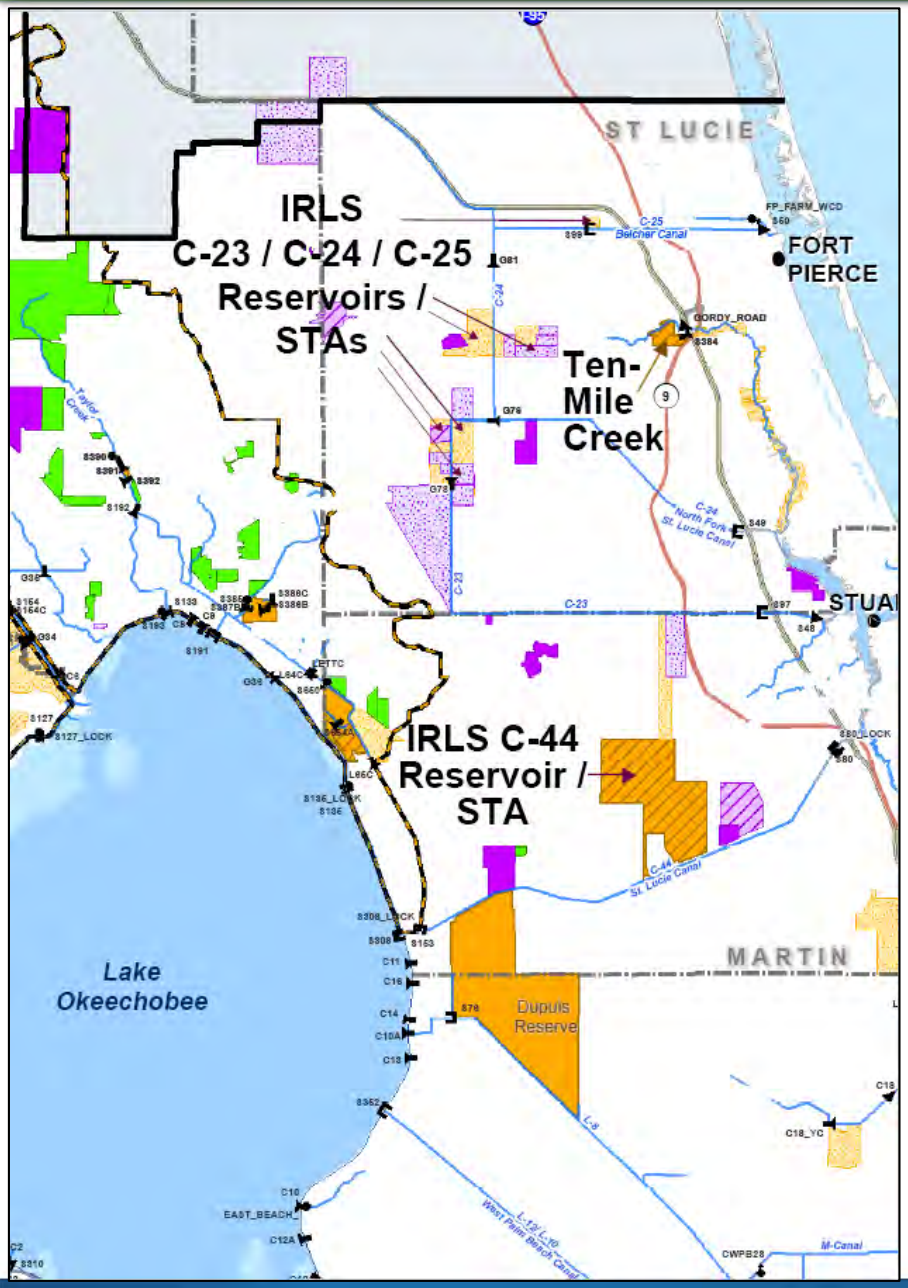
CERP

- C-43 Reservoir
  - Broke ground in 2016

NEEPP & BMAP

- Ag BMPs & Local Projects
- C-43 Water Quality Treatment
- Lake Hicpochee Restoration
  - Land Acquired in 2016
- Dispersed Water Management
- Septic to Sewer Cost Share
  - Governor Scott's 2016 Proposal

Indian River Lagoon South



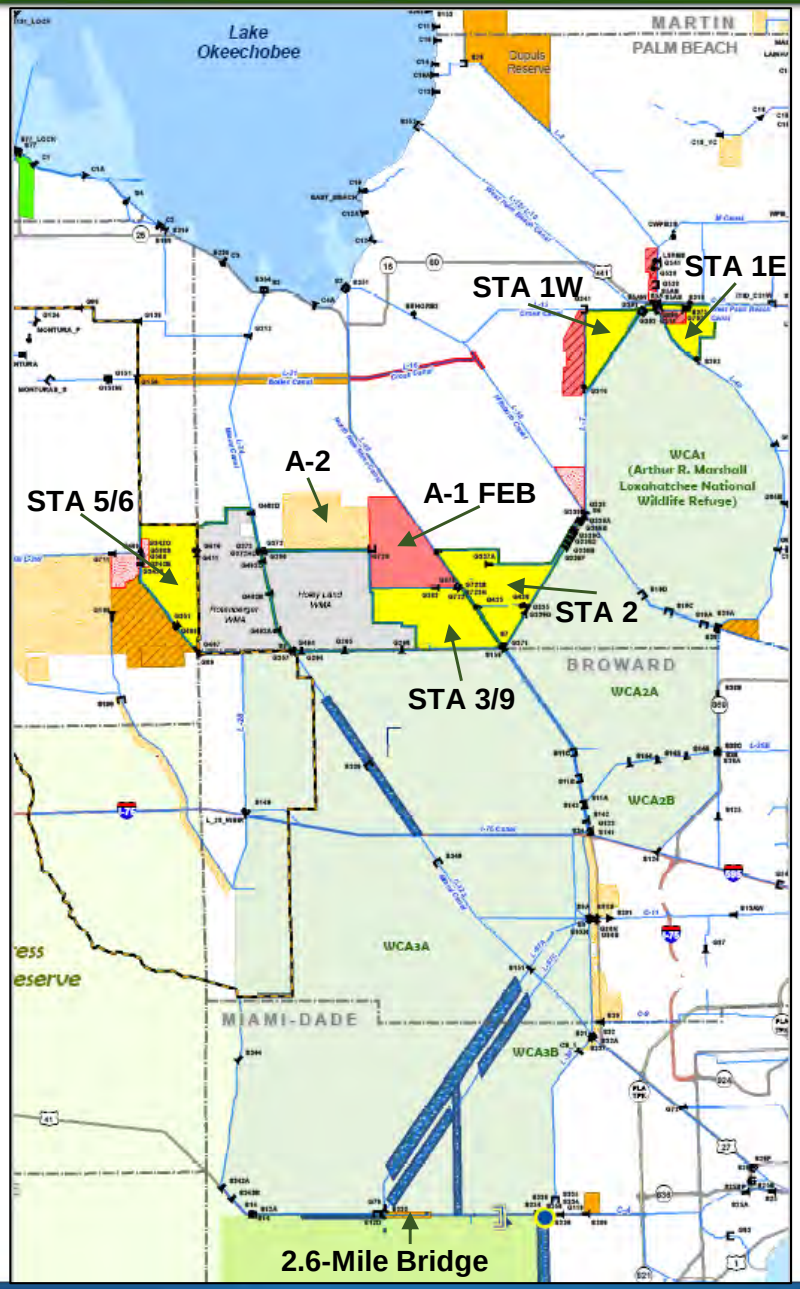
CERP

- C-44 Storage & Treatment
  - Started in 2014, finish 2019
- C-23, C-24, & C-25 Storage & Treatment
- 10-Mile Creek Water Preserve Area (transferred to District)

NEEPP & BMAP

- Dispersed Water Management
- Agriculture BMPs & Local Projects
- Septic to Sewer Cost Share
  - Governor Scott's 2016 Proposal

EAA and Everglades



CERP

- Central Everglades Project
  - Authorized in 2016
- Western Everglades Restoration Planning
  - Initiated in 2016

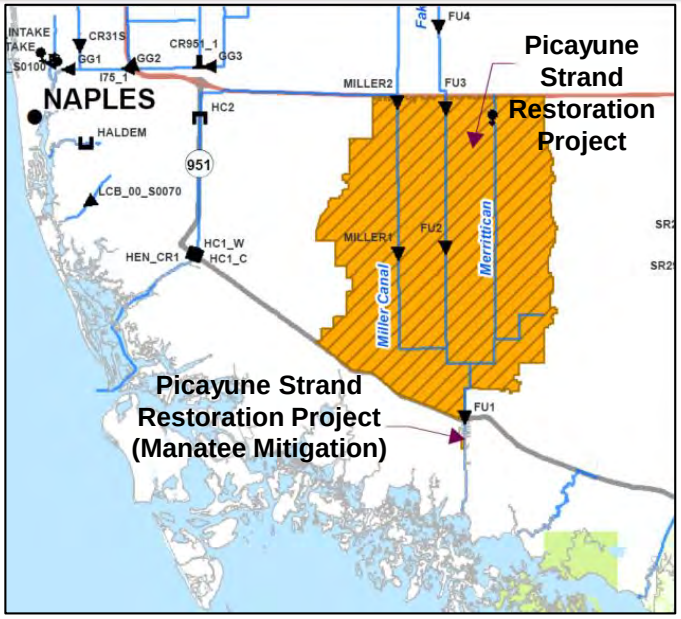
Governor Scott's Restoration Strategies

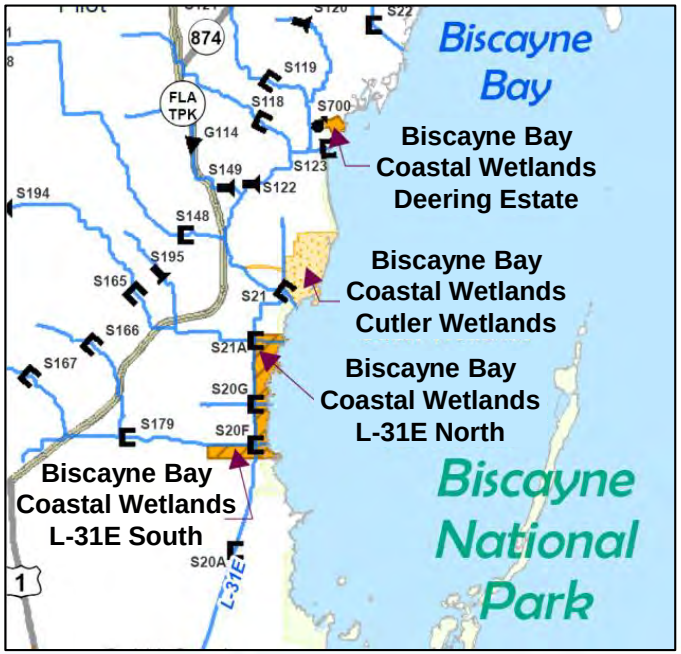
- Passed in 2012 ($880M)
  - Source Controls
  - Flow Equalization Basins
  - Stormwater Treatment Areas

Pre-CERP

- C-111/South Dade Projects
- Modified Water Deliveries

Other Projects





Picayune Strand

- Wetland/Hydrologic Restoration
  - 55,000 Acres
- Road Removal and Canal Backfill

Loxahatchee River

- Hydrologic Restoration
- Water Storage & Treatment

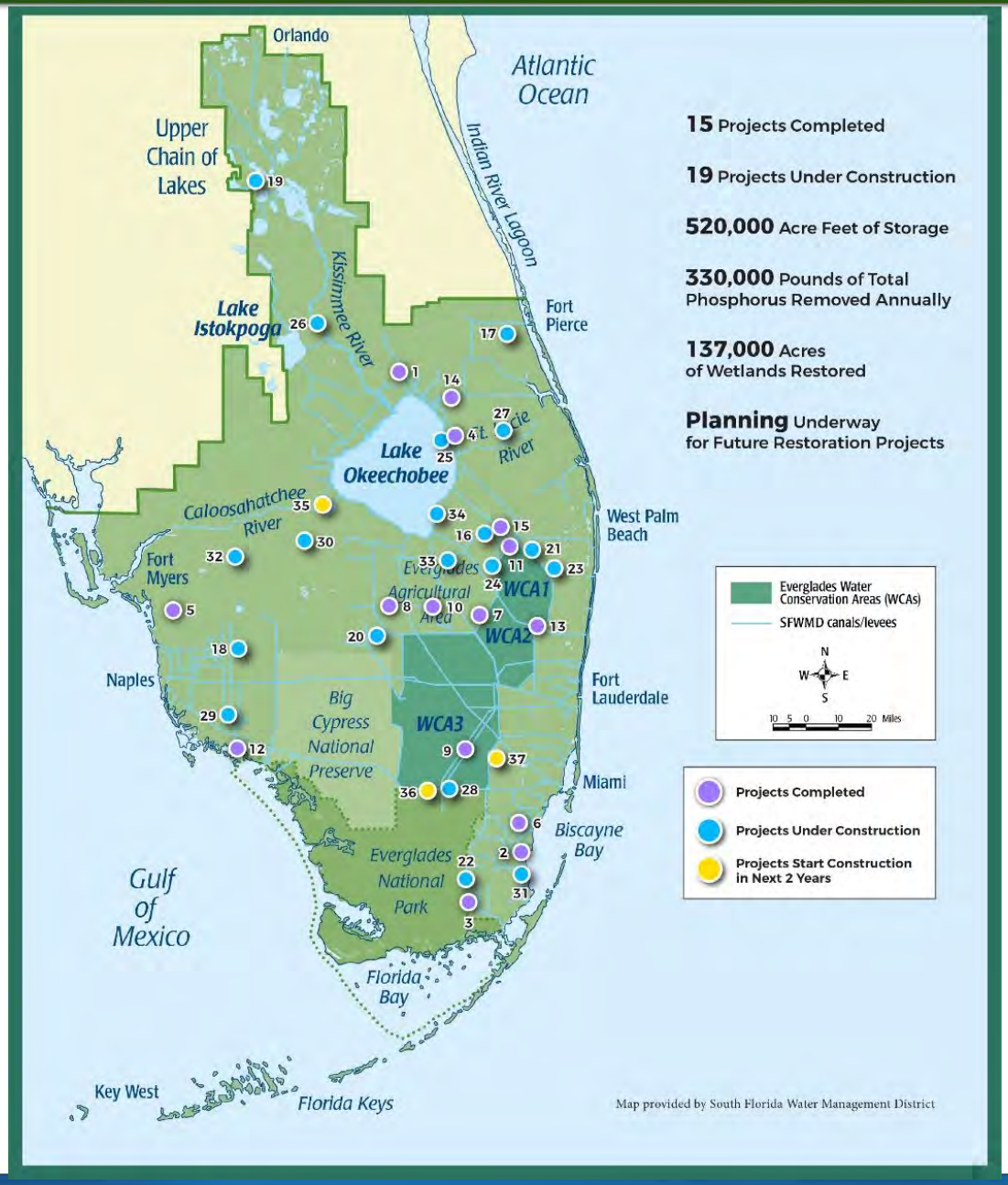
Biscayne Bay Coastal Wetlands

- Wetland/Hydrologic Restoration
  - Deering Estate
  - Cutler Wetlands
  - L-31 East

Current State Assisted Construction

Project	15-16	16-17	Future costs	Benefits
C-44	$40 M	$60 M	$25 M	60,000 acre-ft of storage and nutrient removal (26 MT/year)
C-43	$11.8 M	$37 M	$435 M	170,000 acre-ft of storage and nutrient removal (9 MT/year)
Restoration Strategies	$32 M	$32 M	$32 M/yr (until 2024)	105,000 acre-ft of storage and nutrient removal (47 MT/year)
Dispersed Water Mgmt.	$5 M	$52.8 M	~$20 M/yr	405,944 ac-ft per year of storage
Picayune Strand	$0	$5 M	$27 M	Water quality improvements to downstream estuaries and 55,000 acres of wetland restoration
Biscayne Bay Coastal Wetlands	$0	$5.8 M	$28.2 M	Improve timing and distribution of water flow to Biscayne Bay; 1,750 acres of wetland restoration
Kissimmee River Restoration	$20 M	$0	$0	20,000 acres wetland restoration and 44 miles of historic river
Lakeside Ranch Phase 2	$0	$9 M	$31 M	Water quality improvements for Lake Okeechobee (1,200 acre-ft of storage and nutrient removal – 8 MT/year)
Lake Hicpochee (Phase 1)	$0	$16.9 M	$13 M (est.)	Caloosahatchee river watershed restoration and water quality improvements (1,300 acre-ft of storage and nutrient removal)

EVERGLADES
Restoration Projects Since 2011



17/18 Budget Request

$112.9 Million
- Finish C-44
- Continue C-43
- Planning & Design
  - Lake Okeechobee Watershed
  - Western Everglades
  - Old Tamiami Trail Removal
  - C-111 South Dade
  - Picayune Strand

$32 Million
- Restoration Strategies

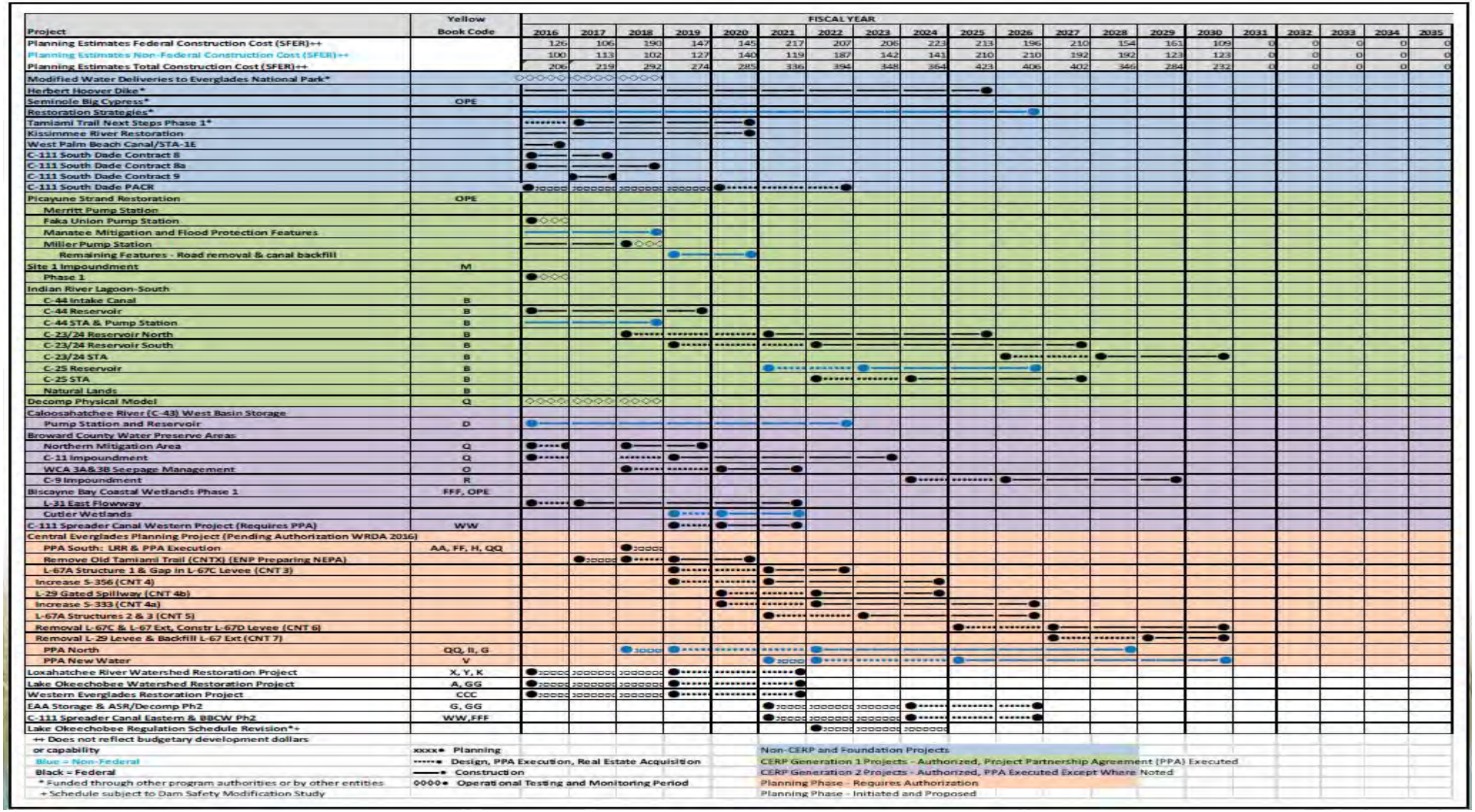
$39 Million
- Lakeside Ranch Phase 2
- Dispersed Water Management

$20 Million
- Septic to Sewer Cost Share

TOTAL PROJECT COST: $203.9 Million

$25.8 Million
- Everglades Debt Service

Integrated Delivery Schedule



Project	Yellow Book Code	FISCAL YEAR 2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Planning Estimates Federal Construction Cost (SFER)++		126	106	190	147	145	217	207	206	223	213	196	210	154	161	109	0	0	0	0	0
Planning Estimates Non-Federal Construction Cost (SFER)++		100	113	102	127	140	119	187	142	141	210	210	192	192	123	123	0	0	0	0	0
Planning Estimates Total Construction Cost (SFER)++		206	219	292	274	285	336	394	348	364	423	406	402	346	284	232	0	0	0	0	0
Modified Water Deliveries to Everglades National Park*																					
Herbert Hoover Dike*																					
Seminole Big Cypress*	OPE																				
Restoration Strategies*																					
Tamiami Trail Next Steps Phase 1*																					
Kissimmee River Restoration																					
West Palm Beach Canal/STA-1E																					
C-111 South Dade Contract 8																					
C-111 South Dade Contract 8a																					
C-111 South Dade Contract 9																					
C-111 South Dade PACR																					
Picayune Strand Restoration	OPE																				
Merritt Pump Station																					
Faka Union Pump Station																					
Manatee Mitigation and Flood Protection Features																					
Miller Pump Station																					
Remaining Features - Road removal & canal backfill																					
Site 1 Impoundment	M																				
Phase 1																					
Indian River Lagoon-South																					
C-44 Intake Canal	B																				
C-44 Reservoir	B																				
C-44 STA & Pump Station	B																				
C-23/24 Reservoir North	B																				
C-23/24 Reservoir South	B																				
C-23/24 STA	B																				
C-25 Reservoir	B																				
C-25 STA	B																				
Natural Lands	B																				
Decomp Physical Model	Q																				
Caloosahatchee River (C-43) West Basin Storage																					
Pump Station and Reservoir	D																				
Broward County Water Preserve Areas																					
Northern Mitigation Area	Q																				
C-11 Impoundment	Q																				
WCA 3A&3B Seepage Management	O																				
C-9 Impoundment	R																				
Biscayne Bay Coastal Wetlands Phase 1	FFF, OPE																				
L-31 East Flowway																					
Cutler Wetlands																					
C-111 Spreader Canal Western Project (Requires PPA)	WW																				
Central Everglades Planning Project (Pending Authorization WRDA 2016)																					
PPA South: LRR & PPA Execution	AA, FF, H, QQ																				
Remove Old Tamiami Trail (CNTX) (ENP Preparing NEPA)																					
L-67A Structure 1 & Gap in L-67C Levee (CNT 3)																					
Increase S-356 (CNT 4)																					
L-29 Gated Spillway (CNT 4b)																					
Increase S-333 (CNT 4a)																					
L-67A Structures 2 & 3 (CNT 5)																					
Removal L-67C & L-67 Ext, Constr L-67D Levee (CNT 6)																					
Removal L-29 Levee & Backfill L-67 Ext (CNT 7)																					
PPA North	QQ, II, G																				
PPA New Water	V																				
Loxahatchee River Watershed Restoration Project	X, Y, K																				
Lake Okeechobee Watershed Restoration Project	A, GG																				
Western Everglades Restoration Project	CCC																				
EAA Storage & ASR/Decomp Ph2	G, GG																				
C-111 Spreader Canal Eastern & BBCW Ph2	WW,FFF																				
Lake Okeechobee Regulation Schedule Revision*+																					

++ Does not reflect budgetary development dollars or capability

Blue = Non-Federal

Black = Federal

* Funded through other program authorities or by other entities

+ Schedule subject to Dam Safety Modification Study

xxxx● Planning

·····■ Design, PPA Execution, Real Estate Acquisition

——■ Construction

0000● Operational Testing and Monitoring Period

Non-CERP and Foundation Projects

CERP Generation 1 Projects - Authorized, Project Partnership Agreement (PPA) Executed

CERP Generation 2 Projects - Authorized, PPA Executed Except Where Noted

Planning Phase - Requires Authorization

Planning Phase - Initiated and Proposed

Contact

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Ecosystem Restoration
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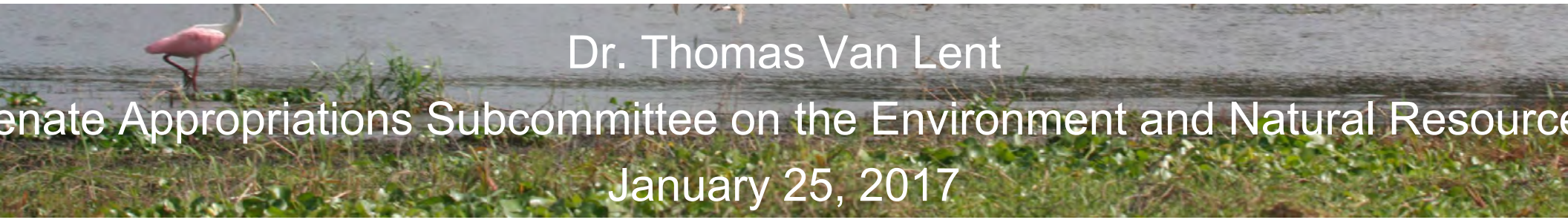
850.245.2030

Storage Solutions

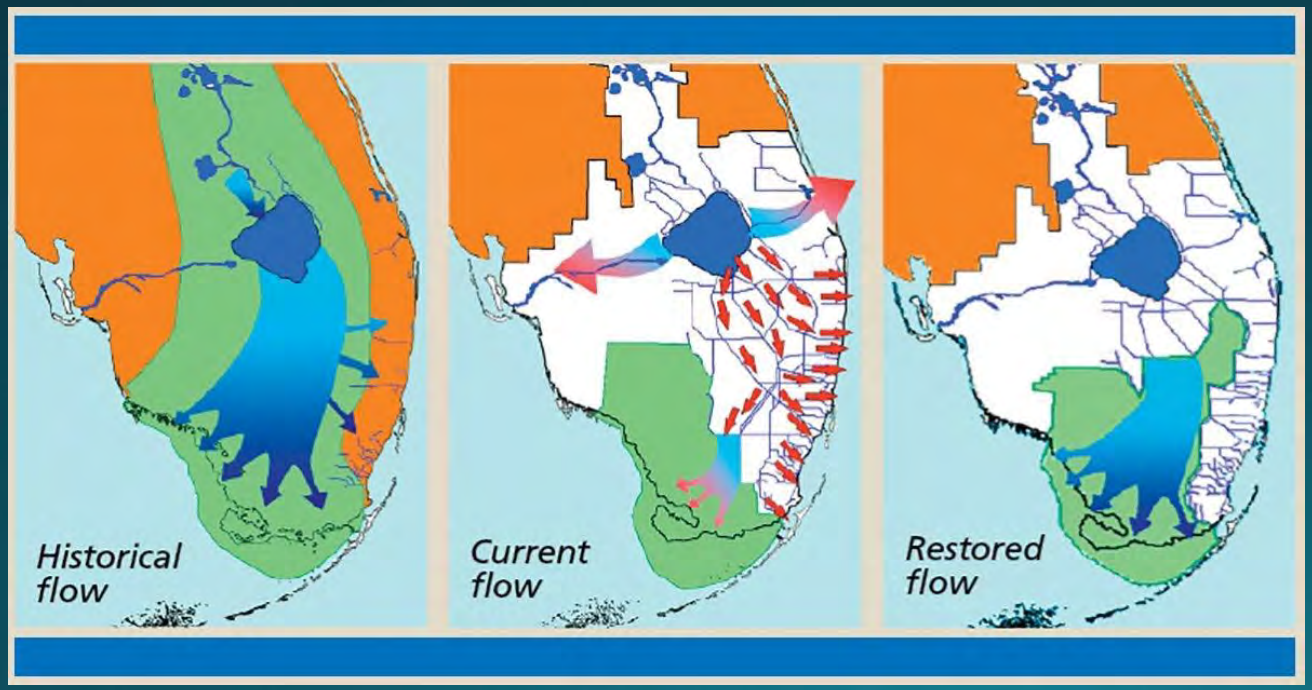


Dr. Thomas Van Lent

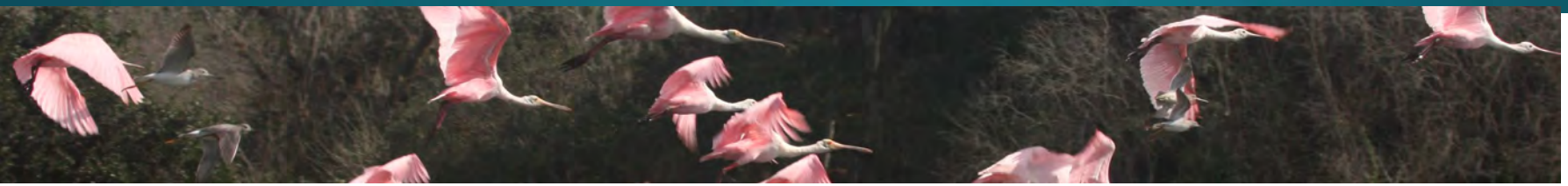
enate Appropriations Subcommittee on the Environment and Natural Resource

January 25, 2017

The Basics



- Water flowed from the Lake south to Everglades
- Today's water management systems sends most Lake excess to estuaries and dams the Everglades
- Fix is Comprehensive Everglades Restoration Plan



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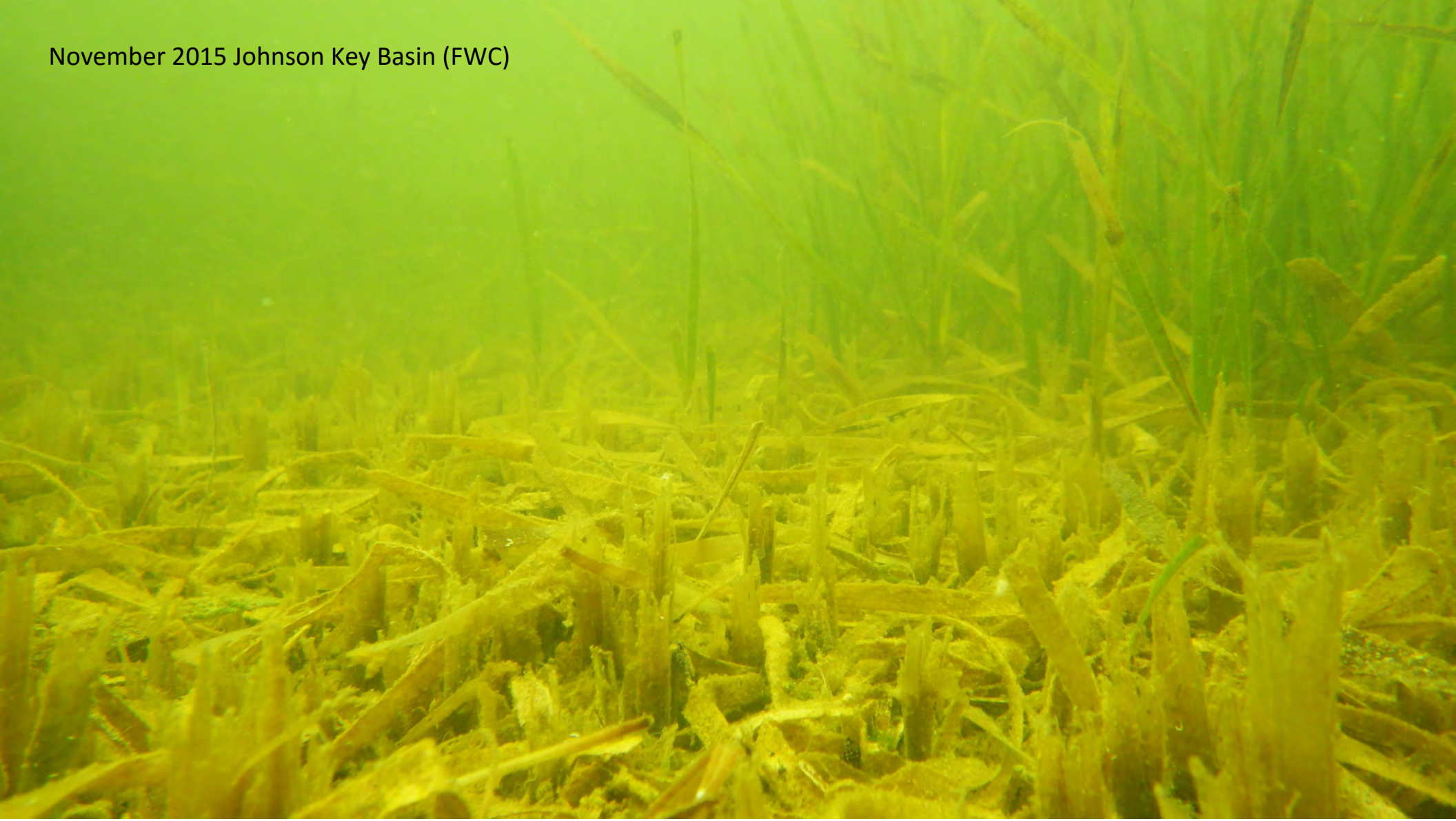
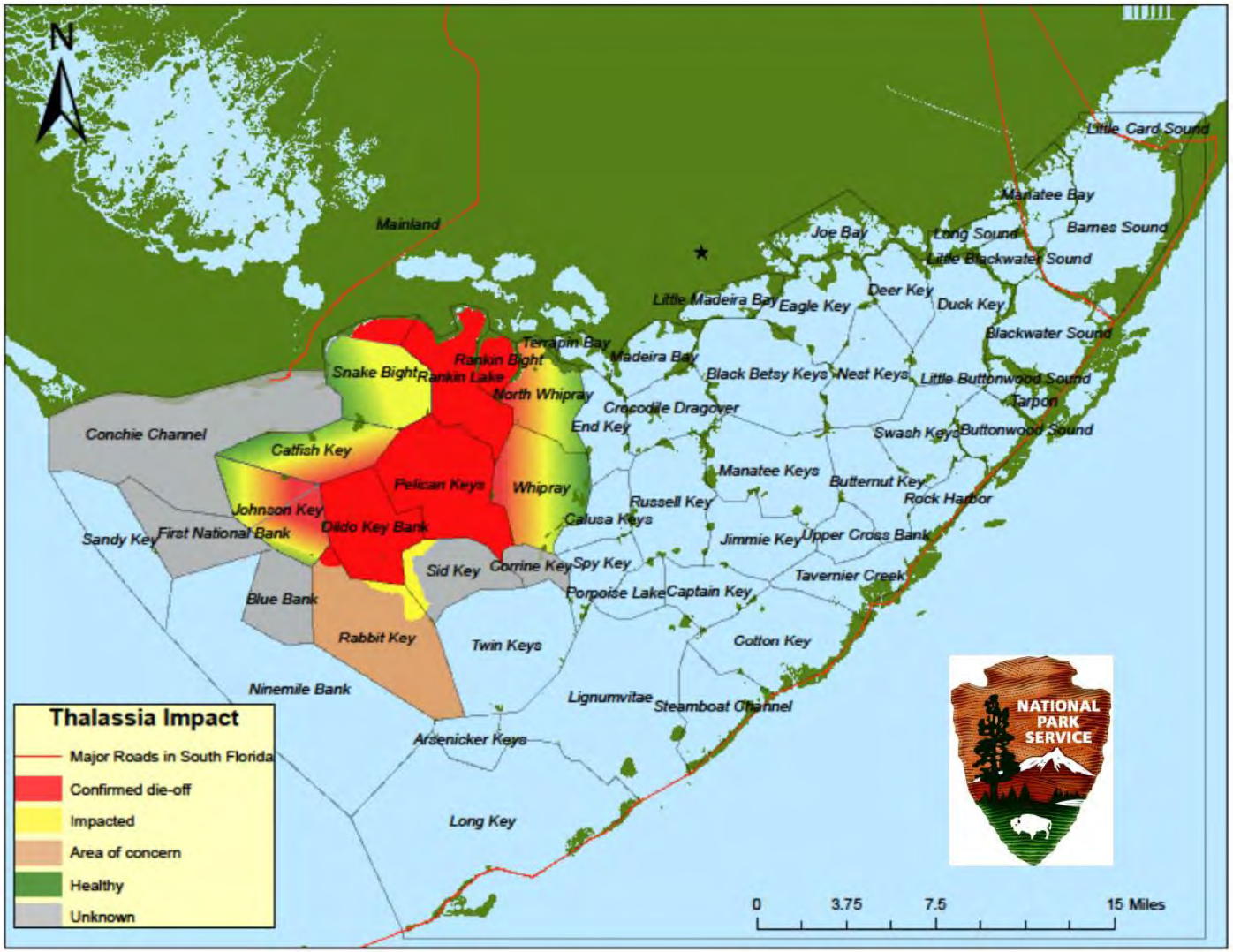
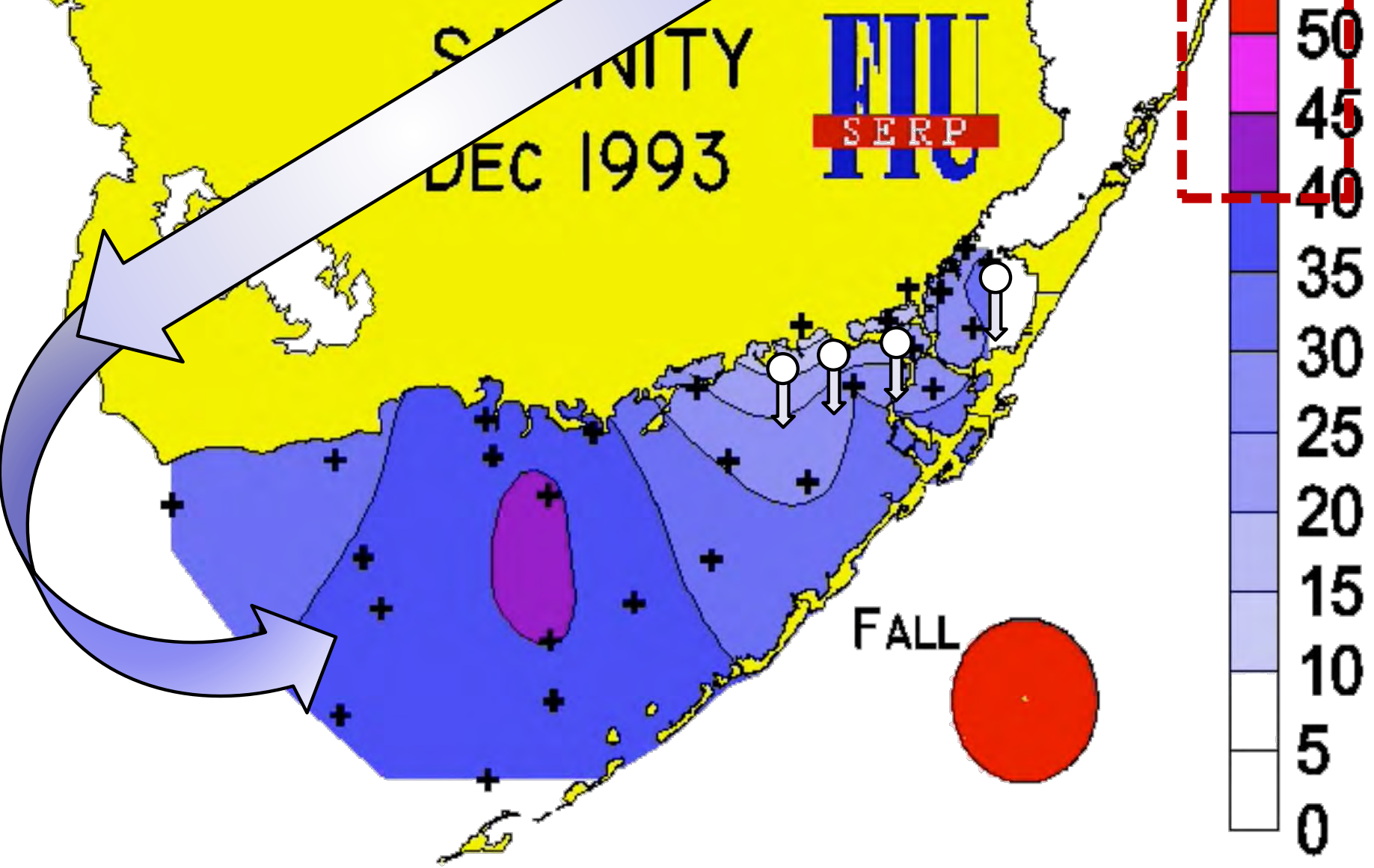
Richard Graulich/The Palm Beach Post via AP

November 2015 Johnson Key Basin (FWC)



Estimated *Thalassia* Die-off Area (Jan. 2015)




NITY
DEC 1993
FIU
SERP
FALL
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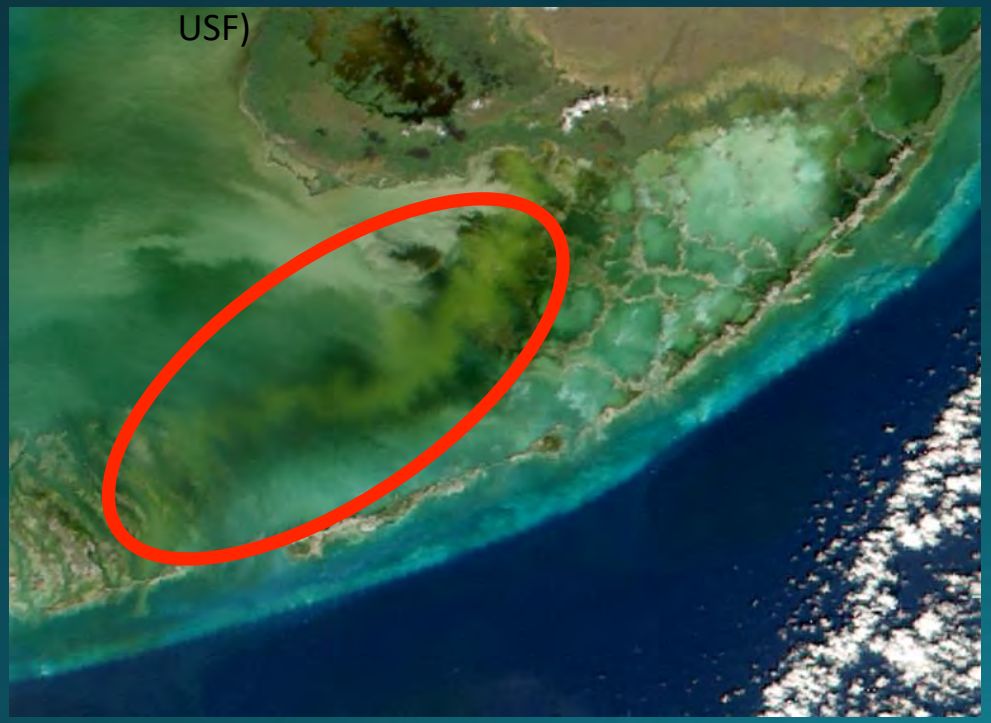
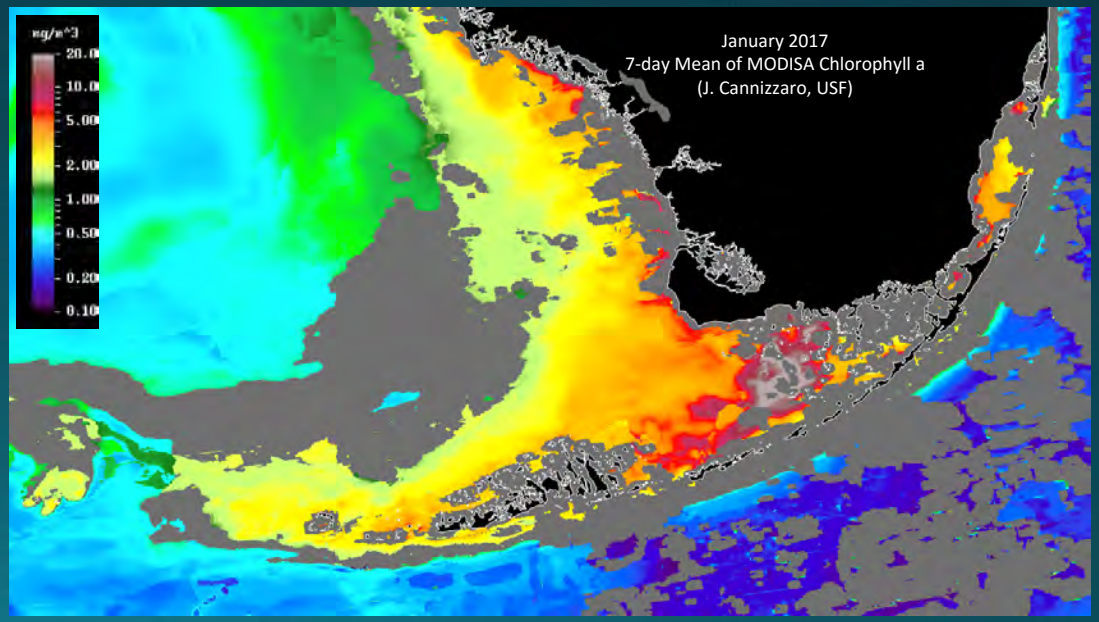
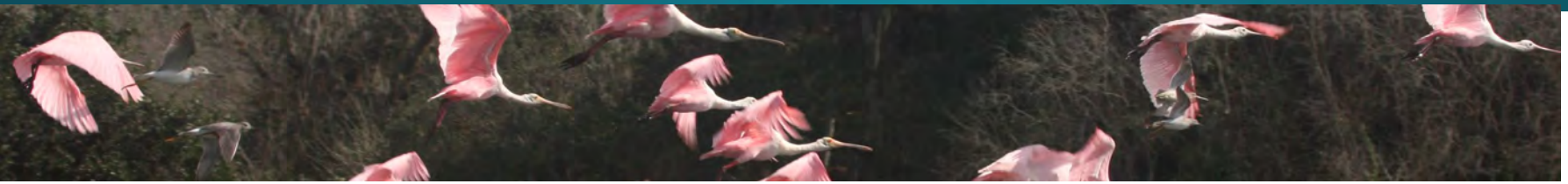
Algae Bloom in Florida Bay

November 2016 MODIS (J. Cannizzaro, USF)







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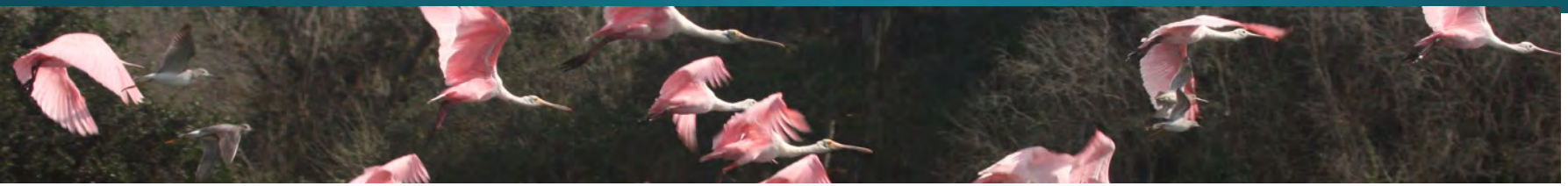
Proposal for a Storage Reservoir

9.1.5 Everglades Agricultural Area

9.1.5.1 Everglades Agricultural Storage Reservoirs (G)

This feature includes above-ground reservoir(s) with a total storage capacity of approximately 360,000 acre-feet located in the Everglades Agricultural Area in western Palm Beach County and conveyance capacity increases for the Miami, North New River, and Bolles and Cross Canals. The initial design for the reservoir(s) assumed 60,000 acres, divided into three, equally sized compartments (1, 2, and 3), with the water level fluctuating up to 6 feet above grade in each compartment. The final size, depth and configuration of this facility will be determined through more detailed planning and design.

- Broad scientific consensus that storage south of Lake Okeechobee is critical to the future of water infrastructure for South Florida.
- The Comprehensive Plan calls for 118 billion gallon reservoir on 60,000 acres at 6 ft depth.
- A proposal for reservoir represents a fast-tracking of a storage project that is in the Plan, is consistent with Legislative direction, and represents the fastest path for relief to the St. Lucie, Caloosahatchee and Florida Bay.

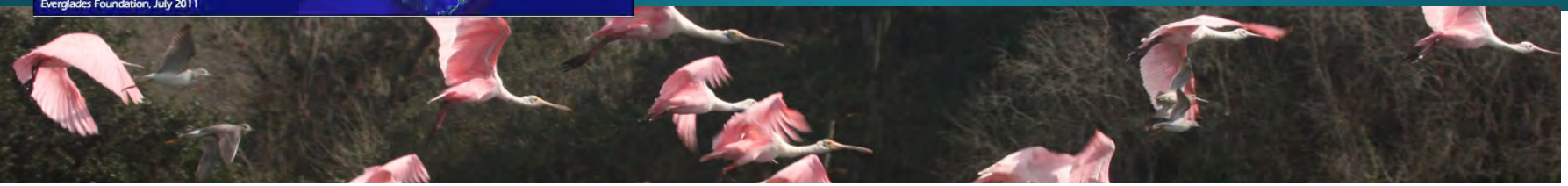


THE EVERGLADES FOUNDATION

Prioritizing Storage Projects

- Legacy Florida Act passed in 2016 prioritizes “projects that reduce harmful discharges of water from Lake Okeechobee to the St. Lucie and Caloosahatchee estuaries…”
- We found that a south reservoir reduces harmful estuary discharge volumes by an average of 50%
- We found that a north reservoir reduces harmful estuary discharges by an average of 6%
- A southern reservoir reduced discharges more because it opens a new outlet from Lake Okeechobee

In



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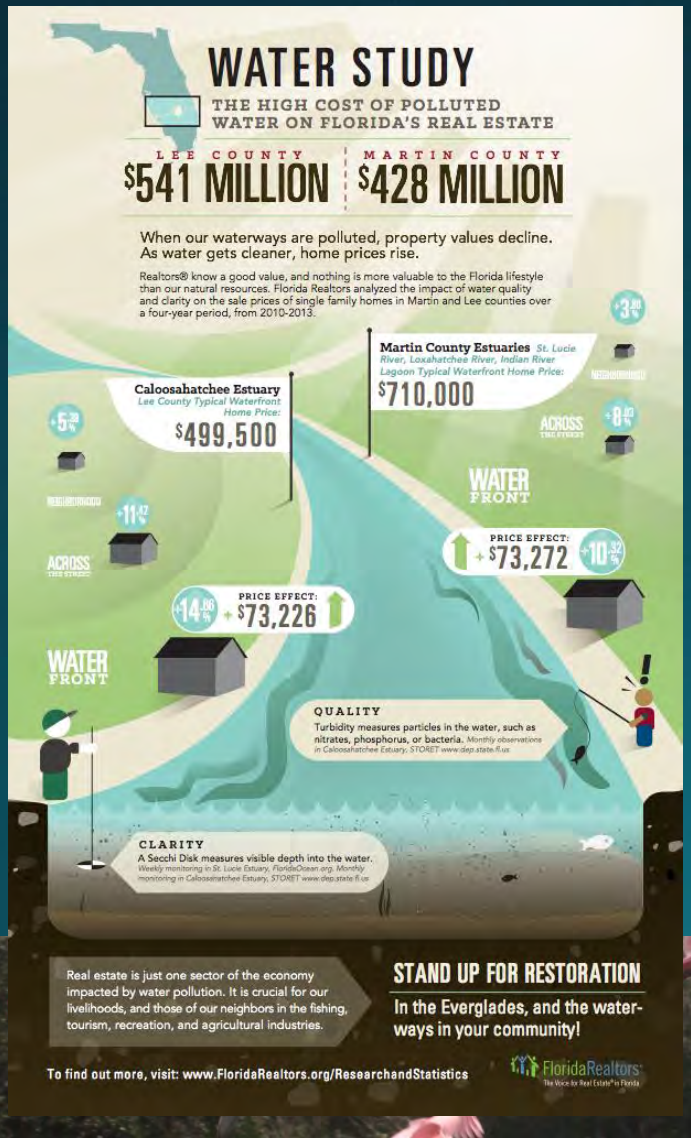
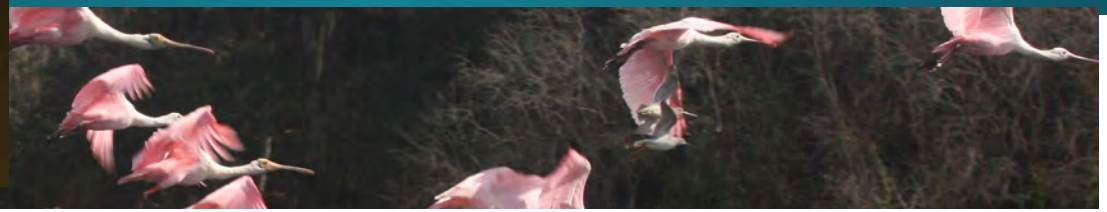
Economic Benefits



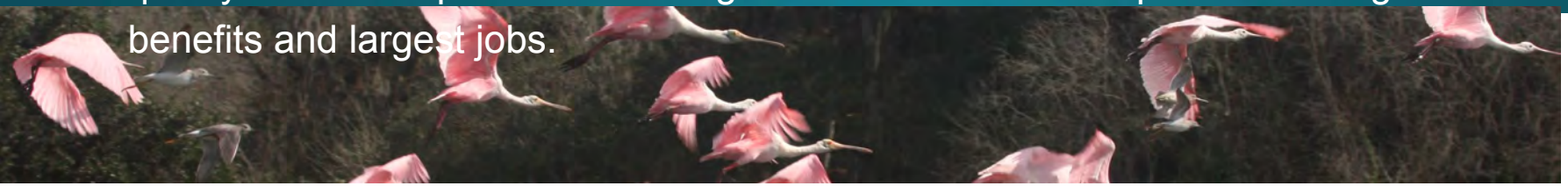
- Reduction of damaging estuary releases also has highest economic benefits.
- Florida Realtors© study found:
  - polluted water in the St. Lucie and Caloosahatchee estuaries decreases home values;
  - losses from June - September 2013 event were $541 million in Lee County and $428 million in Martin county.
- Mather Economics (2010) found that improvements from CERP to real estate from improving water quality would result in $15 billion in benefits and 273,000 jobs.



THE EVERGLADES FOUNDATION

Summary

- Damaging flood releases to St. Lucie and Caloosahatchee estuaries and drought damage in Florida Bay will continue until the major changes are made to Central and South Florida Project: The Comprehensive Everglades Restoration Plan
- A major feature of the Plan is storage, including a reservoir in the Everglades Agricultural Area Reservoir of 118 billion gallons on 60,000 acres.
- The proposal for a southern reservoir represents fast-tracking the storage project that will have the most benefit to the St. Lucie, Caloosahatchee, and Florida Bay estuaries.
- A reservoir south of Lake Okeechobee creates a new outlet from Lake Okeechobee, benefiting the Lake, the St. Lucie, the Caloosahatchee and the Everglades and Florida Bay.
- Florida Realtors© estimated a nearly $1 billion loss from summer of 2013. Improving water quality in the Comprehensive Everglades Restoration Plan produces the greatest economic benefits and largest jobs.



THE EVERGLADES FOUNDATION

Thank You.

THE EVERGLADES FOUNDATION

Reducing harmful Lake Okeechobee discharges and Everglades restoration:

Agricultural Landowners in the Everglades Agricultural Area

APPROPRIATIONS SUBCOMMITTEE ON THE ENVIRONMENT AND NATURAL RESOURCES

Senator Rob Bradley, Chair

Senator Lauren Book, Vice Chair

January 25, 2017

Ernie Barnett

Water and Land Advisors, Inc.

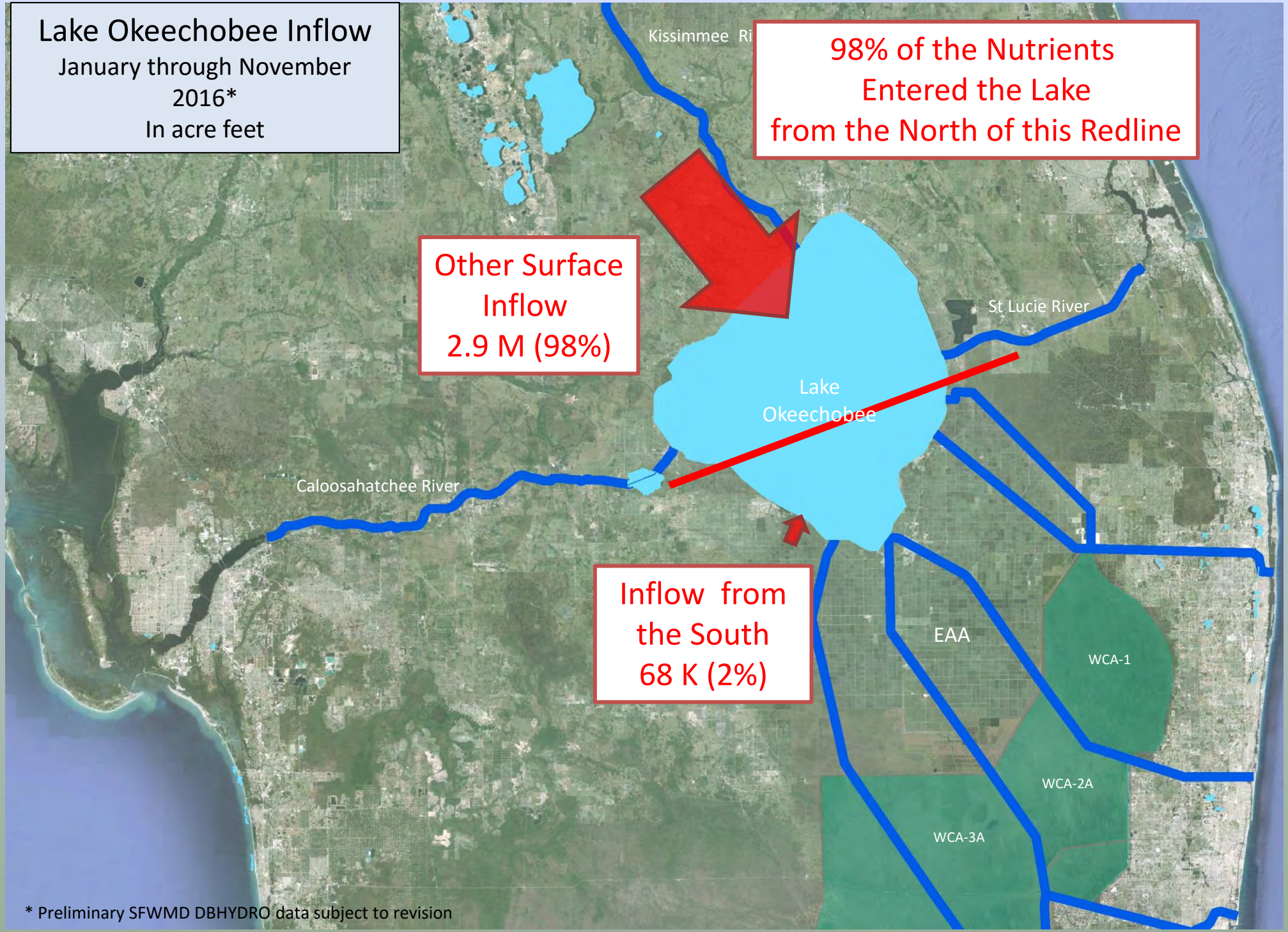
Presentation Overview

- The Problem
- Water Volumes in a Flood Year (2016)
  - Lake Okeechobee
  - The Estuaries
  - The Everglades
- Can Lake Discharges be Eliminated?
  - Above ground reservoirs
  - ASR and Deep Injection Wells
  - Lake Regulation Schedule
- The Landowners perspective

Lake Okeechobee Inflow

January through November 2016*

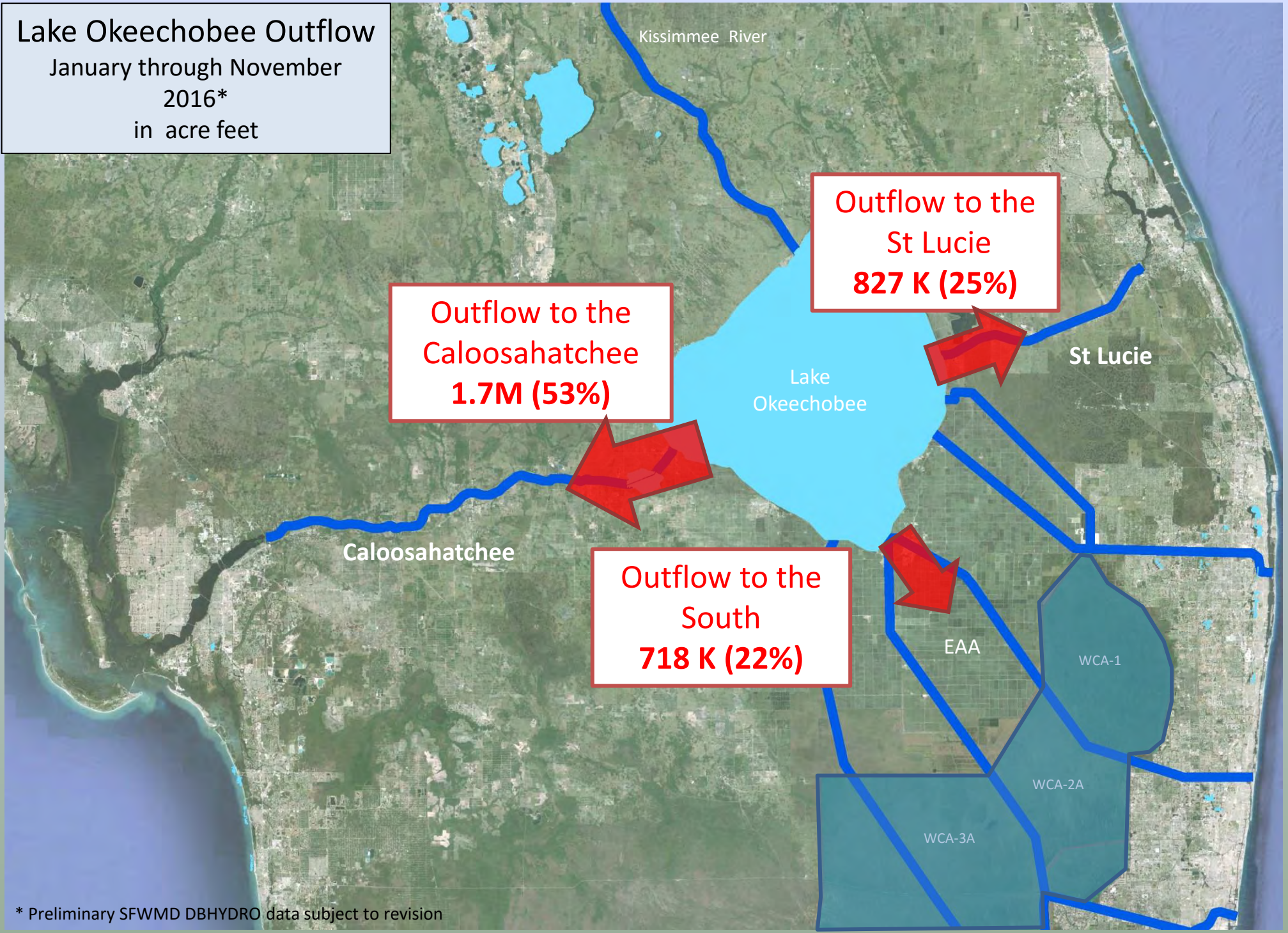
In acre feet



* Preliminary SFWMD DBHYDRO data subject to revision

Lake Okeechobee Outflow

January through November 2016*
in acre feet



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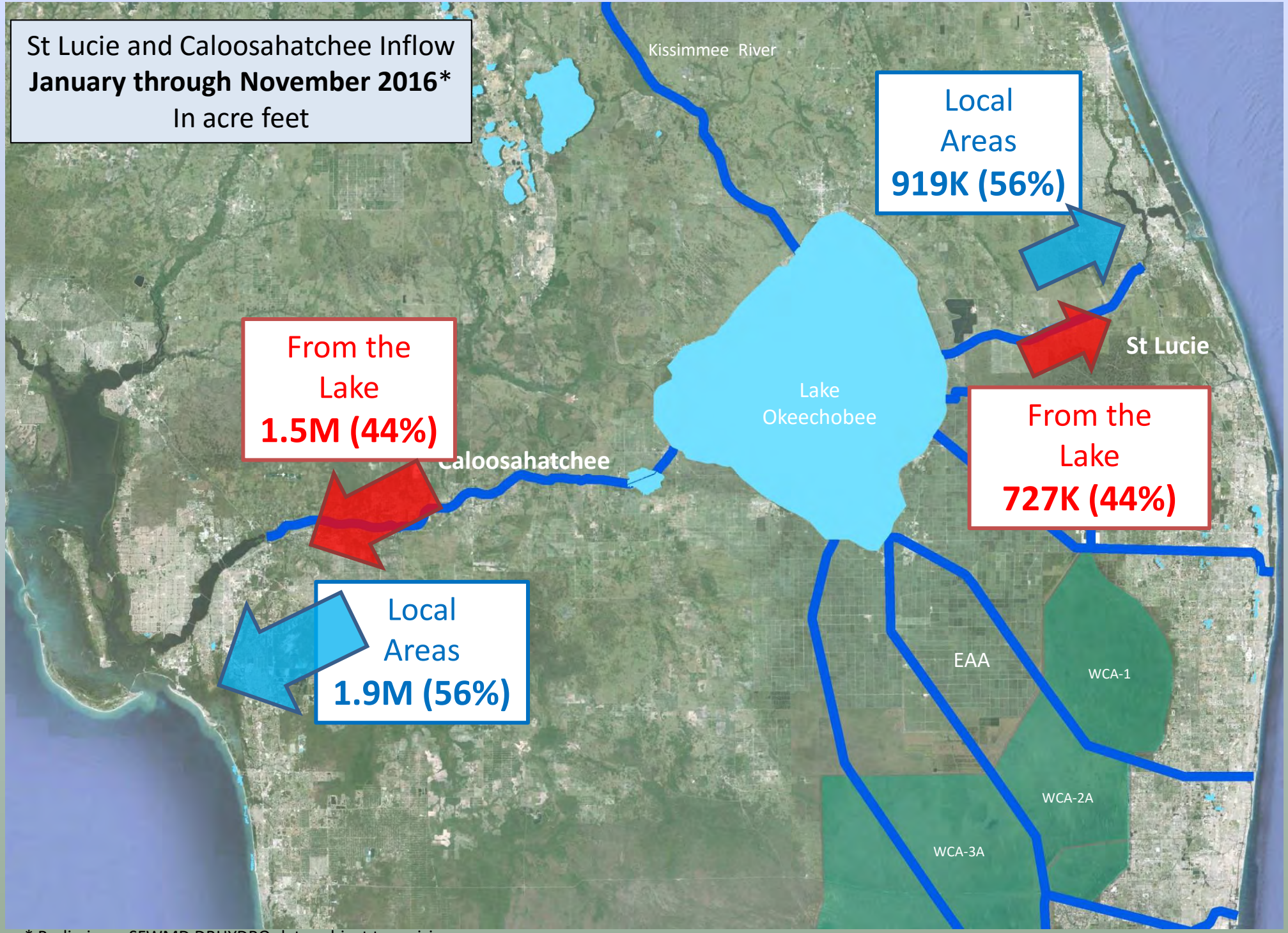
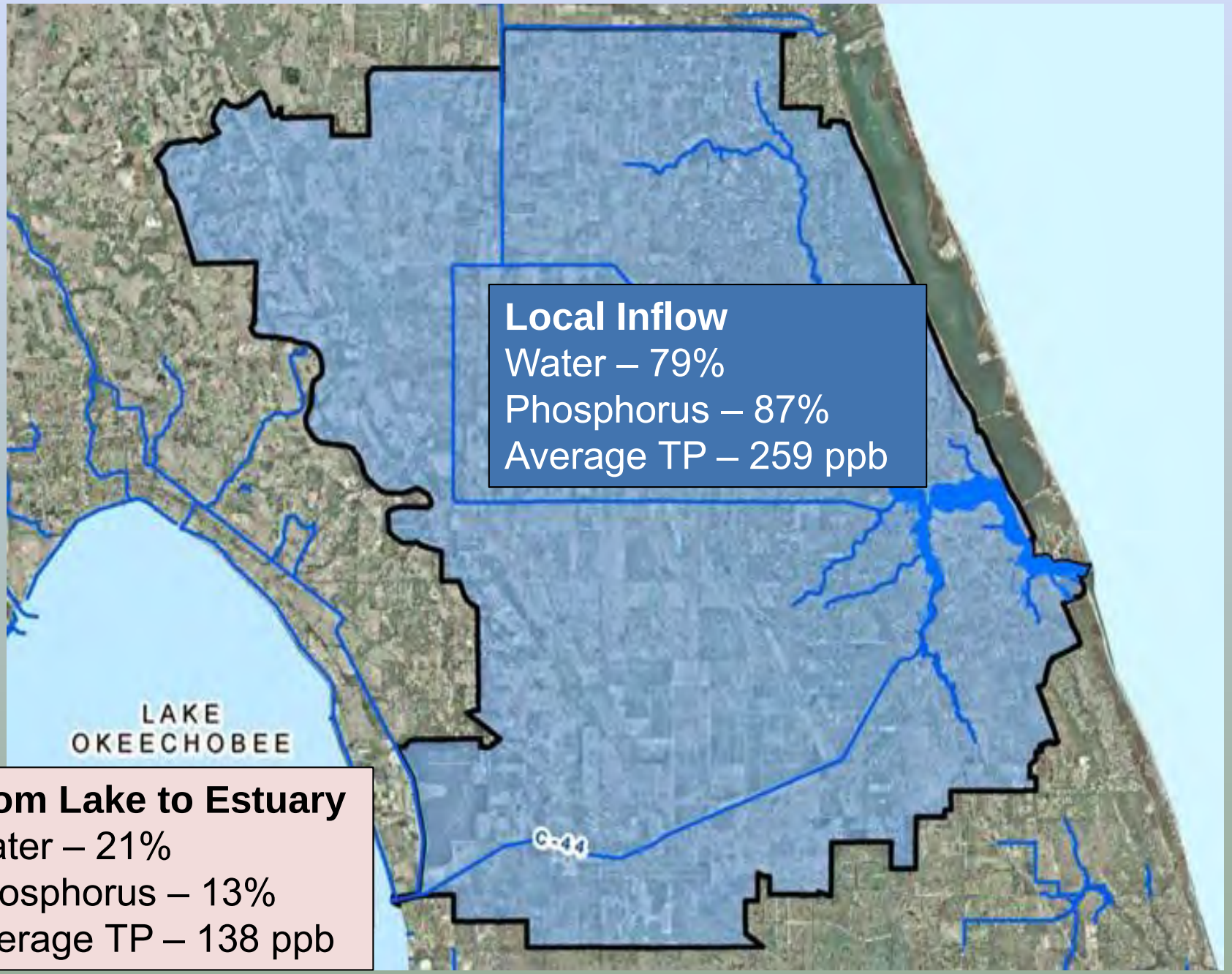


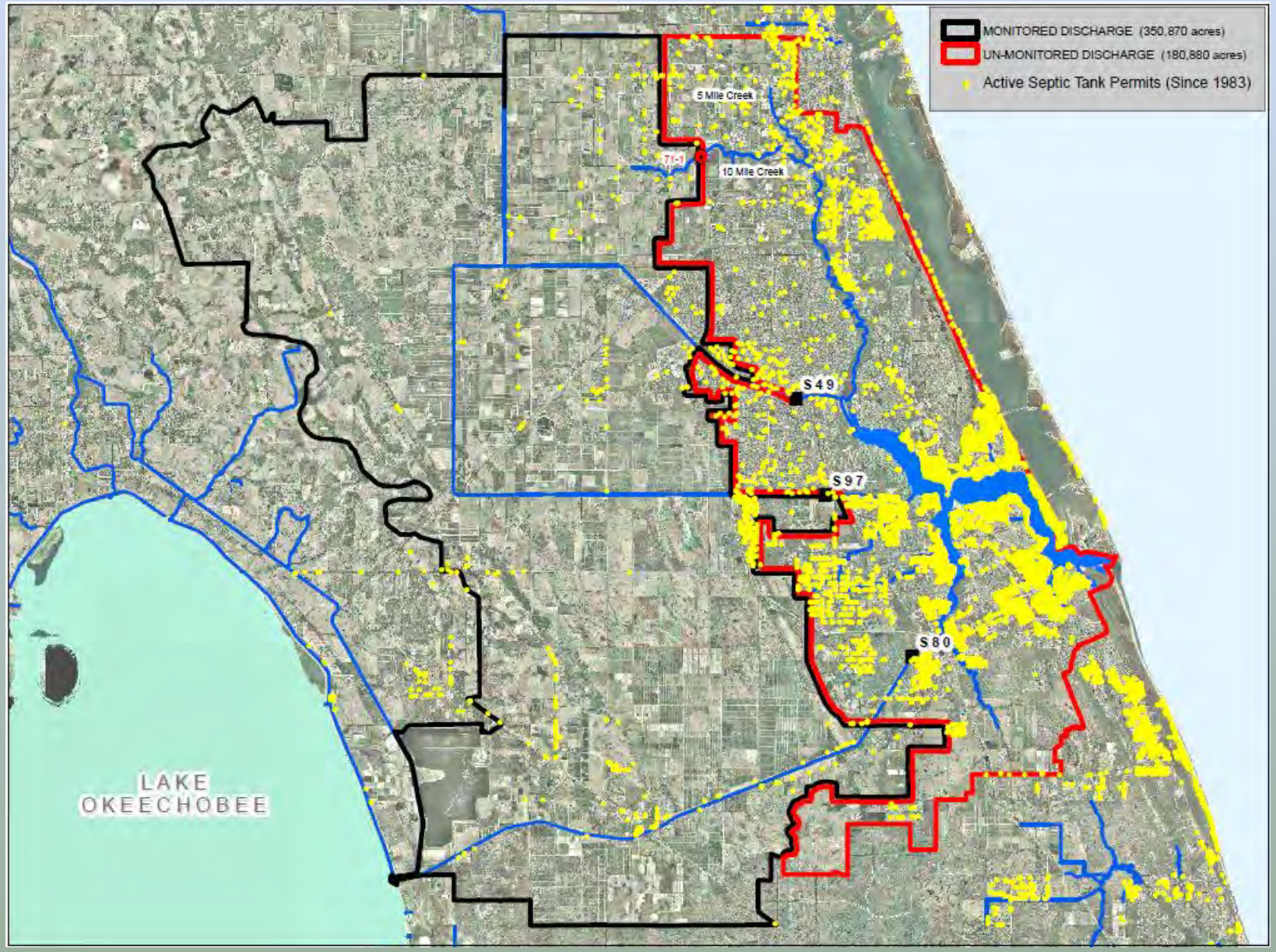
* Preliminary SFWMD DBHYDRO data subject to revision.

Flow to the St. Lucie Estuary 2011-2015

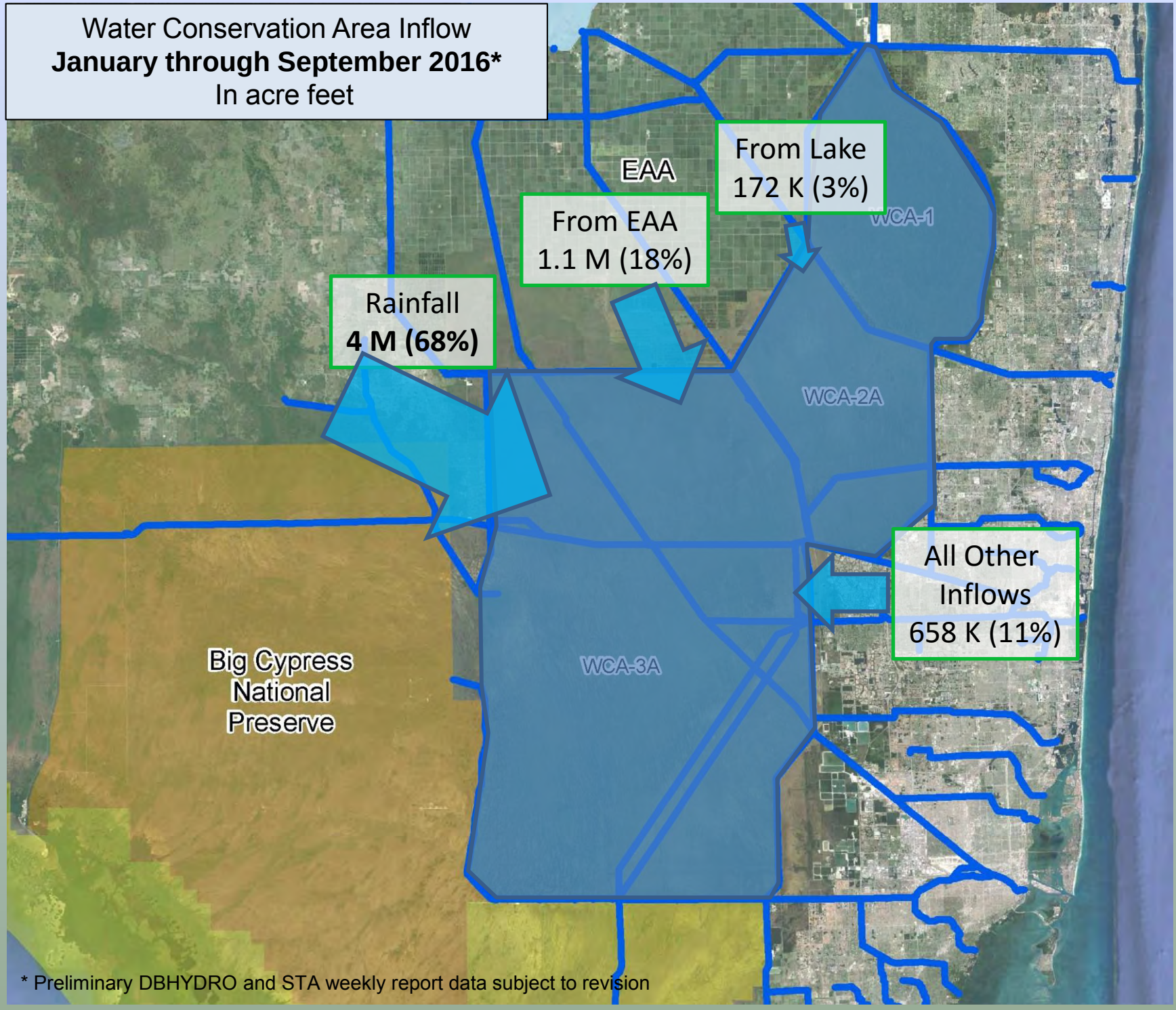


Source: South Florida Water Management District

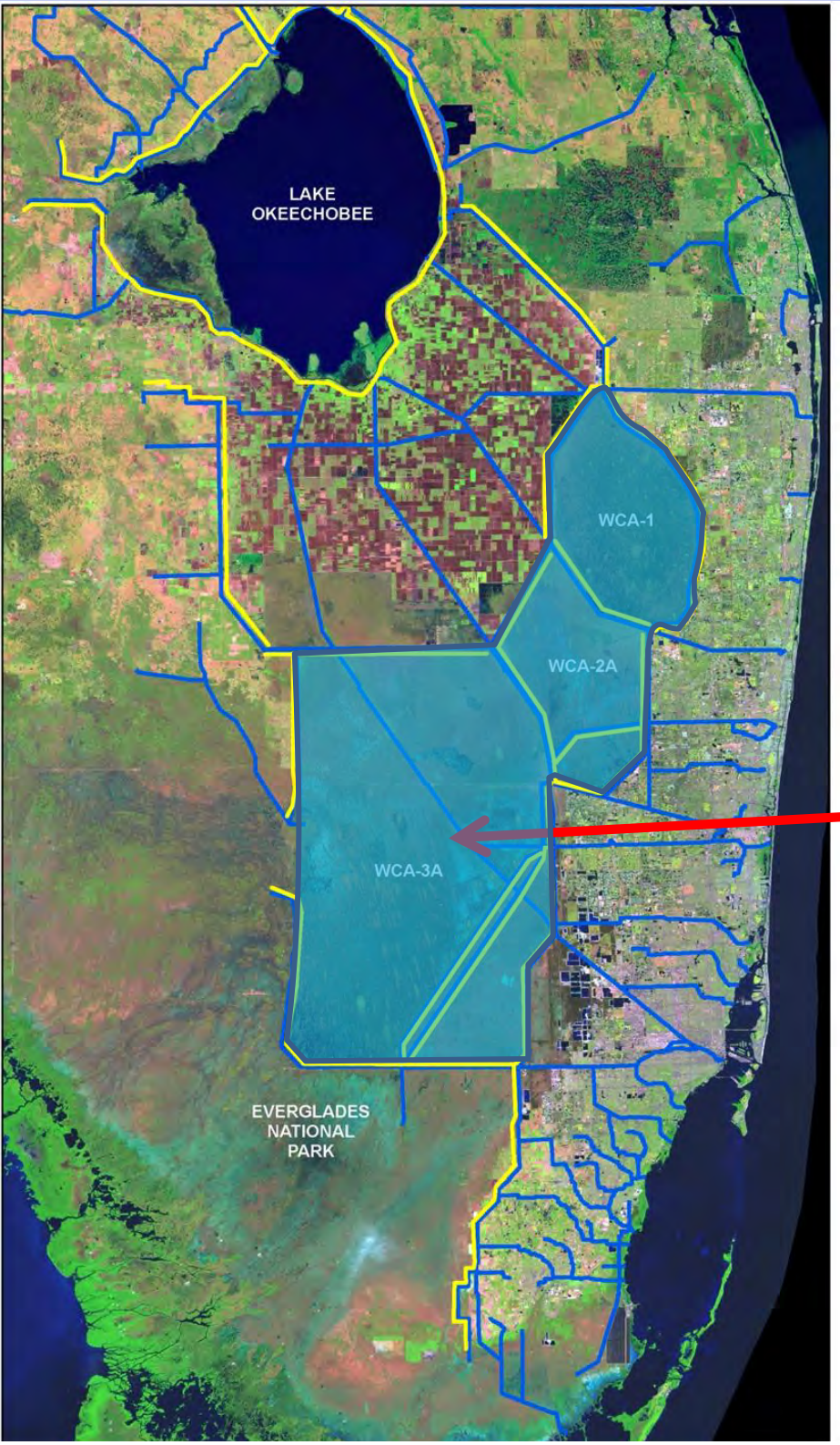
SEPTIC TANKS NEAR THE INDIAN RIVER LAGOON



Source: Florida Department of Health



* Preliminary DBHYDRO and STA weekly report data subject to revision



The down stream conditions in the Everglades remained above flood stage for several months during every high Lake discharge event in the past 25 years. 2016 was typical.

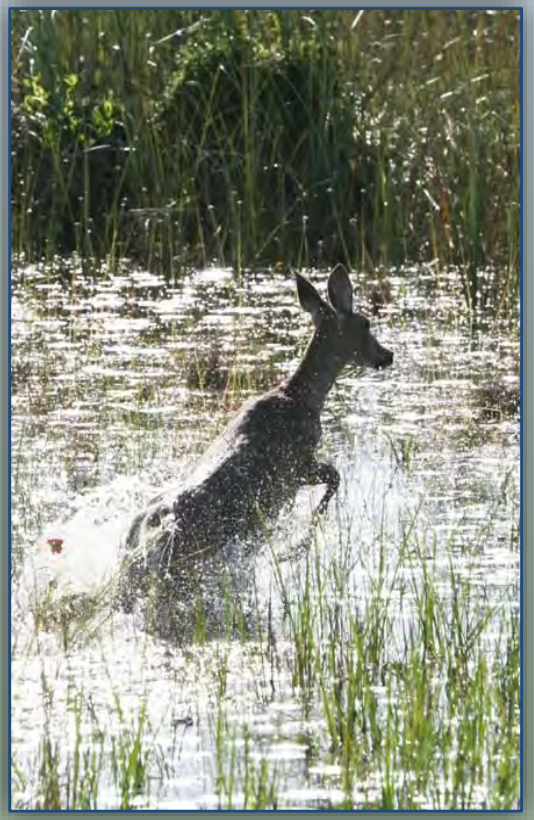
Water Conservation Area 3 water level in 2016

Greater Everglades High Water Levels

Tree islands are damaged by extended high water levels

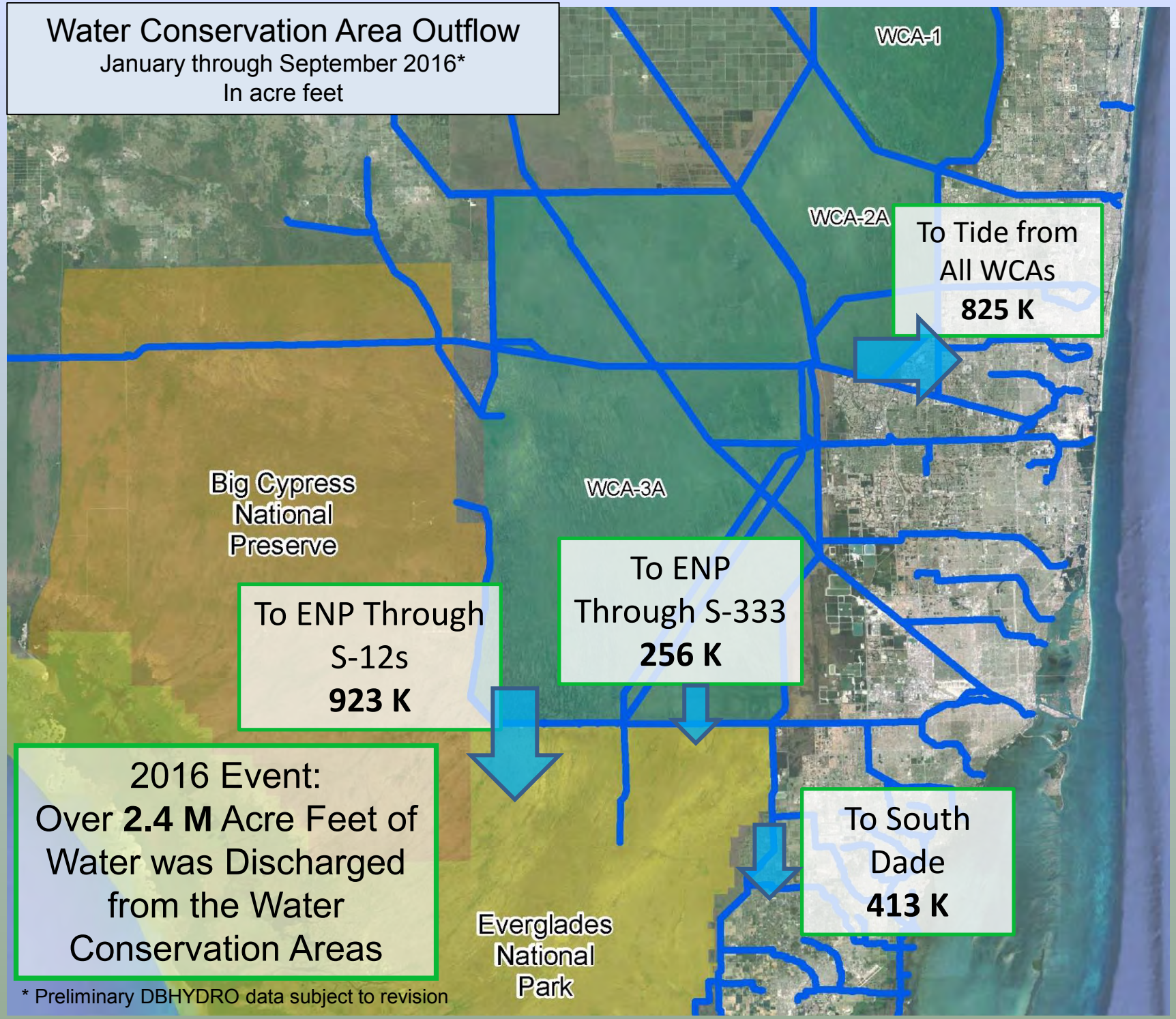
Alligator nests are often flooded

Deer and other terrestrial animals are driven out or starve



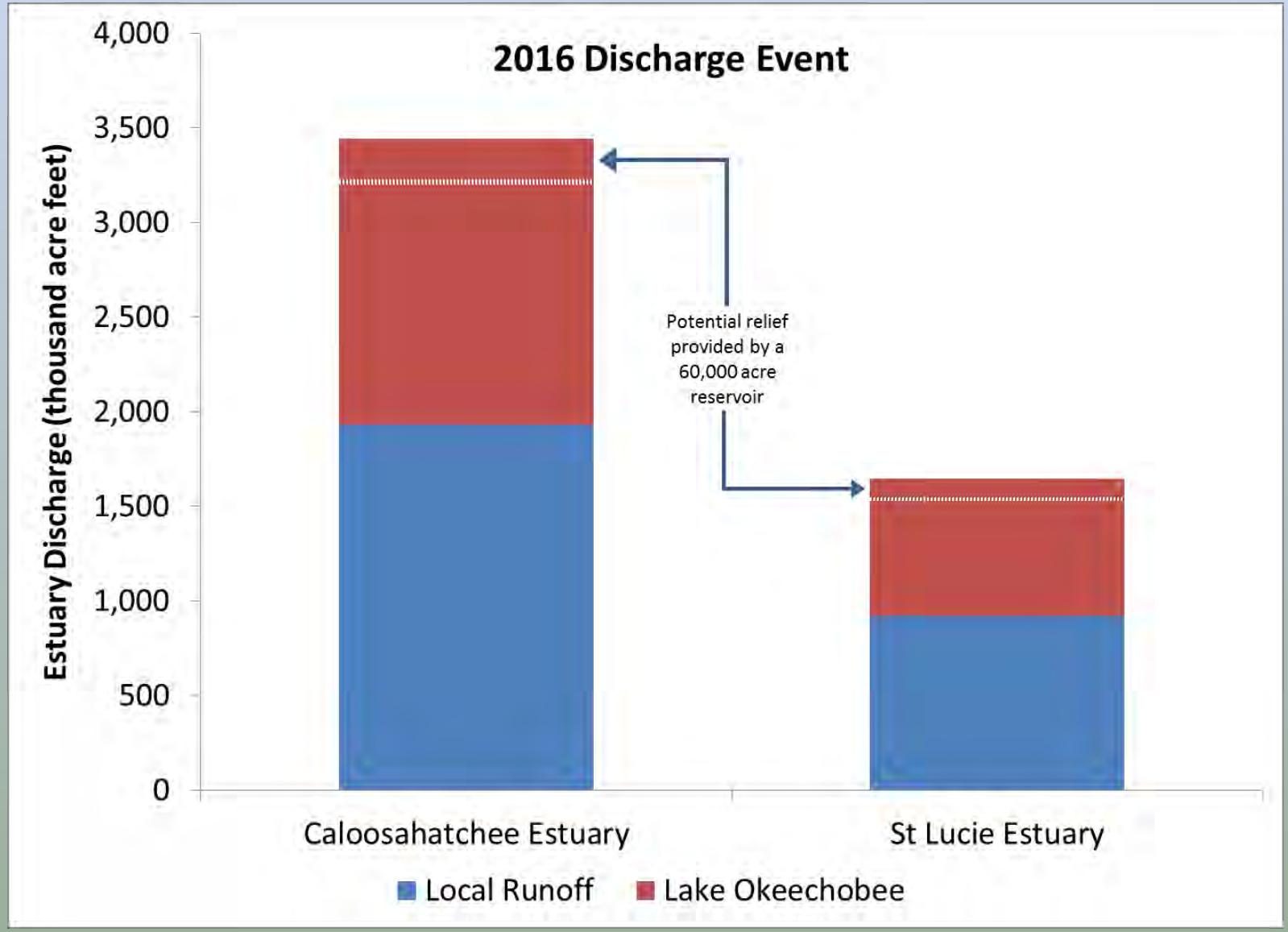
Water Conservation Area Outflow

January through September 2016*
In acre feet



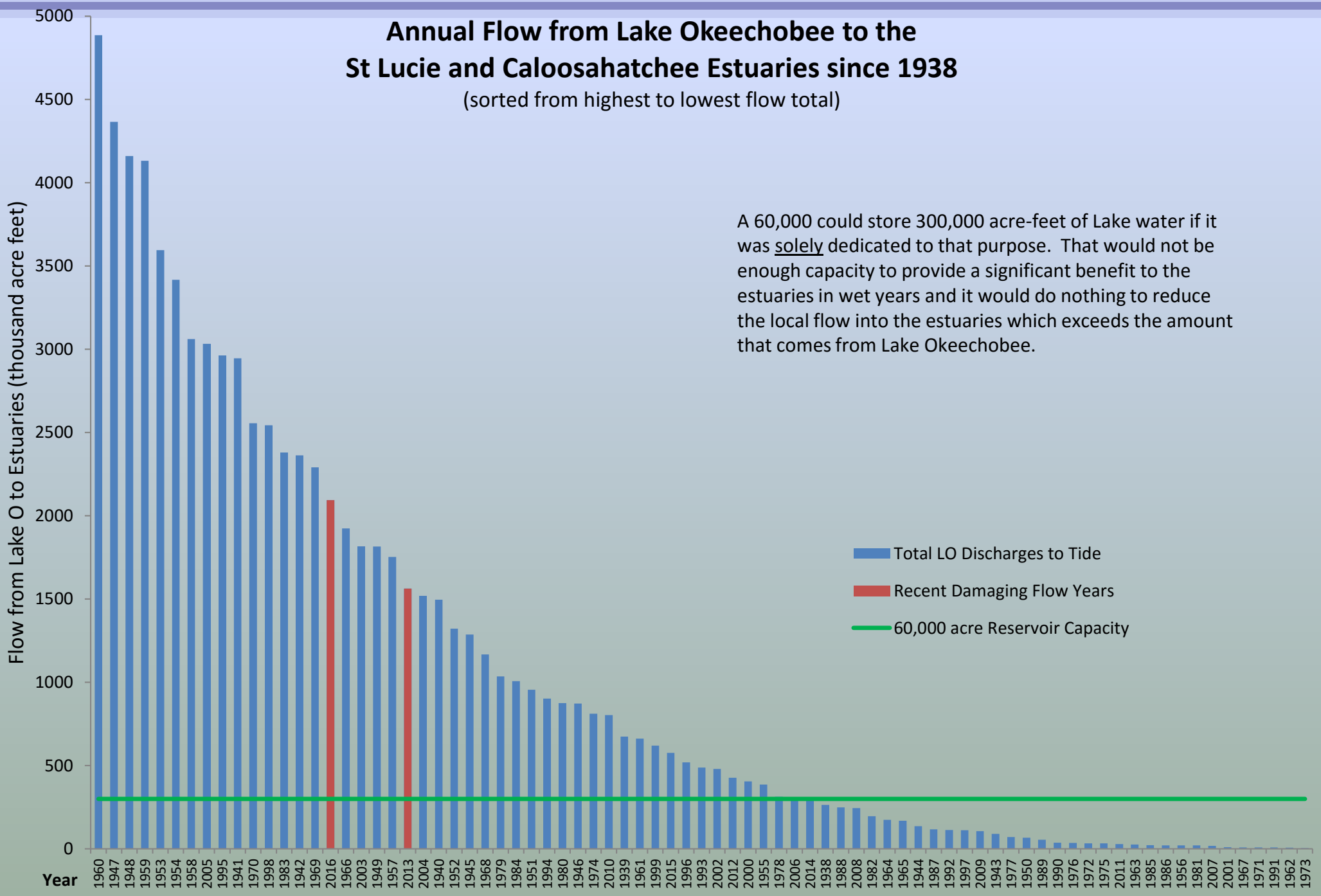
* Preliminary DBHYDRO data subject to revision

Estuary Flow in 2016
Relief Provided by a South of Lake Reservoir



Annual Flow from Lake Okeechobee to the St Lucie and Caloosahatchee Estuaries since 1938

(sorted from highest to lowest flow total)

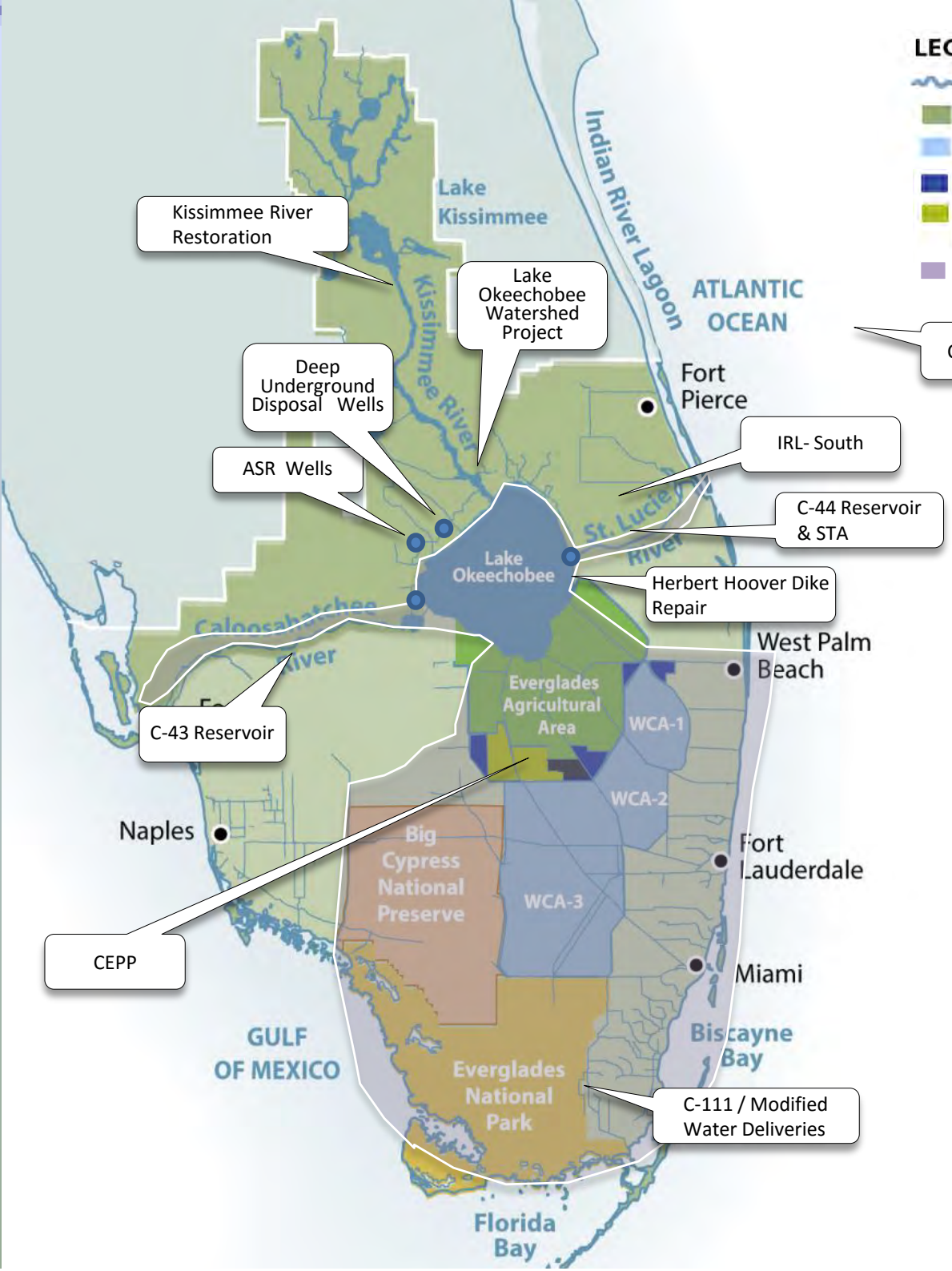


A 60,000 could store 300,000 acre-feet of Lake water if it was solely dedicated to that purpose. That would not be enough capacity to provide a significant benefit to the estuaries in wet years and it would do nothing to reduce the local flow into the estuaries which exceeds the amount that comes from Lake Okeechobee.

Reservoir provides only minor benefit 26 of 79 years (33%). It fills quickly and high estuary releases are required.	Some benefit 9 of 79 years (11%)	Reservoir provides no benefit 44 of 79 years (56%). No additional Lake Okeechobee water to send south. Environmental releases to the Caloosahatchee rather than the reservoir receive the water.

UF – Water Institute Study Options

1. **Accelerate completion of existing approved projects**
2. **Provide Water Storage and Treatment North of Lake Okeechobee**
3. **Provide Additional Water Storage, Treatment and Conveyance South of Lake Okeechobee**
   - Develop a strategic plan for the next increment of south-of-lake storage, treatment and conveyance to pursue beyond CEPP to take advantage of new north-of-lake storage and treatment, and more closely meet the performance targets of both the estuaries and the Everglades ecosystem
   - Building a deeper Reservoir on the Talisman site EAA (A-1&A2), is a decision that "could be revisited during the development of the detailed design phase for the CEPP FEB." (page 57)
4. **Deep Well Disposal of Excess Flows**
5. **Operational Changes (Lake Okeechobee Regulation Schedule)**



Actual Solutions to Reduce/Eliminate Discharges

Lake Okeechobee Watershed Project:
PLAN FORMULATION UPDATE

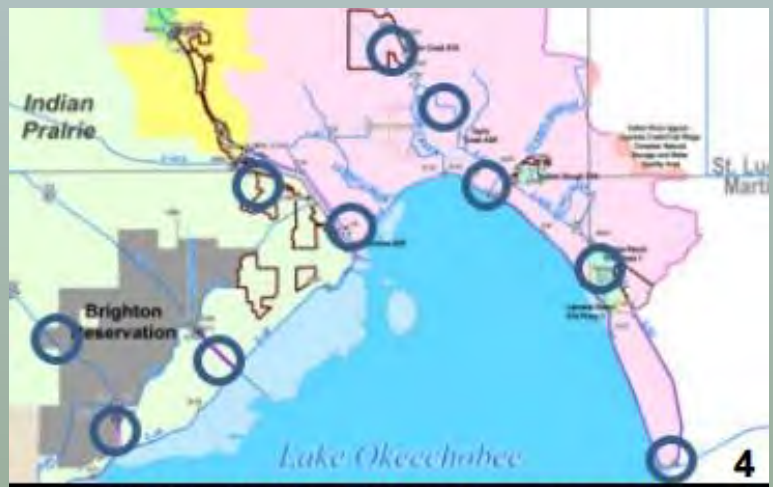
BUILDING STRONG

- **Above Ground Storage Options**
  - Static Storage Capacity 150,000 to 350,000 ac-ft
- **Aquifer Storage and Recovery (ASR) Wells**
  - 60 to 80 ASR Wells
  - Maximum Capacity: 335,000 to 450,000 ac-ft/yr
- **Deep Injection Wells**
  - 30 to 150 Deep Injection Wells
  - Maximum Capacity: 500,000 to 2,500,000 ac-ft/yr

TOTAL STORAGE: Ranges from **985 K** to **3.3 M** acre-feet

Potential Reservoir Sites

Potential Deep Injection Well Sites



Potential Aquifer Storage and Recovery Well Sites

PLAN FORMULATION NOVEMBER/DECEMBER MEETINGS

Lake Okeechobee Watershed Project Delivery Team

Developed 6 Arrays of Alternatives

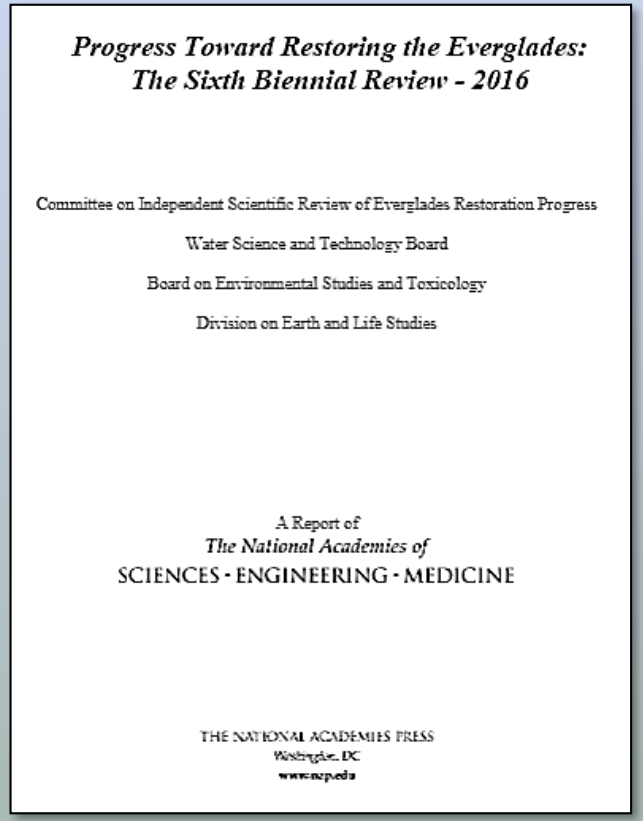
- All include North of the Lake Reservoirs, Aquifer Storage and Recovery (ASR) Wells, and Deep Injection Wells

Initial Plan Formulation demonstrates that the Lake Okeechobee Watershed Project will provide and additional 60-80% reduction in the frequency of harmful discharges from Lake Okeechobee beyond CEPP.

Over a 41 year period of record (492 Months):

- Only **6** months with harmful discharges to the St. Lucie
- Only **12** months with harmful discharges to the Caloosahatchee

National Academies of Science Report



LAKE OKEECHOBEE REGULATION SCHEDULE

The 2008 changes to the Lake Regulation Schedule resulted in a loss of 564,000 ac-ft of storage

"The large impacts on water storage with just modest changes in the lake regulation schedule suggest that Lake Okeechobee is a central factor in future considerations of water storage."

"The financial costs for raising the lake levels likely are negligible, aside from the costs of conducting an environmental impact statement and any enhanced costs of operations. "

EVERGLADES AGRICULTURAL AREA RESERVOIR

"The Central Everglades project implementation report (USACE and SFWMD, 2014a) states that the A-2 FEB could be converted to a deep reservoir at a later date to provide an additional increment of storage. Likewise, the A-1 FEB was constructed with space outside the levee embankment to allow room for increasing the height to allow for greater storage."

SUMMARY

We must reduce or eliminate flood releases from the Lake to the estuaries

The Everglades cannot be a dumping ground for unwanted Lake water

Above-ground reservoirs are:

- Expensive and slow to plan, design, and build
- Always include unintended consequences
- Can never be big enough to solve the problem
- Are more cost effective storage projects – Dispersed Water

Underground options, both ASR and Deep Injection Wells are:

- Less expensive and faster to plan, approve, design, and build
- Much more effective at eliminating lake releases
- No significant land acquisition needed

The Lake Okeechobee Watershed Plan can eliminate over <u>80% of unwanted Lake O discharges at a significantly lower cost</u>

LANDOWNERS PERSPECTIVE

Landowners in the EAA support Everglades Restoration

- Everglades Forever Act
- Central Everglades Planning Project (CEPP)
- Comprehensive Everglades Restoration Plan (CERP)

EAA Reservoir has already been designed and approved

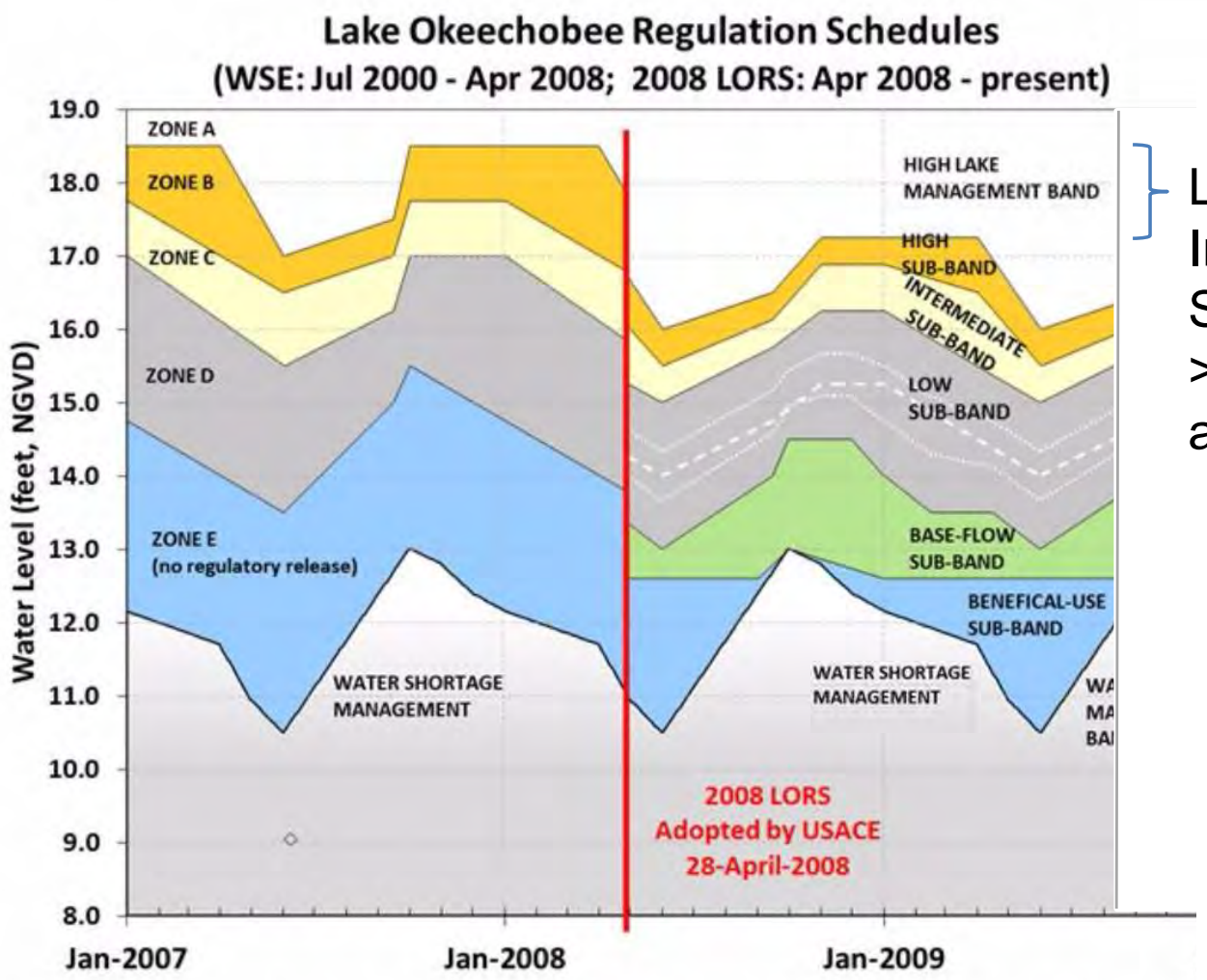
- Congress recently authorized the EAA reservoir in the Central Everglades Planning Project (CEPP), which is part of CERP

Finish already authorized projects and implement the Lake Okeechobee Watershed Project

- Will dramatically reduce the harmful discharges at a lower cost
- Herbert Hoover Dike repairs should be expedited

QUESTIONS?

LAKE OKEECHOBEE REGULATION SCHEDULE



Loss of In-Lake Storage >564,000 acre feet

FIGURE 4-7 A comparison of the release zones of the USACE regulation schedules for Lake Okeechobee before and after April 2008.
SOURCE: SFWMD (2015b).

Lake Okeechobee Discharges and Everglades Restoration: Effects on Downstream Estuaries

Appropriations Subcommittee on the Environment and Natural Resources
January 25th, 2017

Brian E. Lapointe, Ph.D.

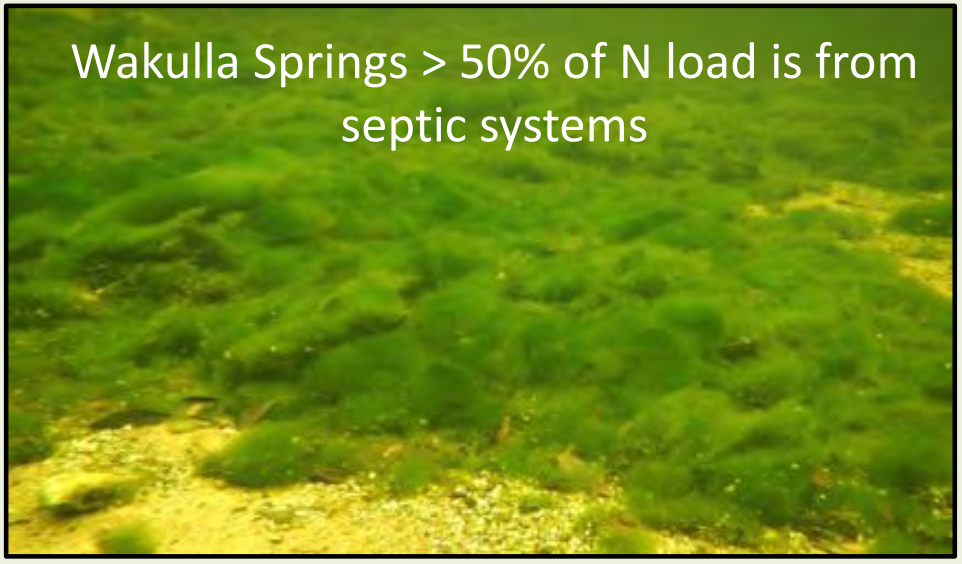
HARBOR BRANCH
FLORIDA ATLANTIC UNIVERSITY
Ocean Science for a Better World™

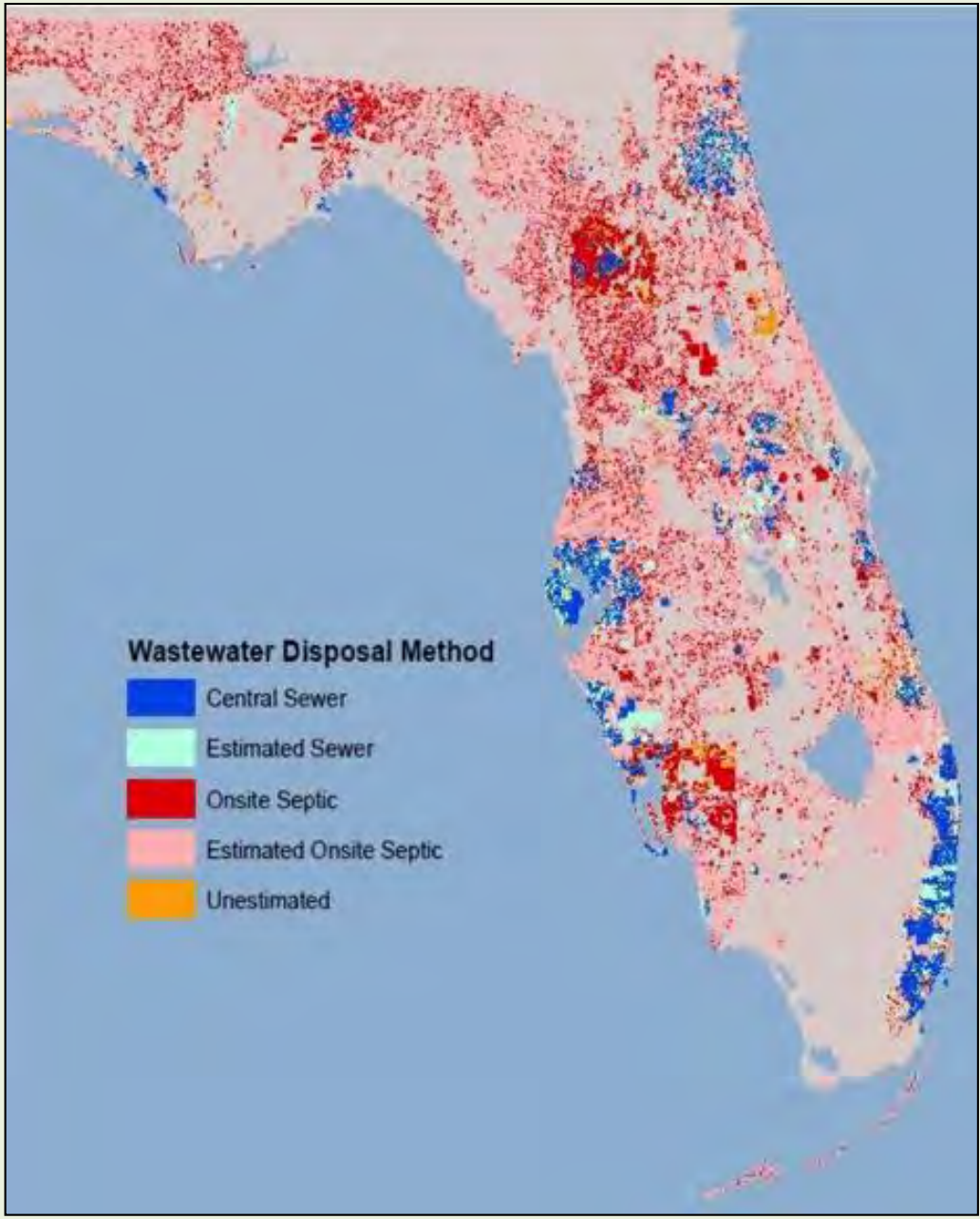
Wastewater Treatment in Florida

• Estimated N-loading from septic systems in Florida is substantial[1]

Fertilizer: 308,647,167 lb/yr
Septic systems: 52,910,942 – 108,026,508 lb/yr
Atmospheric inputs: 13,007,273 – 20,723,453 lb/yr

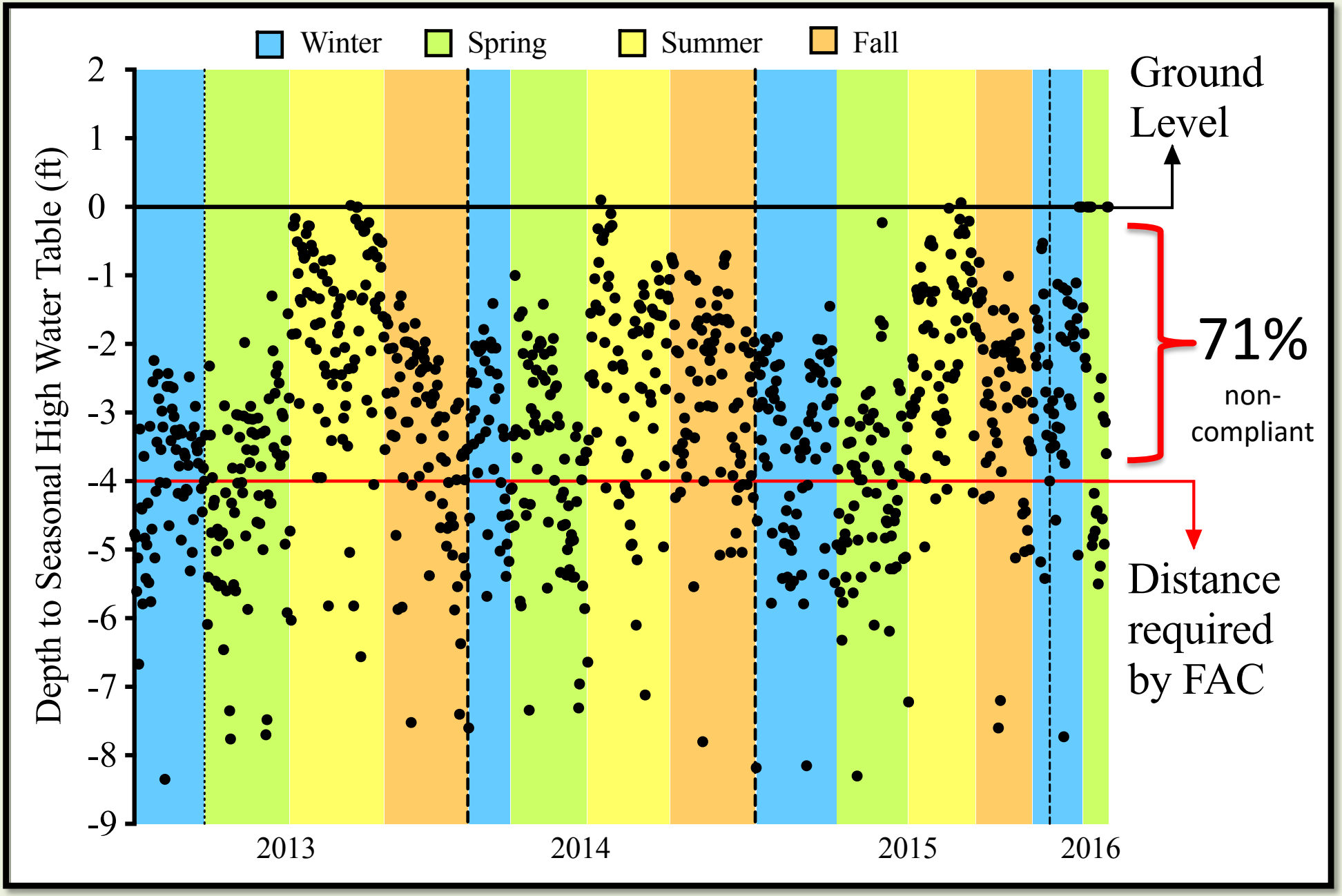
Reclaimed water: 264,554 – 573,201 lb/yr



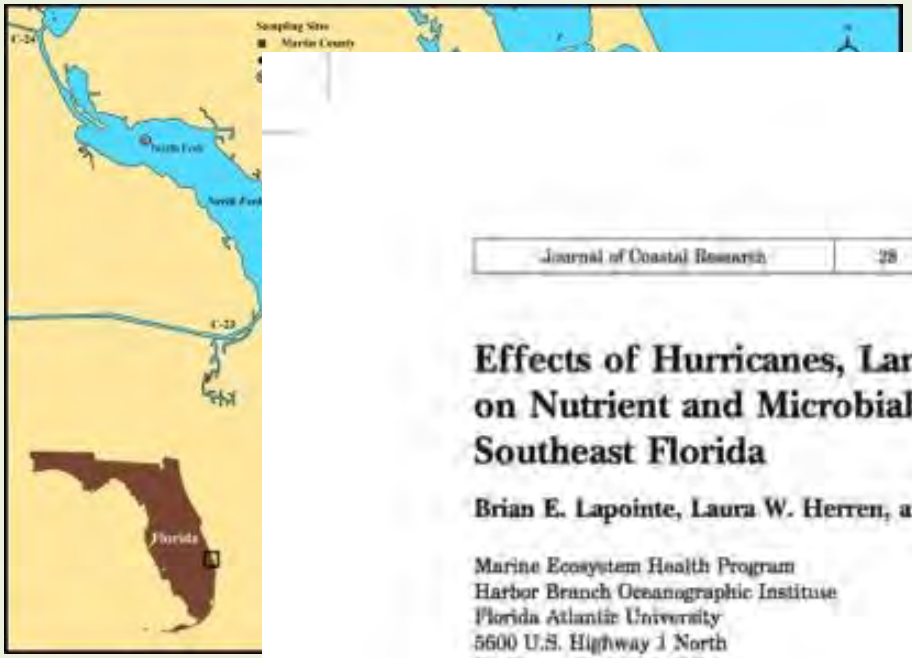


[1]Badruzzman et al. 2012

Distance Between Septic Drainfield and Seasonal High Water Table: Charlotte County



St. Lucie Estuary Study: 2005-2006



- Sampled in June & November 2005,

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Journal of Coastal Research | 28 | 6 | 1345–1361 | Coconut Creek, Florida | November 2012

Effects of Hurricanes, Land Use, and Water Management on Nutrient and Microbial Pollution: St. Lucie Estuary, Southeast Florida

Brian E. Lapointe, Laura W. Herren, and Bradley J. Bedford

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JCR
www.JCRonline.org

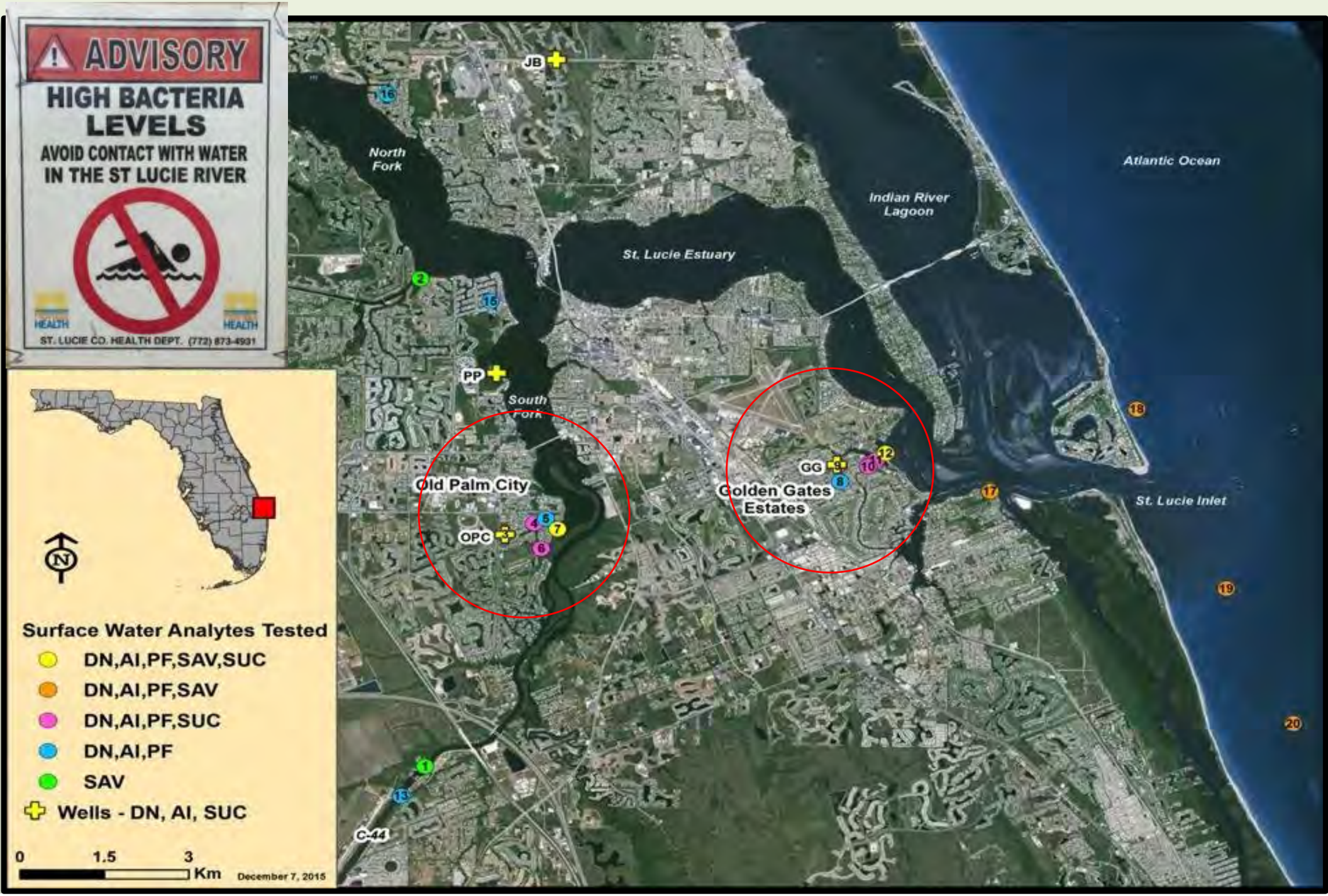
ABSTRACT

Lapointe, B.E.; Herren, L.W., and Bedford, B.J., 2012. Effects of hurricanes, land use, and water management on nutrient and microbial pollution: St. Lucie Estuary, southeast Florida. *Journal of Coastal Research*, 28(6), 1345–1361. Coconut Creek (Florida), ISSN 0749-0208.

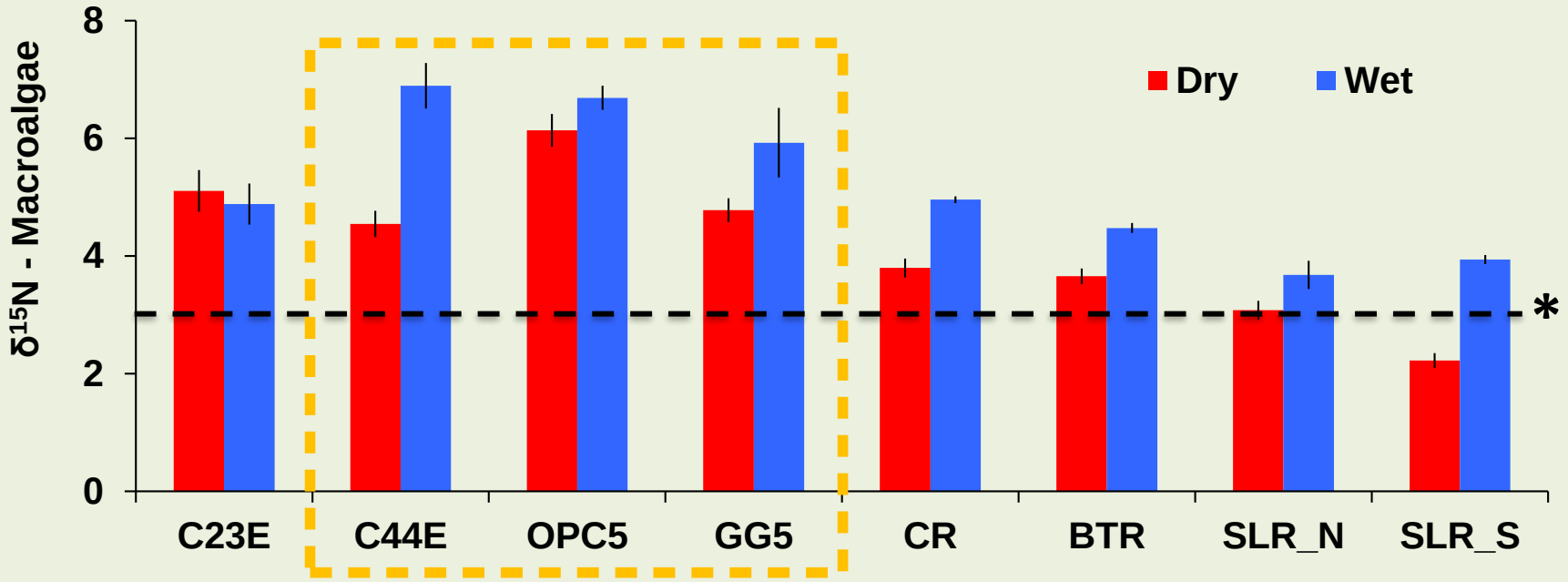
Multiple hurricanes impacted southeast Florida during 2004 and 2005, producing record rainfall and large-scale stormwater runoff into the urbanized St. Lucie Estuary (SLE). To assess effects on water quality, field samples were taken in June and November 2005 and March 2006 along the SLE's three main segments: the South Fork, connected via the C-44 canal to Lake Okeechobee; the North Fork, which receives residential and agricultural runoff from the C-23 and C-24 canals; and the Middle Estuary, which flows into the Indian River Lagoon and Atlantic Ocean. Salinities were <1‰ throughout the normally brackish estuary during the 2005 samplings, but returned to near-normal levels by March 2006 in all but the South Fork. Low salinities in 2005 correlated with low dissolved oxygen, high turbidity, elevated nitrogen and phosphorus concentrations, and high fecal and total coliform counts. Highest turbidity (84.4 NTU), nitrate (37.9 μM), and total dissolved nitrogen (130.8 μM) concentrations occurred in the South Fork, whereas the highest ammonium (15.4 μM), soluble reactive phosphorus (10.5 μM), and total dissolved phosphorus (13.8 μM) concentrations occurred in the North Fork. High fecal and total coliform counts occurred in tidal creeks adjacent to dense residential areas that rely on septic tanks for on-site sewage disposal. The data suggest that increased stormwater retention, minimization of freshwater releases from Lake Okeechobee, and enhanced treatment of both stormwater and sewage are needed to mitigate future stormwater-driven water quality perturbations in the SLE.

ADDITIONAL INDEX WORDS: *Rainfall, stormwater, salinity, nitrogen, phosphorus, coliform, bacteria.*

Watershed to Reef Septic Study: 2015



Sewage Pollution Indicator – $\delta^{15}N$ Macroalgae

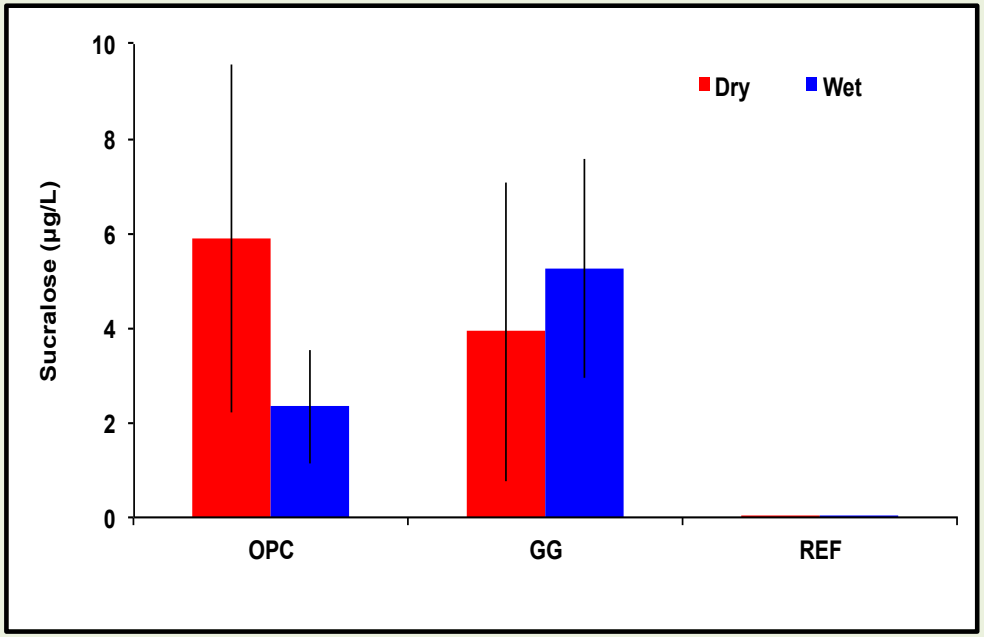


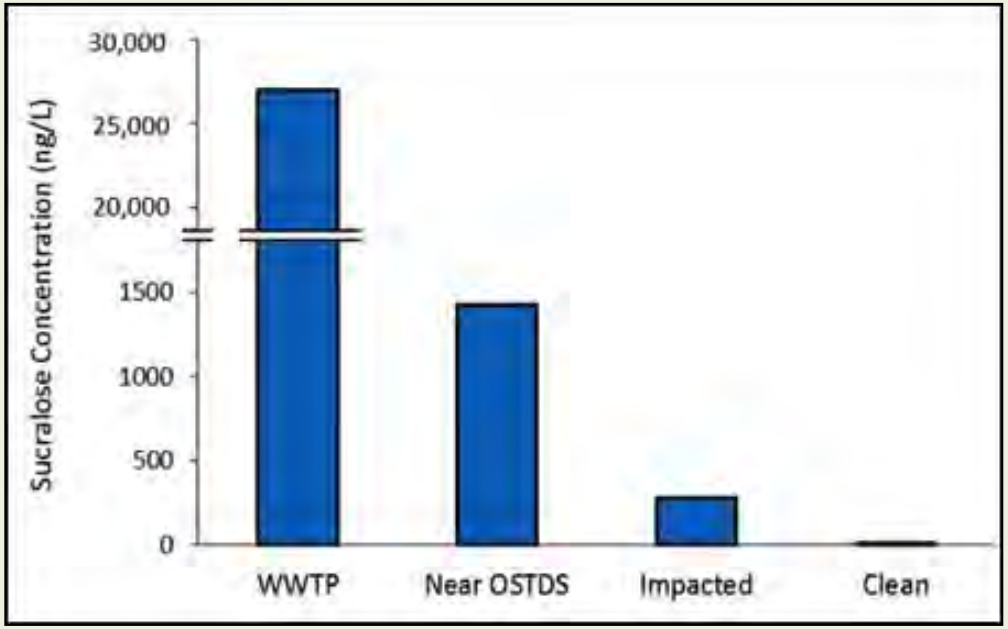
*Values > 3 o/oo indicate wastewater contamination

Nearshore reefs: increasing abundance of algae, urchins, and boring sponges

A Human Tracer: Sucralose

- Conservative tracer of human wastewater
- Cattle, raccoons, pets, and wildlife do not use sucralose
- Shows dilution of septic effluent into surface waters

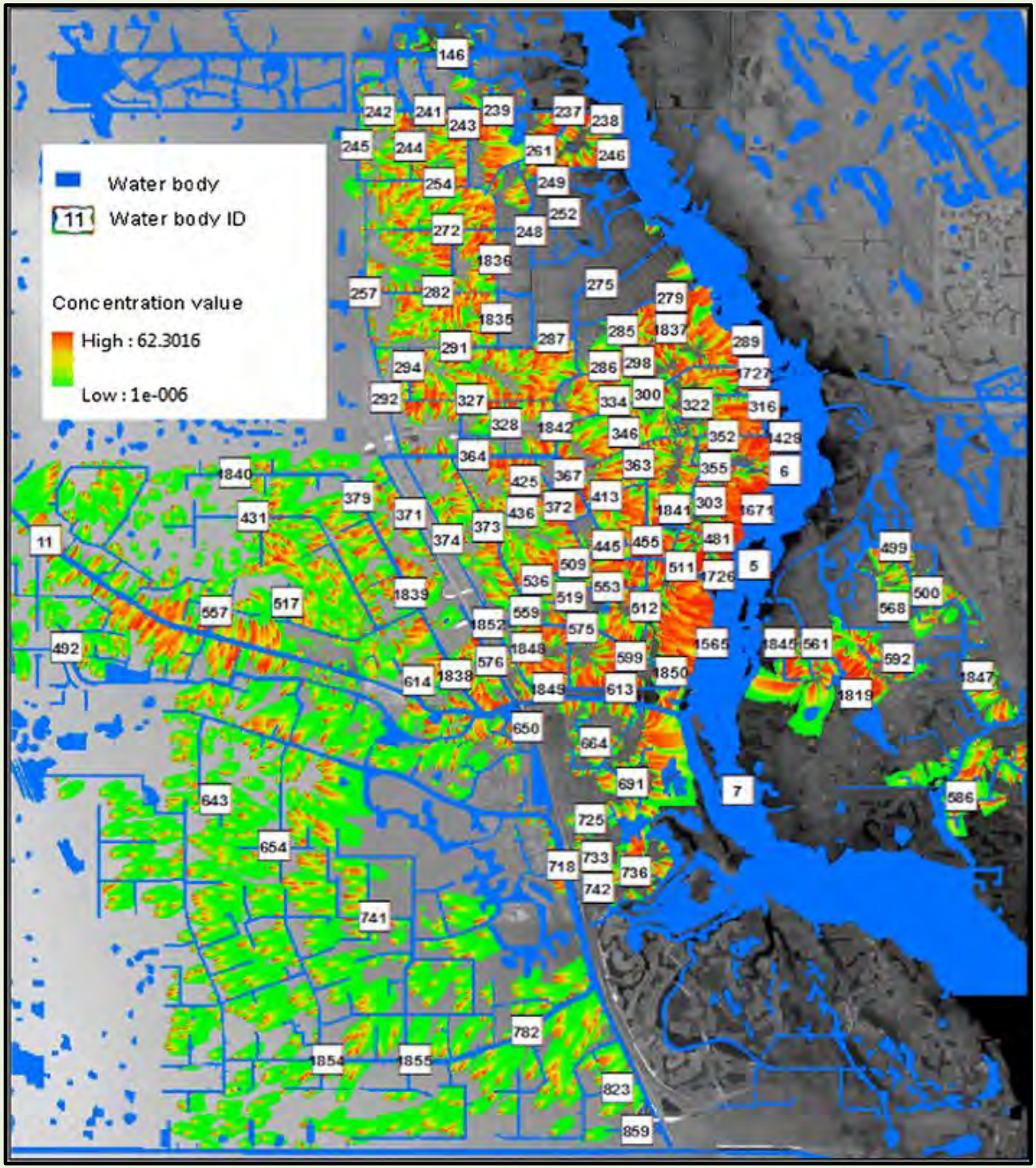




Simulated Nitrogen Plumes in the St. Lucie River*

- WBIDs are shown for water bodies with N-loads > 0.05 kg/day
- Simulated plumes show flow pattern of groundwater to surface water

*Ye et al., 2017



Septic Loading and Nitrogen Budget: St. Lucie Estuary, WY 1997-2015*

- Martin & St. Lucie Counties[1]
  Known septic systems= 43,224
  Total estimated septic systems=64,210

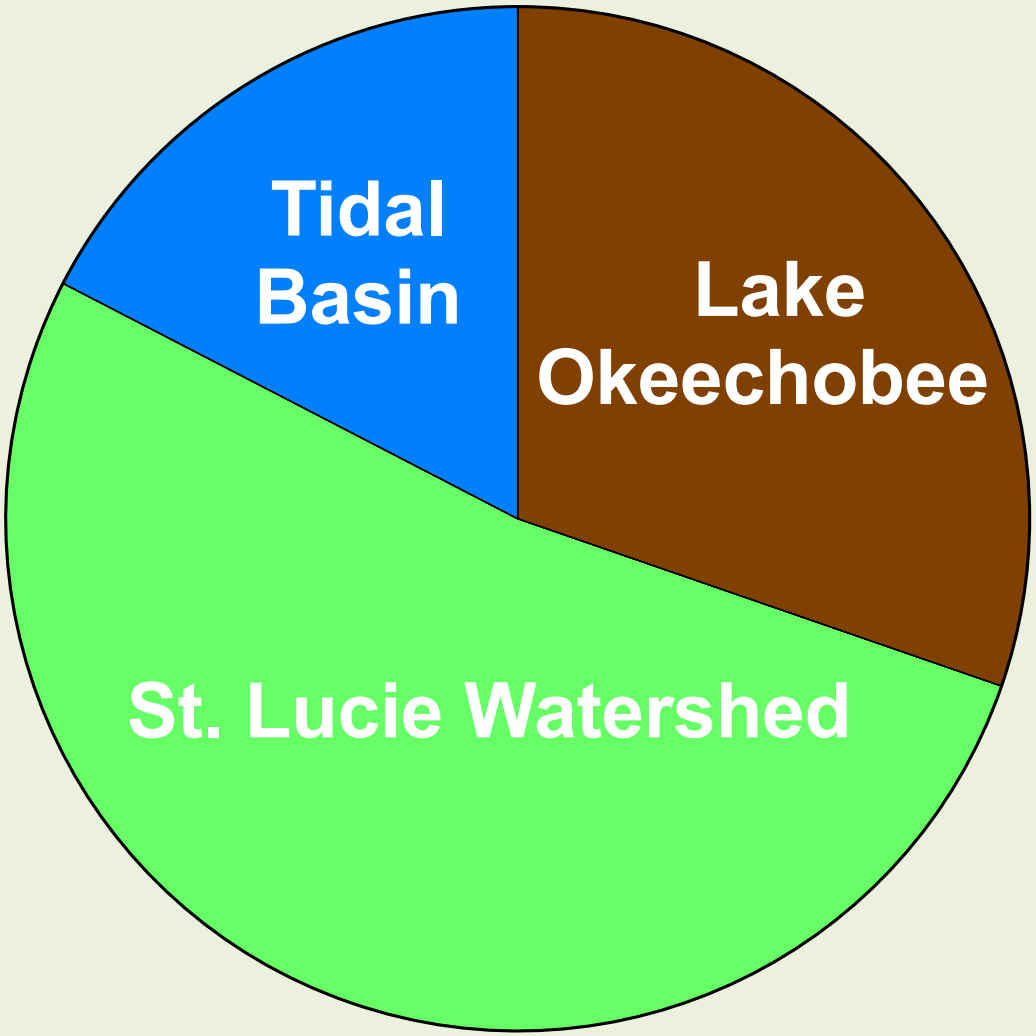
- N-loading calculation
  =9.7 lbs N/person[2] x 2.5 ppl x # tanks

- N-loading by septic tank effluent
  Martin County & St. Lucie Counties
  =1,048,182 – 1,557,093 lbs/yr

- **Septic systems contribute 27 – 41% TN**

- Reactive nitrogen loading
  Lake Okeechobee (18% reactive)
  =206,485 lbs/yr
  Septic tank effluent (75% reactive[3])
  =786,137 – 1,167,819 lbs/yr

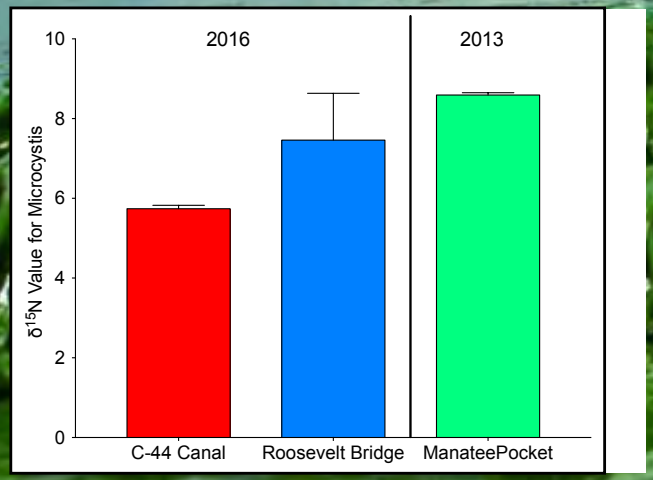
- Septic reactive N-loading > 400% of Lake Okeechobee load



*Zheng et al., South Florida Environmental Report, 2016

[1]FDOH, 2015 [2]FDEP, 2014 [3]Bicki et al., 1984

Microcystis Blooms in the St. Lucie Estuary: June 2016

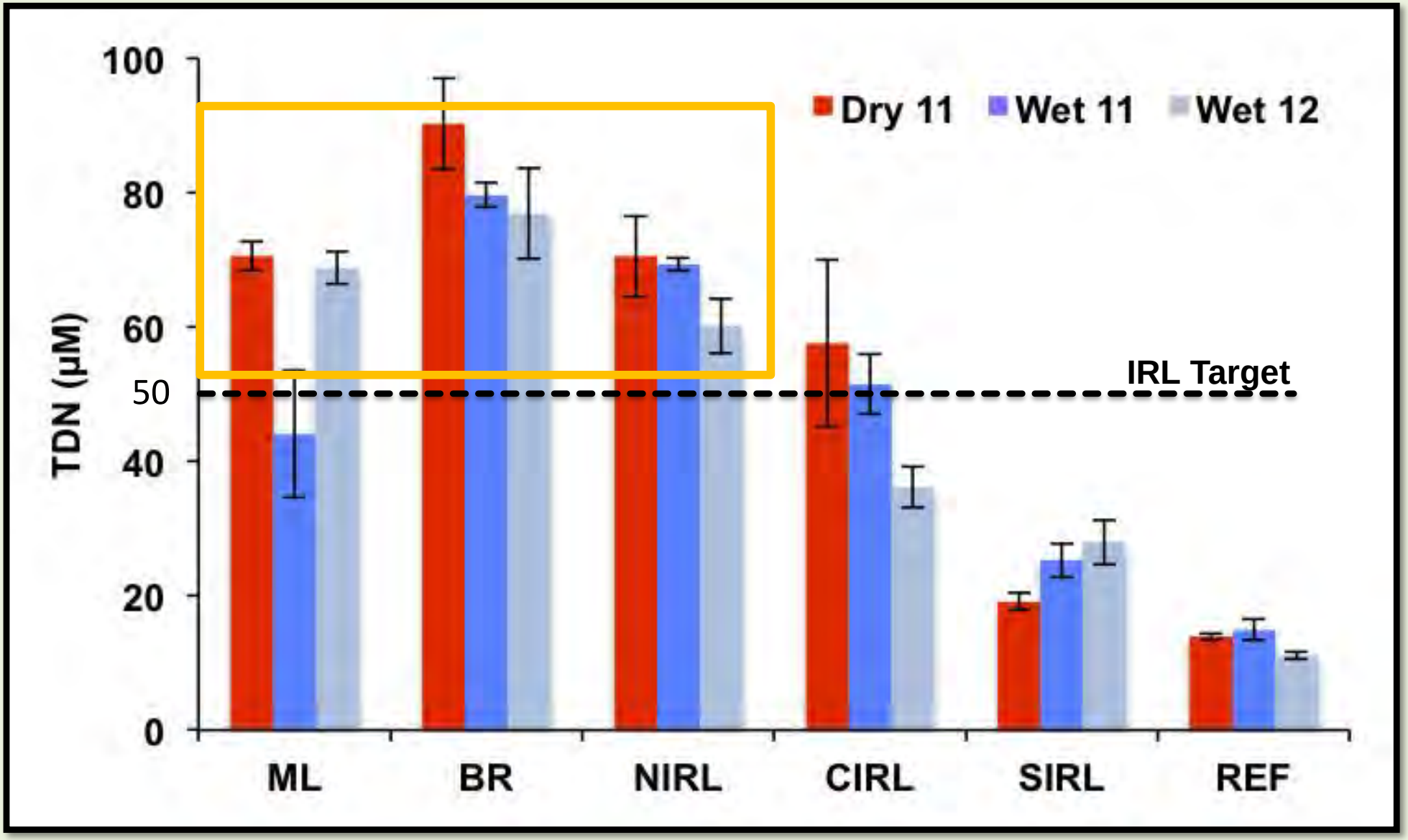


North vs. South Fork:

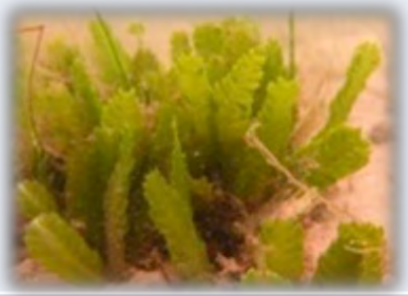
- **600% higher P**
- **100% higher ammonium**

Brown Tides in the Northern IRL
Not Related to Lake Okeechobee Discharges

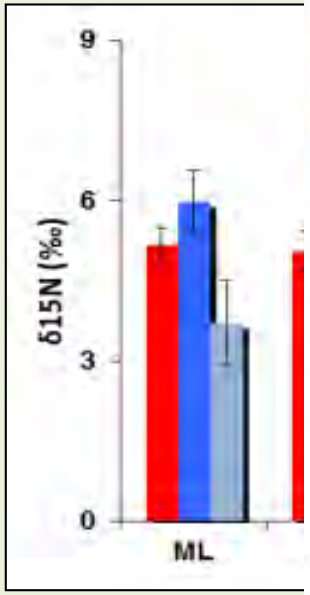
TDN (Total Dissolved Nitrogen) in the Indian River Lagoon Segments



Macroalgae as Bio-Observatories in the IRL

Gracilaria tikvahiae 	***Caulerpa prolifera*** 
Hypnea musciformis 	*Hypnea spinella* 
Caulerpa mexicana 	*Laurencia filiformis* 
Acetabularia schenckii 	*Acanthophora spicifera* 

Stable N Isotopes in Macroalgae Identify Sewage N Source



Contents lists available at ScienceDirect

Harmful Algae

journal homepage: www.elsevier.com/locate/hal

Evidence of sewage-driven eutrophication and harmful algal blooms in Florida's Indian River Lagoon

Brian E. Lapointe *, Laura W. Herren, David D. Debortoli, Margaret A. Vogel

Harbor Branch Oceanographic Institute at Florida Atlantic University, Harmful Algal Bloom Program, 5600 US 1 North, Fort Pierce, FL 34946, USA

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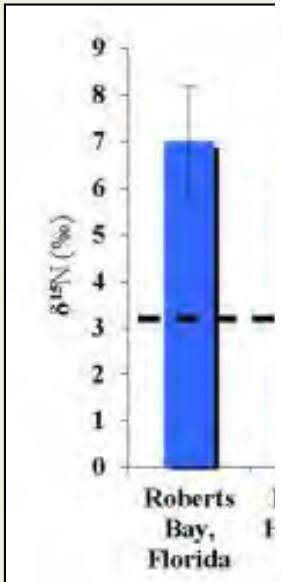
ABSTRACT

Nutrient pollution is a primary driver of eutrophication and harmful algal blooms (HABs) in estuaries and coastal waters worldwide. In 2011–2012, 20 sites evenly distributed throughout the 251-km long Indian River Lagoon (IRL) were assessed during three sampling events for dissolved nutrients (DIN, SRP, TDN, TDP) and chlorophyll *a*. Benthic macroalgae were also analyzed for $\delta^{13}C$, $\delta^{15}N$, and C:N:P contents to identify potential nutrient sources and gauge the type and degree of N and P limitation. The mean DIN and SRP concentrations throughout the IRL were high, averaging 4.24 ± 0.45 and 0.68 ± 0.06 μM, respectively, explaining the widespread occurrence of HABs during the study. High TDN concentrations (up to 152 μM) and TDN:TDP ratios (>100:1) in the poorly flushed northern IRL, Mosquito Lagoon and Banana River segments reflected the accumulation and cycling of N-rich groundwater inputs that produce P-limitation. These enriched nutrient conditions were associated with unprecedented chlorophyll *a* concentrations (>100 μg/L), dominated by *Resultor* sp. Ø. Moestrup in the Banana River in 2011 and *Aureoumbra lagunensis* D.A. Stockwell, DeYoe, Hargraves and P.W. Johnson in the Mosquito Lagoon and northern IRL in 2012. C:N, C:P, and N:P ratios in macroalgae averaged 15.9, 698.9, and 40.6, throughout the IRL, respectively; significantly higher C:P and N:P ratios in the northern IRL segments suggested strong P-limitation in these N-enriched waters. Macroalgae $\delta^{15}N$ values were enriched throughout the IRL (+6.3‰) and similar to values reported for macroalgae from other sewage-polluted coastal waters. Because point-source sewage inputs to the IRL were largely eliminated through the IRL Act of 1990, these results suggest that non-point source N enrichment from septic tanks (~300,000) represents a significant and largely ignored N-source to the IRL. The high degree of sewage N contamination of the IRL, combined with recent HABs, including toxic ecotypes of the red macroalga *Gracilaria tikvahiae* McLachlan, seagrass loss, and wildlife mortality, indicates a critical need for improved sewage collection and treatment, including nutrient removal.



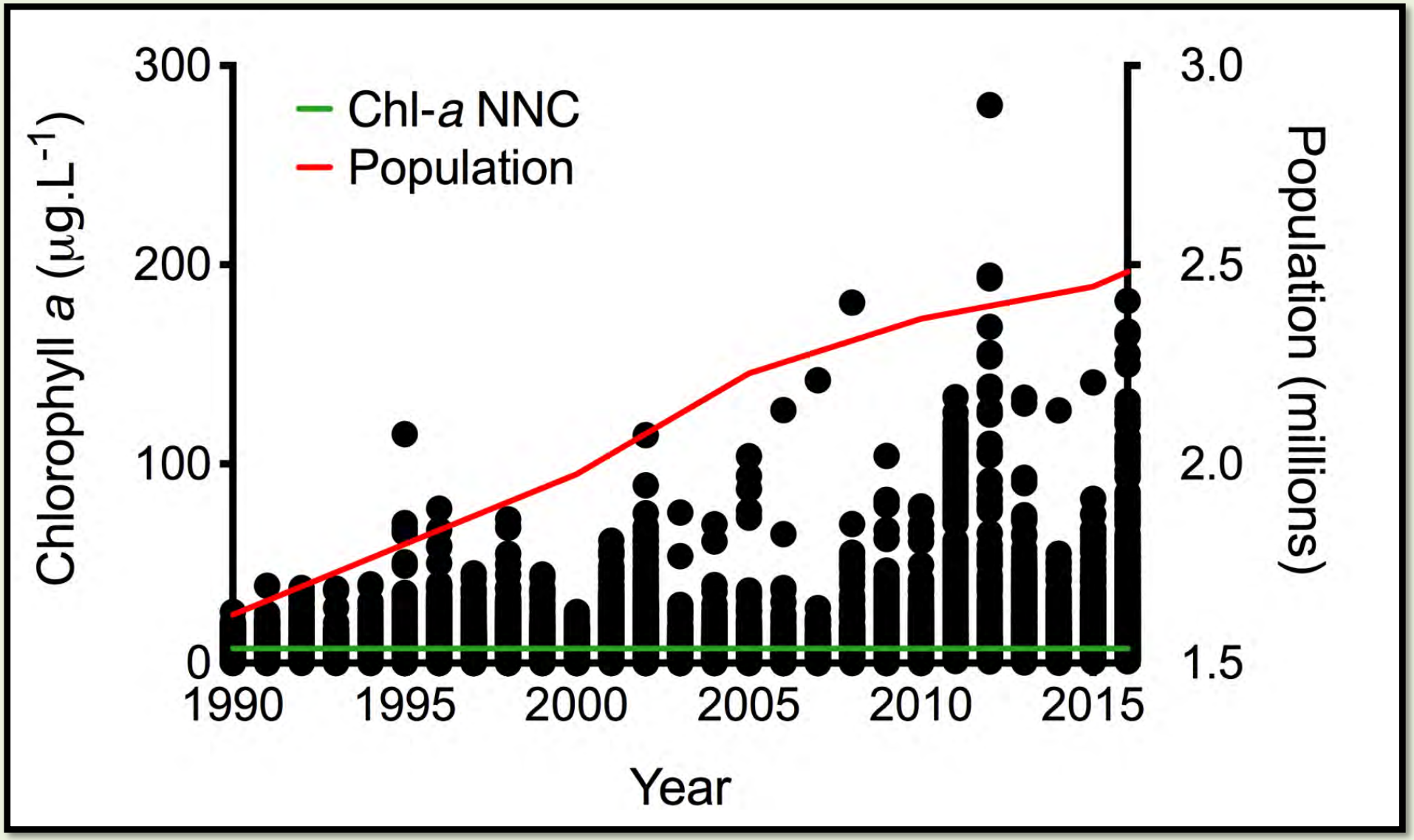
Florida

Level
to +5
o +28
+2
0
:o +2
:o +2
o +2

o/oo

other

Indian River Lagoon
More people - More algae[1]



[1]Chl *a* data from SJRWMD; population data from Florida Demographic Estimating Conference, December 2015 and UF, BEBR, Florida Population Studies, Volume 49, Bulletin 174, January 2016.

Send Water South to Florida Bay? Really?

The Key West Citizen
Vol. 111 No. 46 16 Pages Key West, Fla., Monday, Feb. 24, 1992 25 Cents

Marine sanctuary

Panel: Water quality is top local concern

By Marilyn J. Tarnowski
Citizen Staff Writer

MARATHON — A 22-person advisory panel has agreed that water quality is the single most important issue underpinning the management plan being prepared for the nascent Florida Keys National Marine Sanctuary.

The same panel also found available research and data are scant and inadequate for informed decision-making about what affects marine life and ecology in the Keys.

The group is chartered with advising the National Oceanic and Atmospheric Administration of user-group concerns within the sanctuary. In a two-day session last week in Marathon, the advisory panel reviewed a near-final report that summarizes existing research and known quantities related to the water-quality of the sanctuary and adjacent waters.

The management-plan writing project now moves into a second phase: A Water Quality Steering committee comprised of NOAA, the federal Environmental Protection Agency, and state and local agencies, will develop water quality monitoring and research programs.

The advisory panel, said member George Barley of Orlando, cautioned the Water Quality Steering Committee that its first report may give the impression that ample information is available on water-quality impacts.

"We don't agree there's adequate data," Barley said.

Barley said his committee advocated research and monitoring for water entering the sanctuary and what effect deep sea salty water and freshwater runoff from the Everglades has on sanctuary ecology.

"The South Florida Water management district says it is monitoring the situation, but we are skeptical about that," Barley said.

In 1991, Congress funded $390,000 for Phase I work, the compilation of existing data released earlier this month and reviewed by the user groups last week. For 1992, the federal government has funded $625,000 for the development of research and water quality monitoring projects, the heart of Phase II.

In addition, a Gulf of Mexico Project will add $50,000 for demonstration water quality projects, EPA Regional Administrator Greer Tidwell said.

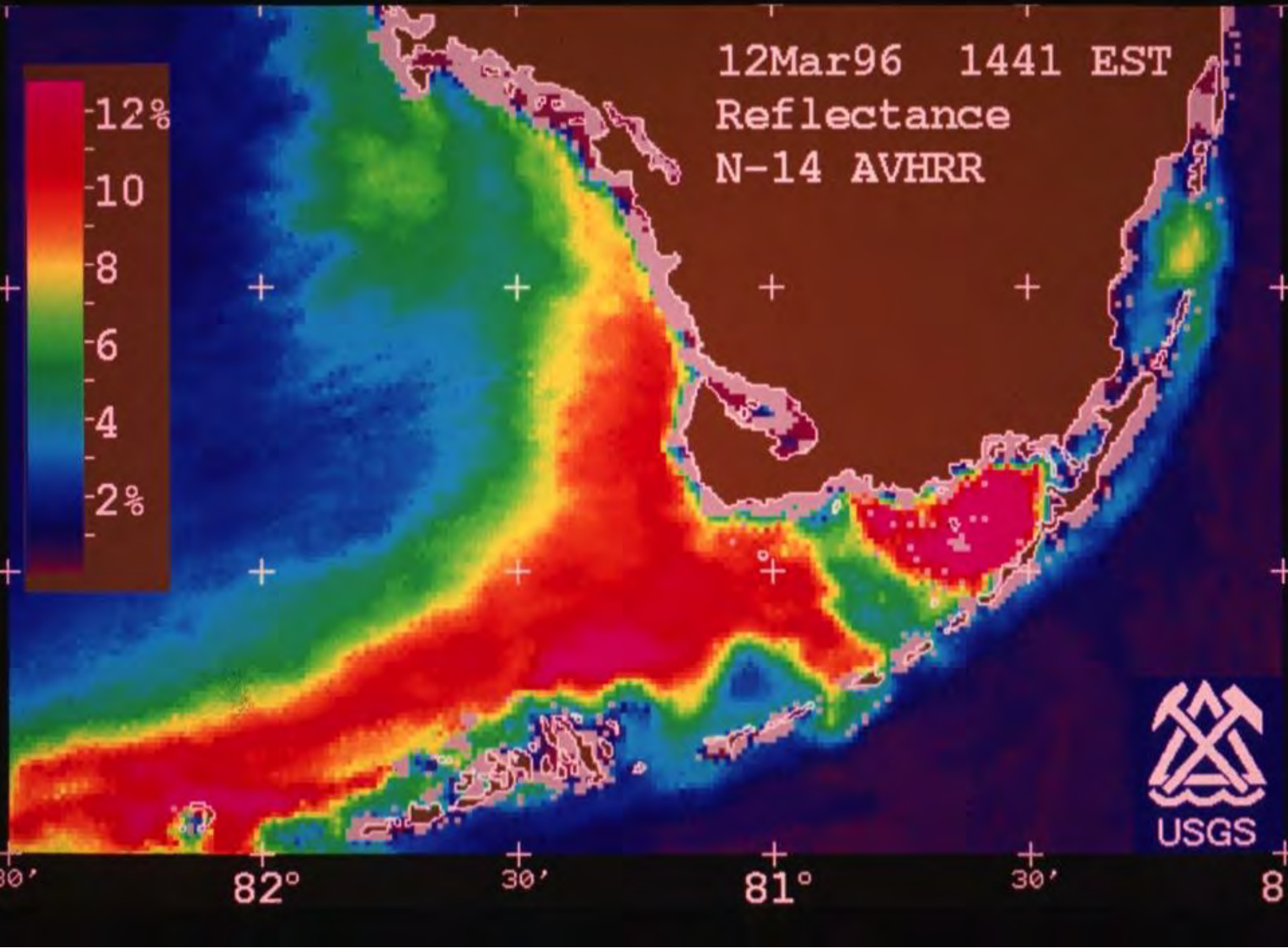
The user groups also advocated a so-called ecosystem approach to research and monitoring, which would identify pollution sources in local and adjacent waters. The water concerns must not stop at sanctuary boundries, Mark Robertson of The Nature Conservatory said. Tidwell said that enlarged scope was already planned.

The advisory committee advocated active pursuit of new technology appropriate to each of the several sources of water degradation.

"This group is the community's link in the development of the management plan," Billy Causey, manager of the sanctuary project, said Thursday after an information session at Buccaneer Lodge.

"Now that all of the public scoping meetings have been held, time is tighter now. The advisory council is here to convey the wishes of the constituencies," he said. The entire management plan must be finished by June 1993.

The Florida Keys National Marine Sanctuary was created by Congress Nov. 16, 1990, to be managed by the NOAA within the Department of Commerce. Legislation included a first-time mandate that the program include water quality program administered in conjunction with the EPA.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6
4
2%
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30'
81°
30'
USGS

THE KEYS

The Miami Herald

SECTION D
WEDNESDAY, JUNE 17, 1992

WHERE THE ALGAE BLOOM

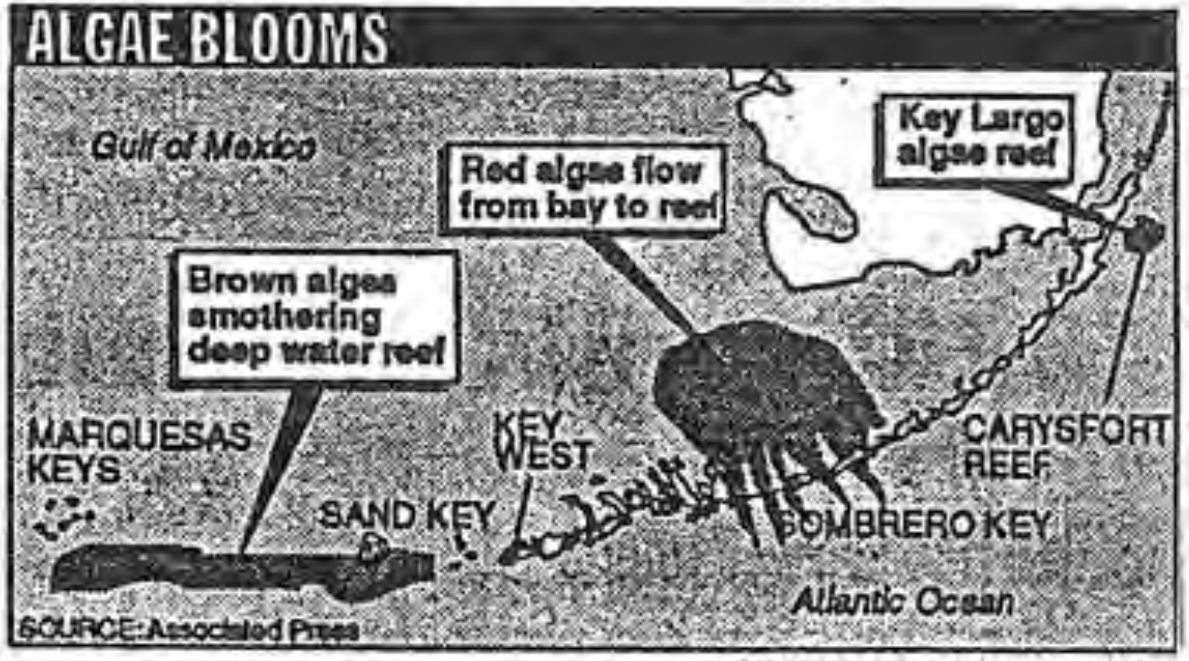
Blanket of algae smothers Keys reef

60-mile growth creates dead zone

By DAN KEATING
Herald Staff Writer

ALGAE SMOTHERS KEYS REEF

Latest bloom stretches for 60 miles, THE KEYS, 1D



RICK BROWNLEE/Miami Herald Staff

Red tide fish kill the worst in years

Algae scourge rounds the Keys

By NANCY KLINGENER
Herald Staff Writer

2/22/95

MARATHON — Red tide, a massive rusty algae bloom, has moved from Florida's west coast through the Gulf of Mexico, rounded the Keys and is heading up the Gulf Stream, killing hundreds of thousands of sea creatures in its path.

"It's killing everything from octopus to tarpon," said Marathon fisherman Karl Lessard. "It's the worst red tide I've seen in 25 years in terms of fish being killed."

It's the same red tide that closed Sarasota-area beaches and shellfish beds last September, state biologists said Tuesday.

It's going up the Gulf Stream, ravaging 'everything from octopus to tarpon.'

Over the last several weeks, researchers and commercial fishermen have tracked the tide's progress through the Gulf and into the Atlantic side of the peninsula.

Red tide is formed by naturally occurring algae that make water look green to brownish red. The single-celled algae organisms emit a poison that attacks the nervous system of fish and accumulates in such filter-feeding animals as clams and oysters.

KEY WEST THE CITIZEN

Tuesday
February 14, 1995

25 cents

Red tide killing Keys fish

By JON STEINMAN
Citizen Staff Writer

MARATHON — A red tide has reached the Keys, leaving a trail of dead fish and worried fishermen in its wake.

"It's caused one of the largest [fish kills] I've ever seen," said Karl Lessard, commercial fisherman and co-founder of the Water Quality Joint Action Group.

The Red Tide — which gets its name from the reddish hue in the water caused by millions of toxic microscopic organisms known as dinoflagellates — is a relatively common occurrence around the globe, according to state Department of Environmental Protection scientists studying the event.

> "It's caused one of the largest fish kills I've ever seen."
>
> — Karl Lessard
> Water Quality Joint Action Group

Though estimates of how many fish have perished as a result of the tide are varied, worried fishermen contacted the South Florida Water Management District and DEE looking for answers.

Monroe County fisherman began reporting dead fish floating on the surface of Florida Bay, with some reports coming from as far south as 20 miles north of Key West, last week.

DEP officials announced that dinoflagellates carried south from waters off Sarasota are the cause of the deaths, and they have alerted officials as far north as North Carolina to warn them of the red tide's progress.

The brand of dinoflagellate that is periodically washed around the Keys by Gulf of Mexico tides is fatal to fish and some sea birds, but not to humans. Humans coming in contact with the substance could suffer migraine headaches or diarrhea, among other symptoms.

Red tides in other parts of the world, such as New England, Malaysia, Japan and California, can be fatal to humans, said Karen Steidinger, a DEP senior research scientist who has studied Florida's red tide for 30 years.

Intrusion of ocean waters into Gulf waters off Florida's West Coast acts as an alarm clock for dinoflagellates there, waking them out of hibernation, she said.

The toxic micro-organisms quickly infect shell fish beds and bottom-feeding fish, and remain in the food chain. The tide that is now floating off the Keys began in September, she said.

"The main thing you see with red tide is fish kills," Steidinger said. "But red tide doesn't de-oxygenate the water, causing fish to suffocate. It causes respiratory failure in fish."

Steidinger has documented red tides through the area in 1976, 1980, 1983 and 1987. In 1987, the tide caught ocean currents as far north as North Carolina.

Eddies off the Gulf Stream, the powerful East Coast current, bring the dinoflagellates close to shore, spreading the organisms' disastrous effects.

KEY WEST THE CITIZEN

Monday
April 29, 1996

50 cents

Bay remedy could be backfiring

Freshwater flows may be causing red tide

y MARC CAPUTO
itizen Staff Writer

KEY WEST — Because 215 manatees suddenly died this ear — 152 since March 5 — ome scientists are blaming the rge red tide off Southwest Flor-a, according to the Associated ress. Meanwhile, scientists om around the world say the d tide indicates a deeper prob-m within Florida's ecosystem, hich will ultimately lead to the death of Florida Bay and the reef.

A red tide, a harmful algae bloom, produces toxins that poison shell fish and cause mass marine animal mortalities, says a national research study entitled the *Ecology and Oceanography of Harmful Algal Blooms*. The algae — a dinoflagellate called *Gymnodinium breve* — also produces an aerosol toxin which can cause human and animal respiratory illness and perhaps even death if inhaled, ECOHAB says.

The AP reports some rescued manatees have shown the effects of inhaling the algae's toxic aerosol. The Gulf of Mexico has had high concentrations of *G. breve* in the past 18 months and a manatee die-off in 1982 was attributed to a red tide.

But scientists from the Florida Marine Research Institute, the U.S. Fish and Wildlife Service and the Center for Disease Control and Prevention have yet to proclaim the red tide the definite culprit for the manatee deaths, the AP says.

Dave Tomasko, of the Southwest Florida Water Management District, says the current year-and-a-half long red tide has affected the quality of the waters from Sarasota County to Collier County. He says the manatee deaths may be a result of manatees eating a diet of marine ani-

See BAY, Page 8A

CAYO CONCH

"I'm glad I wasn't in that tsunami"

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Bacteria alert spreads

CAYO CONCH

"I save me alone, you lobster dese-craters."

THE CITIZEN
KEY WEST

Tuesday
July 27, 1999
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Pollution reaches Tortugas

By MANDY BOLEN
Citizen Staff Writer

KEY WEST – The pristine waters of the Dry Tortugas National Park may not have escaped the threat of bacterial contamination.

The National Park Service, which governs the operation, has issued a preliminary health advisory for the nearshore waters at the Dry Tortugas swimming beach because of "limited and preliminary indications of fecal contamination in portions of the park's waters," a recent news release said.

The results, which came from the Environmental Protection Agency, showed some areas with high levels of E. coli and enterrococci bacteria – both indicators of dangerous bacteria that can cause infection and gastrointestinal disease in humans.

The samples were tested in January of this year, but the National Park Service just received the results because the EPA study of the park was not focused on water quality and took months to assemble, explained Mike Jester, facility manager of Dry Tortugas National Park.

Park officials have not closed any swimming areas as of yet, but have posted advisories near the swimming beach in question.

"Advisories have been posted and we are working on getting notices out to commercial businesses that frequent the park, said Larry Belli, deputy superintendent of Everglades and

See TORTUGAS, Page 10A

TROUBLE IN TORTUGAS: A preliminary health advisory has been issued for the nearshore swimming waters of the Dry Tortugas after testing showed signs of fecal coliform contamination.

ROB O'NEAL/ The Citizen

counts.

Another warning was issued Wednesday for Marathon's Coco Plum Beach.

The advisories came one week after 15 sites were tested between Boca Chica Beach and John Pennekamp Coral Reef State

dard of 800 colonies of fecal coliform per 100 milliliters.

"The Department of Environmental Protection took samples there last Wednesday, Aug. 25, and found the waters at the swimming beach exceeded 1,200 colonies per 100 milliliters,"

oblivious to any danger.

Just before noon, Wayne Robertson, risk manager for the county's Human Resources Department, was investigating a septic tank near the park's baseball field as a possible source for the high count.

standards, Teague said.

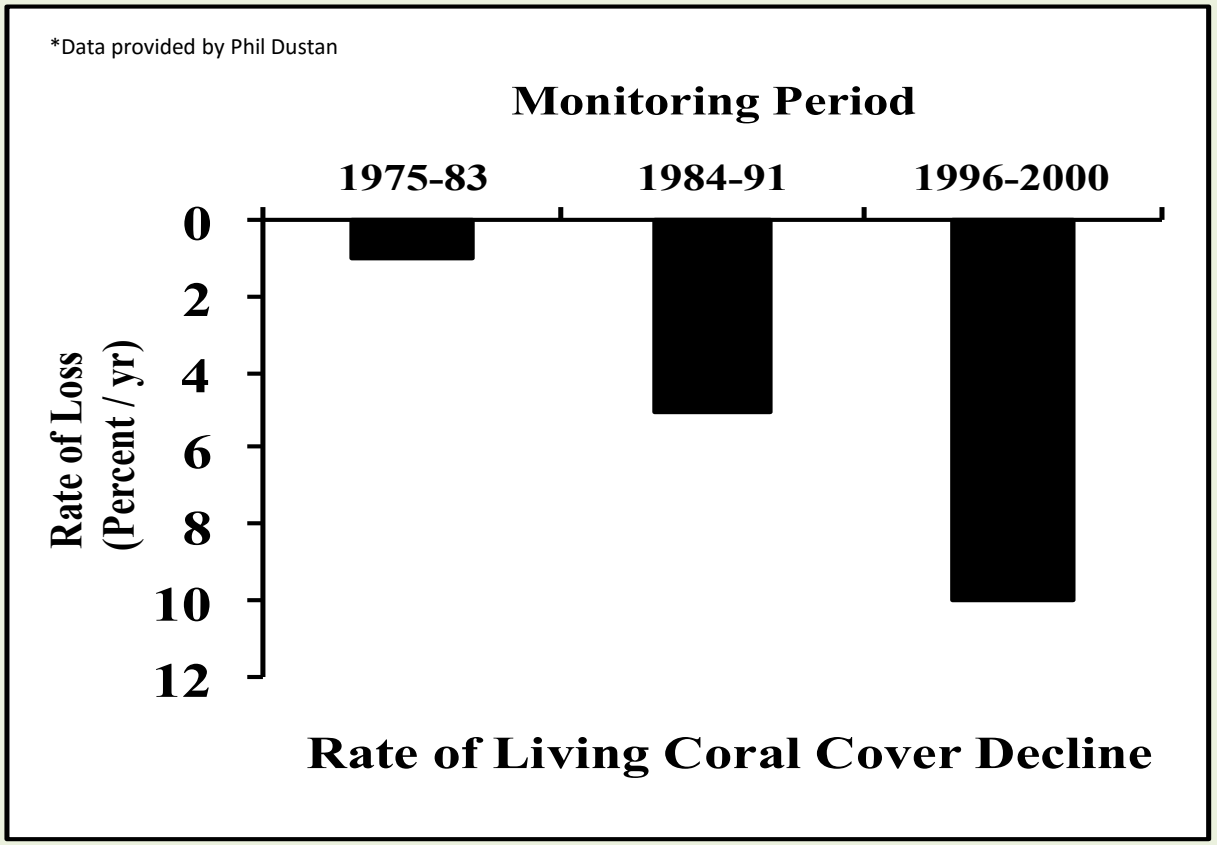
Those beaches include John Pennekamp Coral Reef State Park, Plantation Yacht Harbor beach, Anne's Beach, Long Key State Park, Curry Hammock State Park, Sombrero Beach and Bahia Honda State Park.

STEVE GIBBS/The Citizen

DIRTY WATER: The Florida Department of Health issued health advisories Thursday for Harry Harris Park beach in Tavernier and Coco Plum Beach in Marathon.

Rate of Coral Loss in the Florida Keys: 1975-2000*

*Data provided by Phil Dustan



Algal Blooms Linked to Increased Flows and Nitrogen Enrichment

Naples | Naples Daily News

Report: Everglades restoration may harm Florida Bay

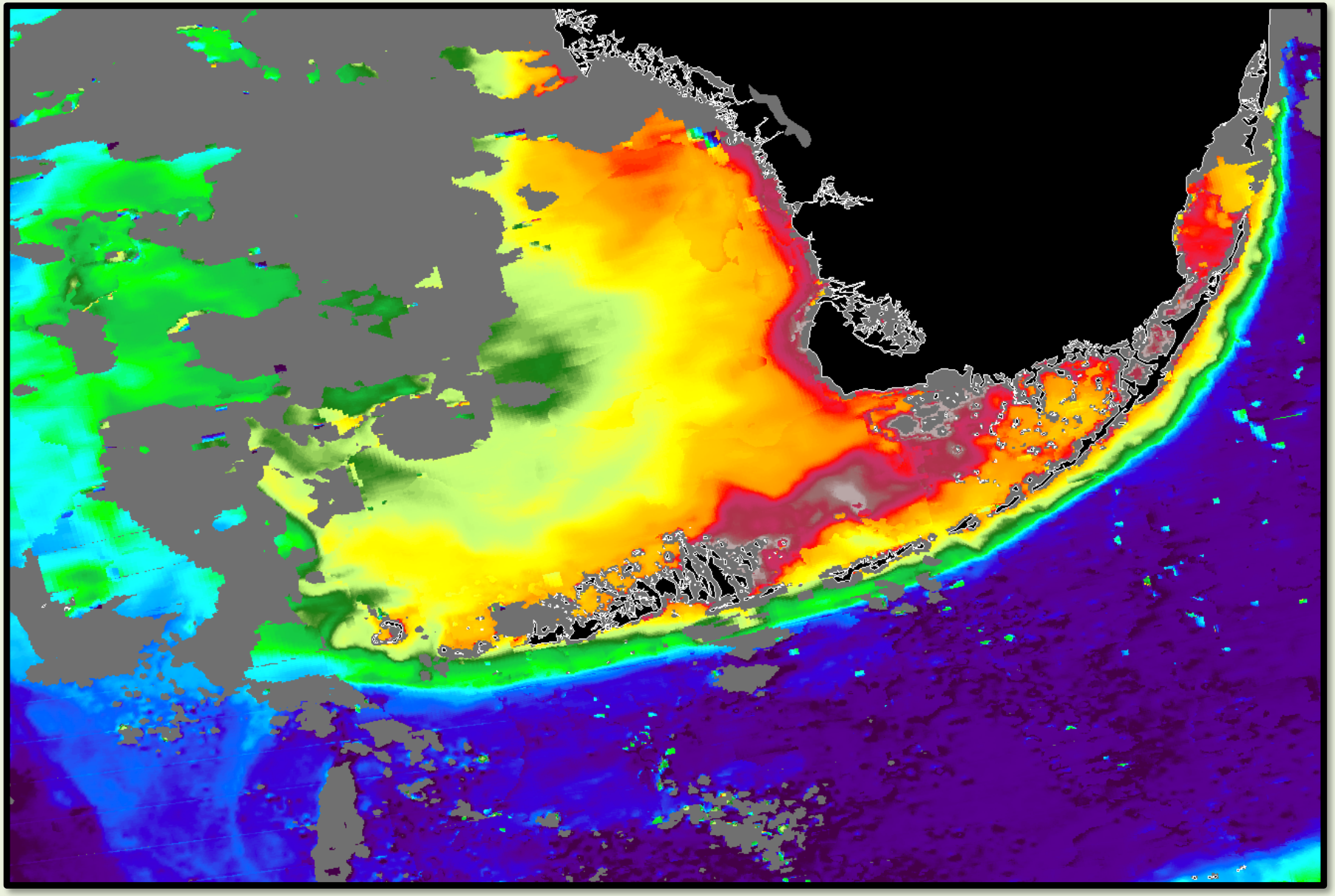
Friday, August 9, 2002

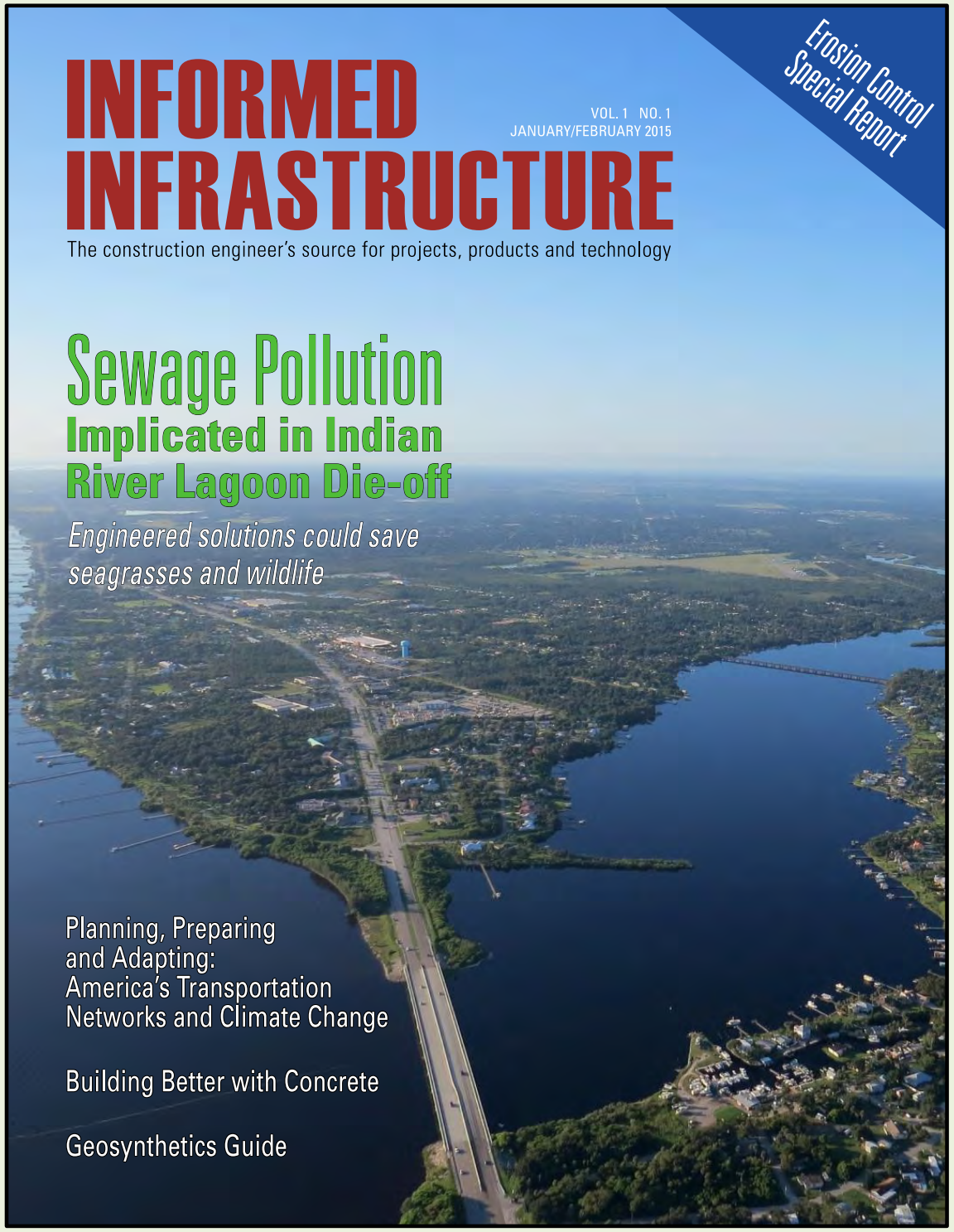
By JENNIFER SERGENT, sergentj@shns.com

The widely held perception that the murky, ailing Florida Bay will recover when the Everglades restoration sends more fresh water there could be wrong, a group of scientists wrote in a report released Thursday.

Florida Bay Algae Bloom and Extreme Rainfall: 2013

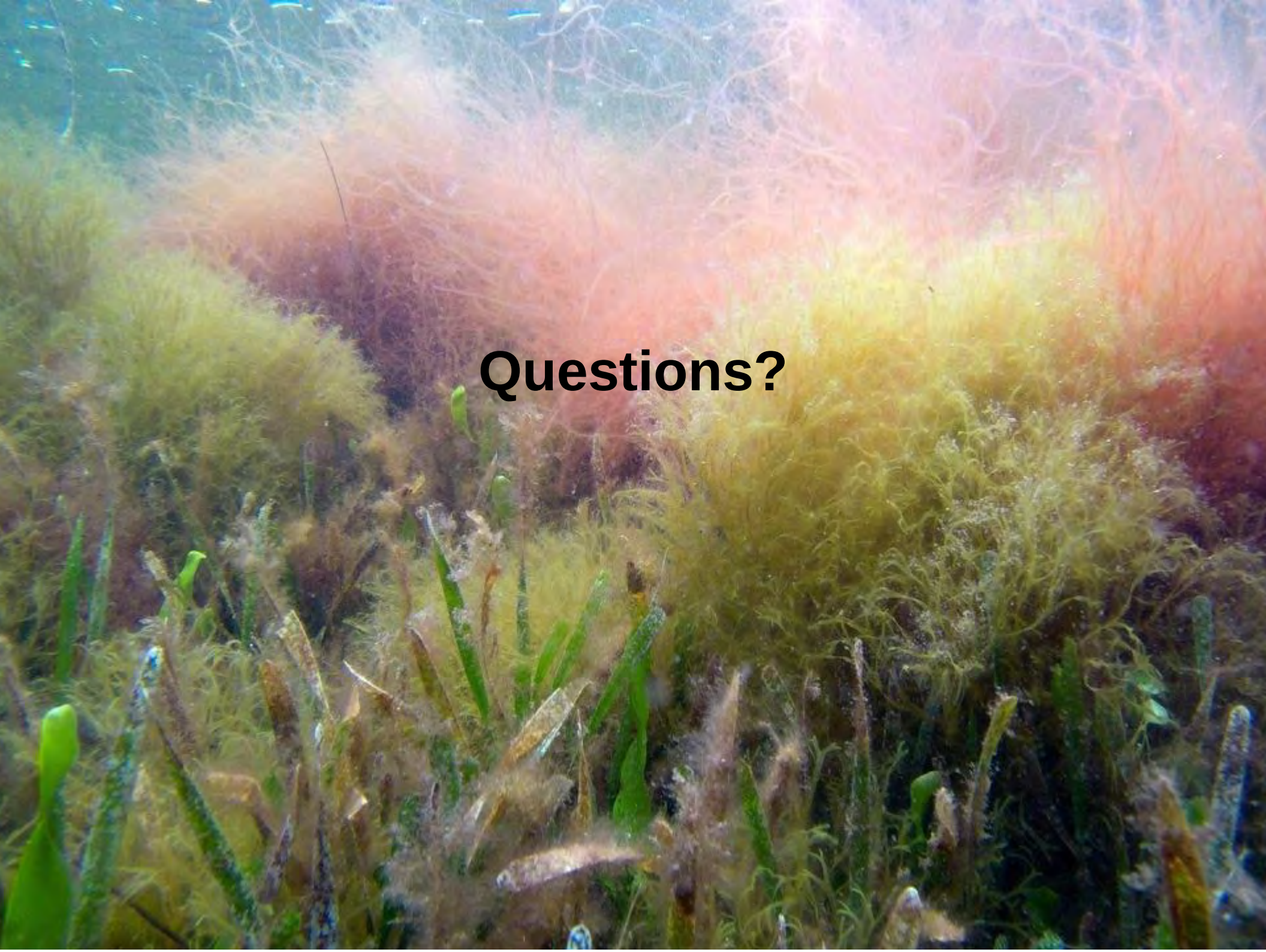
Chlorophyll *a* Composite Dec 3-6, 2013 (Hu, USF)





Moving Forward

- Septic-to-sewer programs
- Advanced Wastewater Treatment (AWT) required for IRL WWTPs
- Store and clean water North, East, and West of Lake O
- Identify N and P sources north of LO and tighten BMPs and BMAPs to reduce nutrients at the source
- Use sound science


Questions?

Point- and Non-Point Source Sewage Pollution

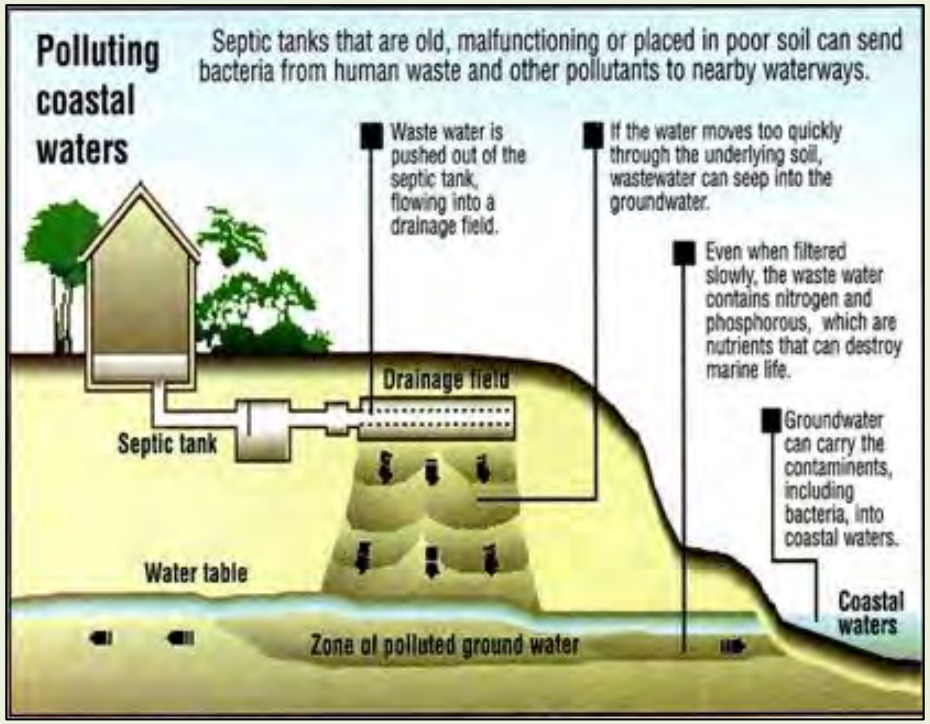
- IRL Act 1990 eliminated sewage outfalls, but not septic systems

- ~ 300,000 non-vacant septic systems exist on IRL watersheds

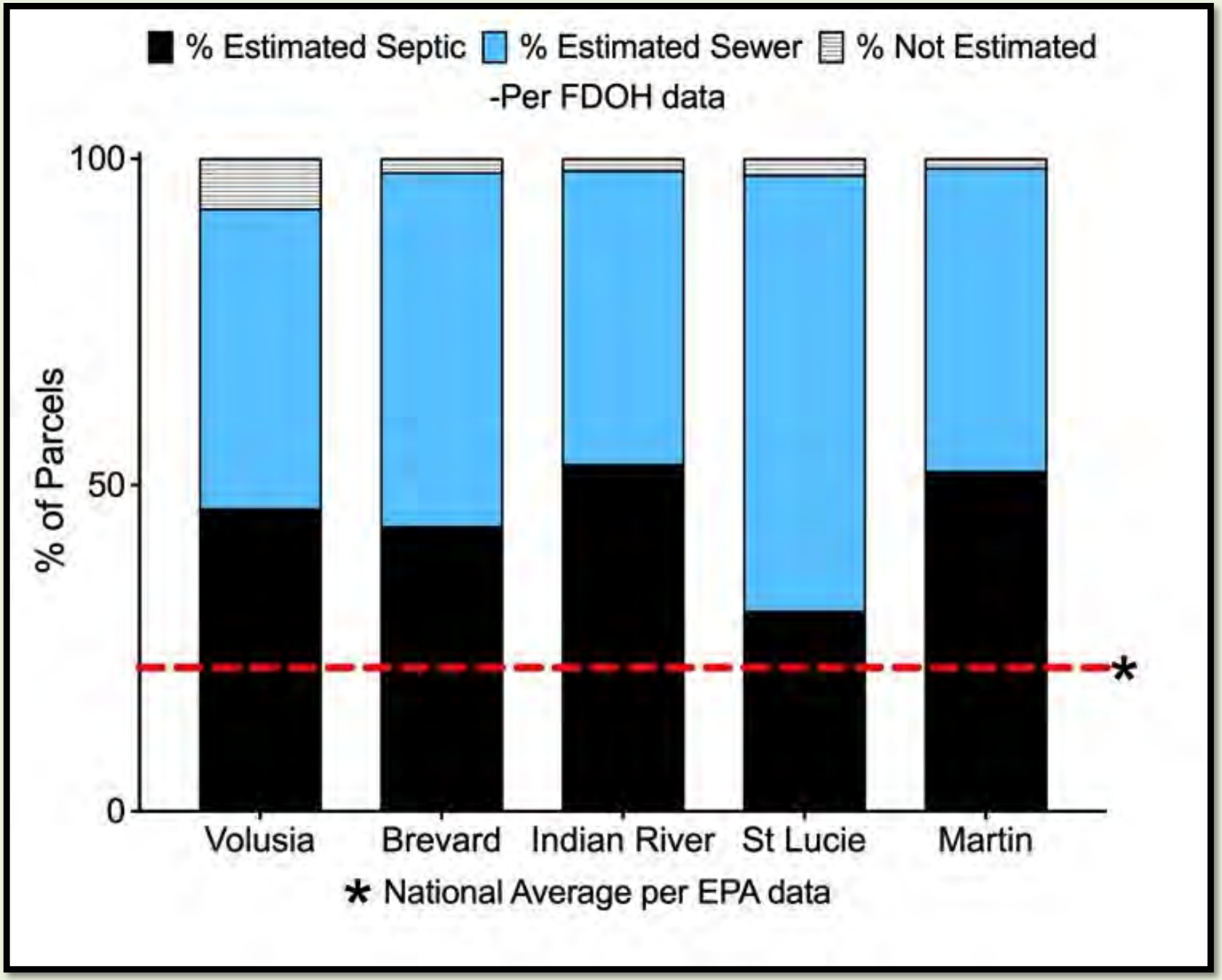
- Soils on IRL watersheds are unsuitable for septic systems, low organic content, high water tables (many do not meet FAC)

- Contaminants include nitrogen, phosphorus, OWCs (pharmaceuticals, hormones, etc.), bacteria, viruses

- Estimated septic system N-load ~ 2,575 tons N/yr (GeoHydros, 2014)



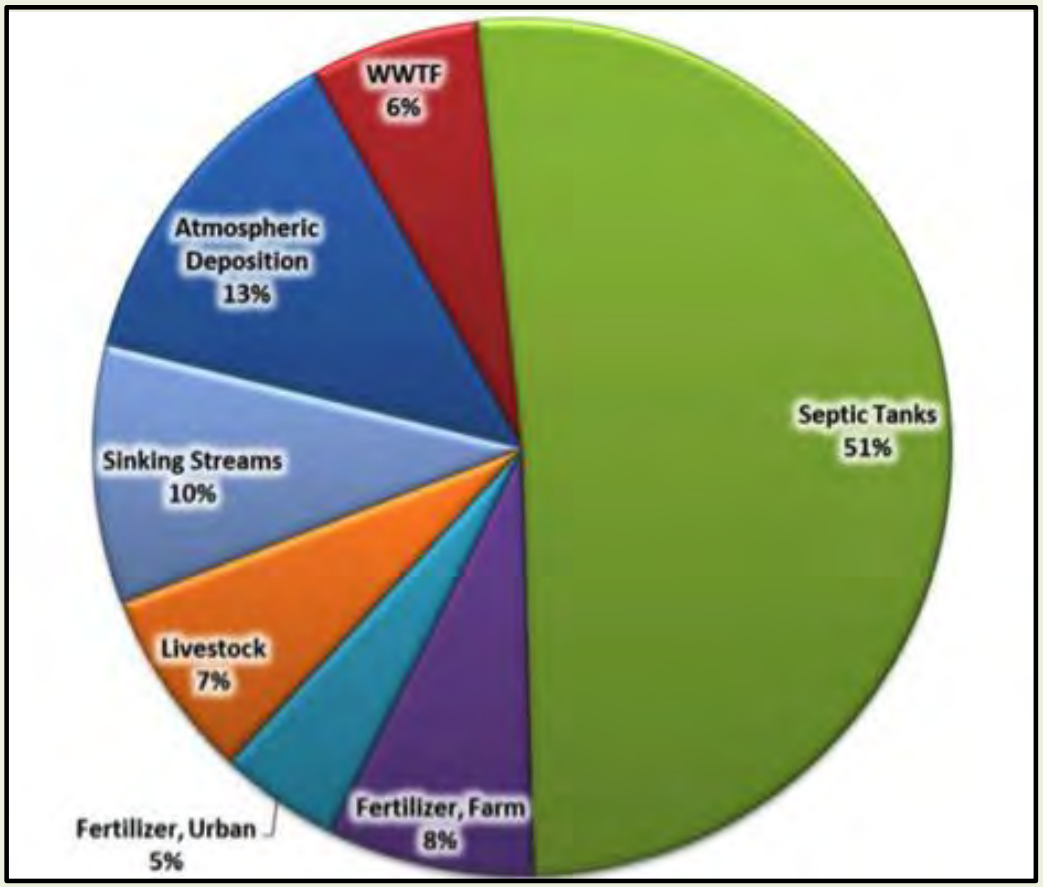
Septic vs. Sewer in the Indian River Lagoon



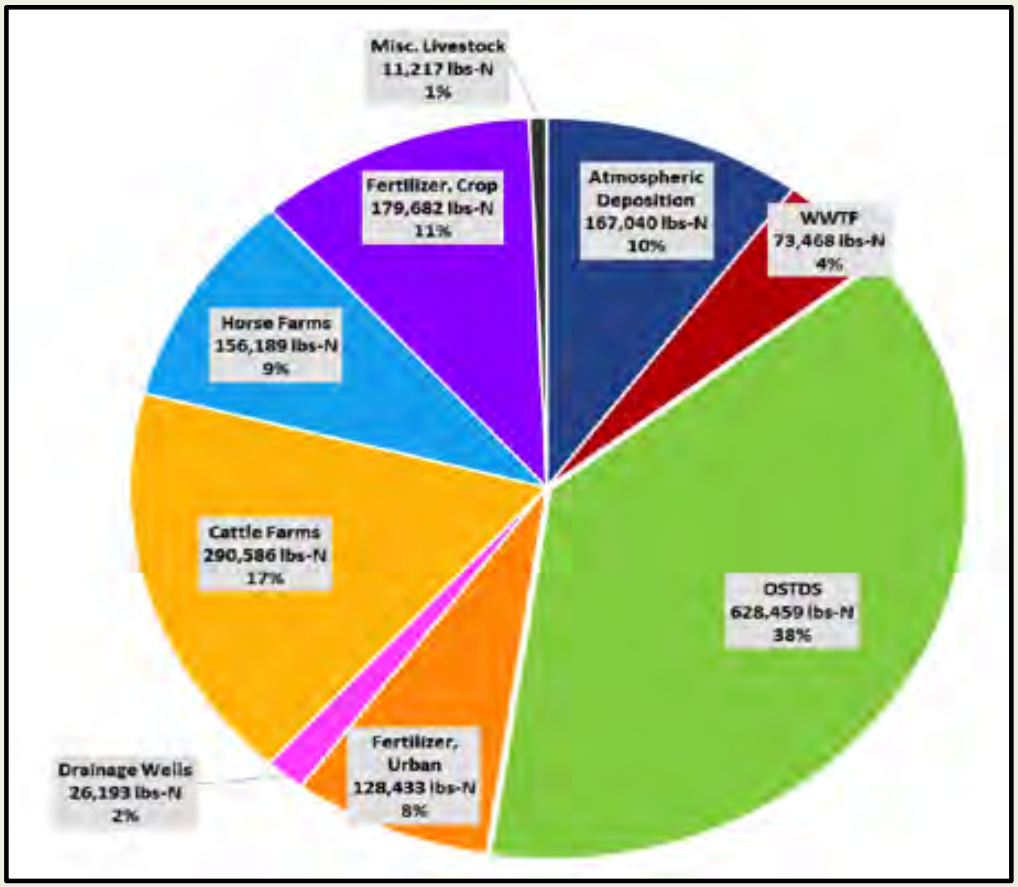
N-Loading to Florida Springs*

Recent studies in Florida's springs indicate septic systems are the major (up to 50%) source of N pollution and have been *greatly* underestimated in previous studies

Wakulla Springs



Silver Springs



*FDEP, 2015