



Water Quality Issues in the Calooshatachee Estuary and SW Florida Coastal Waters

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Darren Rumbold, Ph. D
Professor of Marine Science
Director of Coastal Watershed Institute
The Water School
Florida Gulf Coast University

Water Quality Problems

- Obvious symptoms:
 - Harmful Algal Blooms:
 - Red tide;
 - Cyanobacteria (aka blue green algae)
 - as well as other blooms
 - Mass mortality events, e.g., fish kills
 - Dark (tanic) water
 - Red drift algae washed up on beach

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- More insidious problems:
 - Macroalage overgrowing seagrasses
 - Altered salinity conditions stressing/killing flora and fauna
 - Low dissolved oxygen from blooms of bacteria decomposing organic matter (DOM and dead plankton)
 - Vibrio (flesh-eating bacteria) infections
 - Mercury pollution
 - Shelf estuarization

Cyanobacteria (aka blue green algae) blooms



Admiralty Yacht Club North Ft. Myers. Photo: News press 2018

Cyanobacteria are a major group of bacteria that occur throughout the world. **Freshwater (and brackish)** cyanobacteria may accumulate in surface water supplies as "blooms" and may concentrate on the surface as blue-green "scums."

occur widely in the temperate regions of the world, HABs in Great Lakes



An aerial shot of the Caloosahatchee's algae bloom shot by Calusa Waterkeeper John Cassani. (Photo: Calusa Waterkeeper John Cassani/special to The News-Press) 2018



ABC News
July 2016



NY Times
JULY 2016

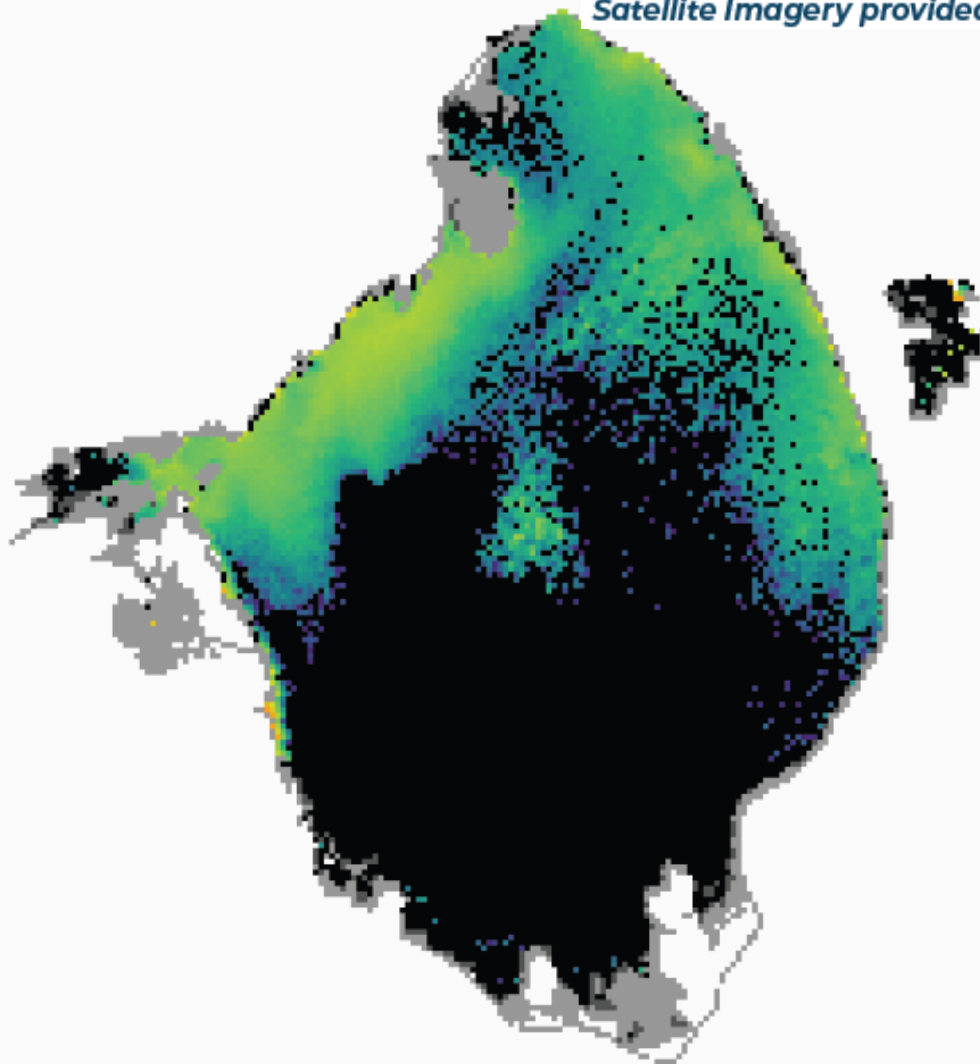


Previous blooms in Caloosahatchee and SLR in 2005, 2013, 2016, 2018 –but why only these years? Following hurricanes???

Cyanobacteria toxins

- **Microcystin-LR**: a hepatotoxin from all freshwater cyanobacteria, depending on conditions
 - toxin production varies greatly among different strains
 - light availability and temperature have been shown to affect toxin production
 - can cause nausea and vomiting if ingested and rash or hay fever symptoms if touched or inhaled. **Drinking water with the toxins can cause long-term liver disease; can aerosolize with crashing waves**
 - Can bioaccumulate
 - degrade in water through biodegradation and photolysis
- **β -N-methylamino-L-alanine (BMAA)**: neurotoxic amino acid from freshwater cyanobacteria, depending on conditions
 - implicated as a significant environmental risk in the development of neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and Amyotrophic Lateral Sclerosis (ALS).
 - **Can bioaccumulate and, in some cases, biomagnify**

Satellite Imagery provided by NOAA



Lake Okeechobee
July 30, 2019

Red tides





Source: The News-Press



> 400 stranded and dead sea turtles from Lee Collier, Charlotte and Sarasota county water

Algae bloom kills record number of manatees

By Melissa Gray and Joe Sutton, CNN

Updated 8:20 AM ET, Tue March 12, 2013



More from CNN



Police raid Korean company which claimed to have found sunken...



Battle of Amiens: Prince William, Theresa May mark offensive...

Cape Haze, Florida

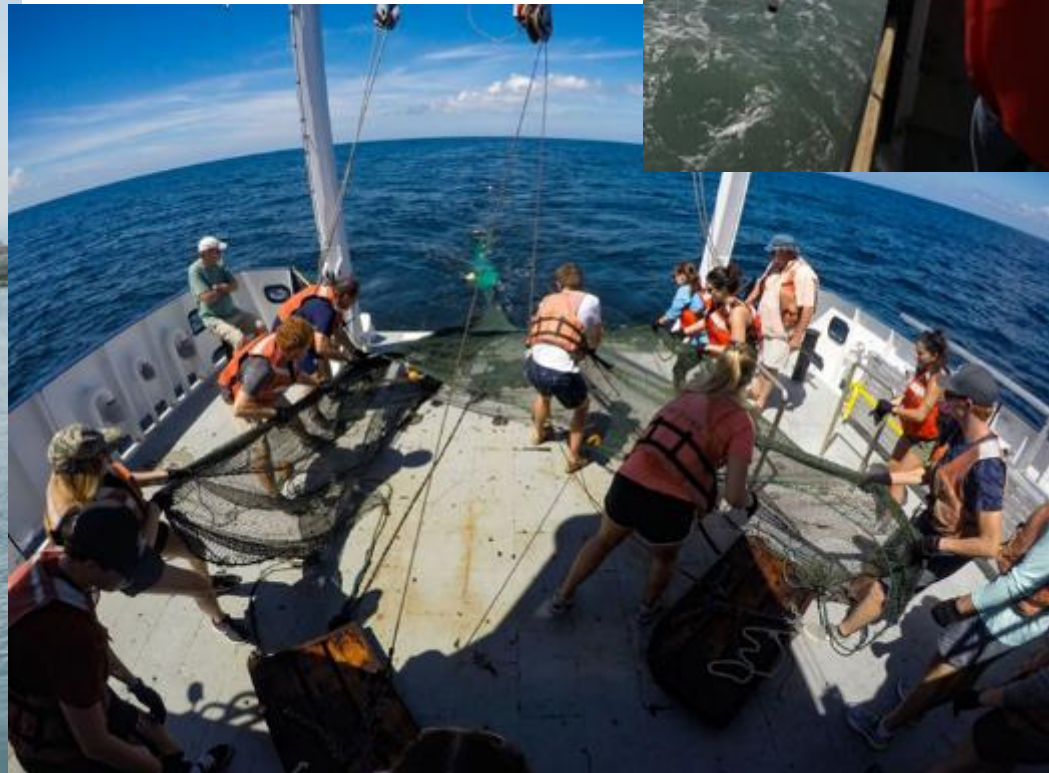
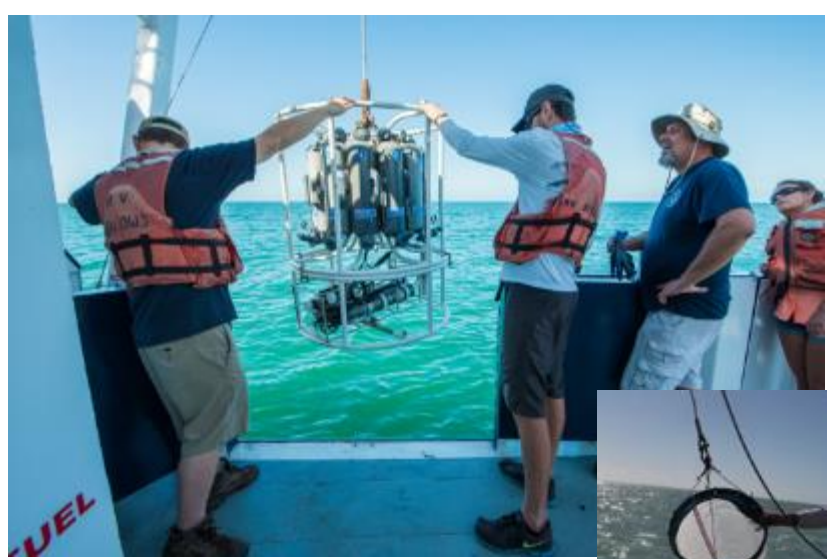
She always goes her own way, but this time she's going with dad

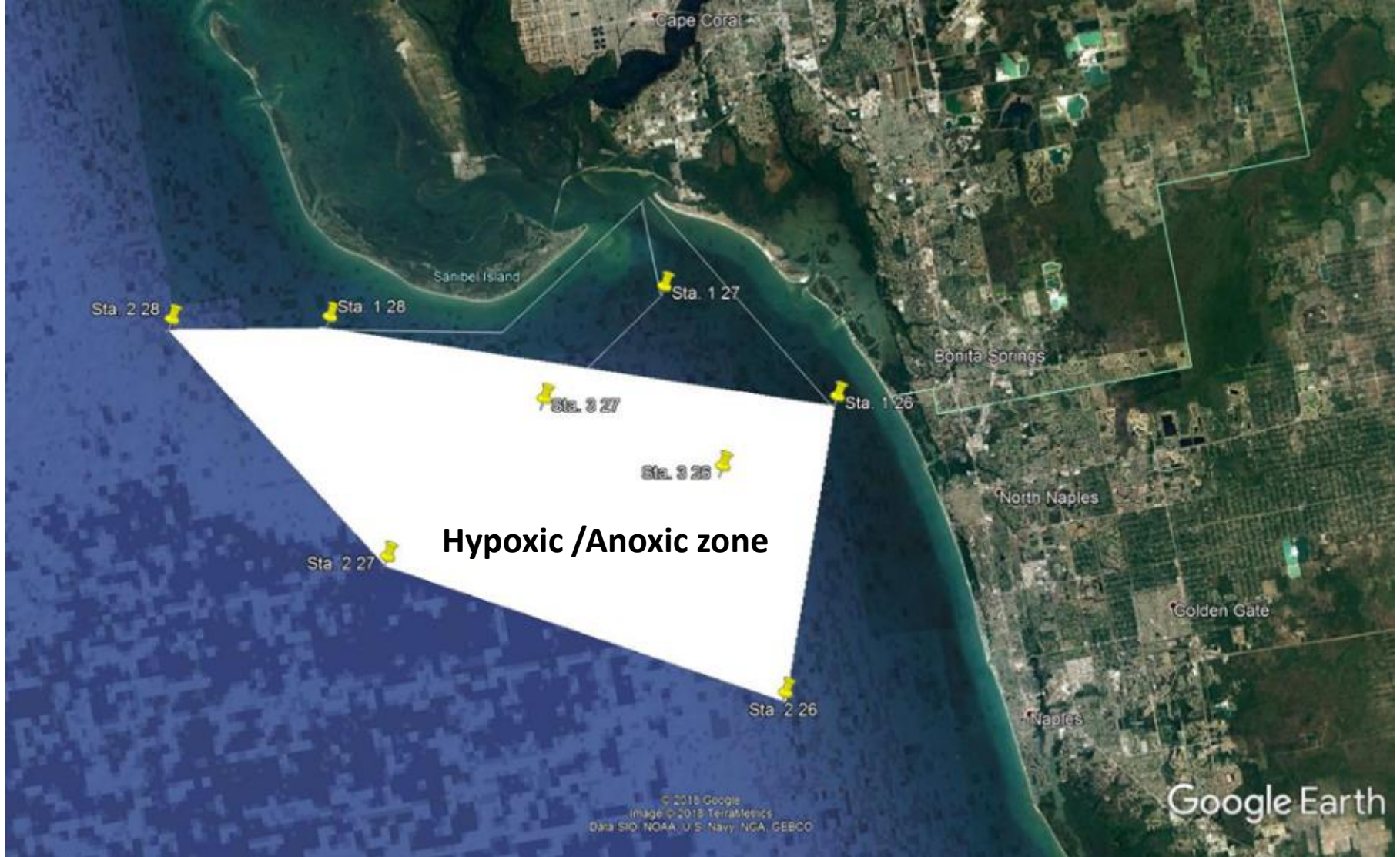


2013 Event



A dead dolphin was found washed up shore on Fort Myers Beach on Sunday 8/12/2018. Volunteers for the Florida Fish and Wildlife Conservation Commission picked it up where it was transported for a necropsy. It is unknown what killed the dolphin. A large red tide outbreak is affecting marine life and humans throughout Southwest Florida. Andrew West/The News-Press





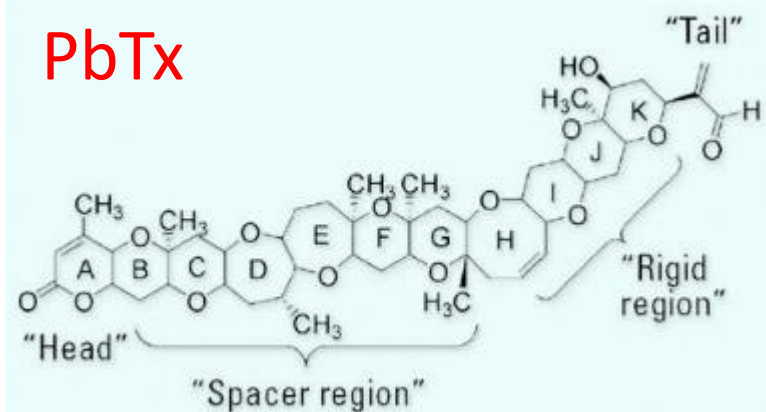
In Sept 2018, we documented a hypoxic/anoxic “dead” zone (bottom water <2 mg O₂/L) extending >500 km²; data collected by SCCF, FWC and NOAA has shown impacted area to be much larger.



Red tide

*Karenia brevis*

PbTx



- Caused by blooms of *Karenia brevis*, a single-celled, naturally occurring organism belonging to a group of algae called dinoflagellates;
- Most recent began in October 2017 and persisted with few patches lingering in Jan 2019
- **Produces brevetoxins (PbTx):** neurotoxin, hemolytic ichthyotoxins, mutagen
 - toxins are stable outside of cell and **persist in the environment: in water, sediment and as residues in tissues; up to 4-5 months in shellfish, 8 months in seagrass epiphytes**, months to >year in sediment
 - free toxins can become aerosolized and produce respiratory irritation, which is usually temporary, but serious illness can occur in people with asthma, COPD, or other respiratory diseases.
 - different forms can bioaccumulate and, then biomagnify

Difficult to definitively link **red tides** to land-derived nutrients

- Fish kills in the Gulf of Mexico similar to red tide **fish kills reported by explorers in the 1500s** with written documentation in the 1840s (Tester and Steidinger, 1997).
- **red tides often begin offshore** (18 to 74 kilometers = 11 to 46 miles)– north of Lee County waters
- **Can take advantage of many different sources of nutrients**

Source of the problem

1. Poor water management

= Quantity, Quality, Timing and Distribution (QQTD)

I. Over drainage / flashy watershed

II. Excessive nutrient inputs

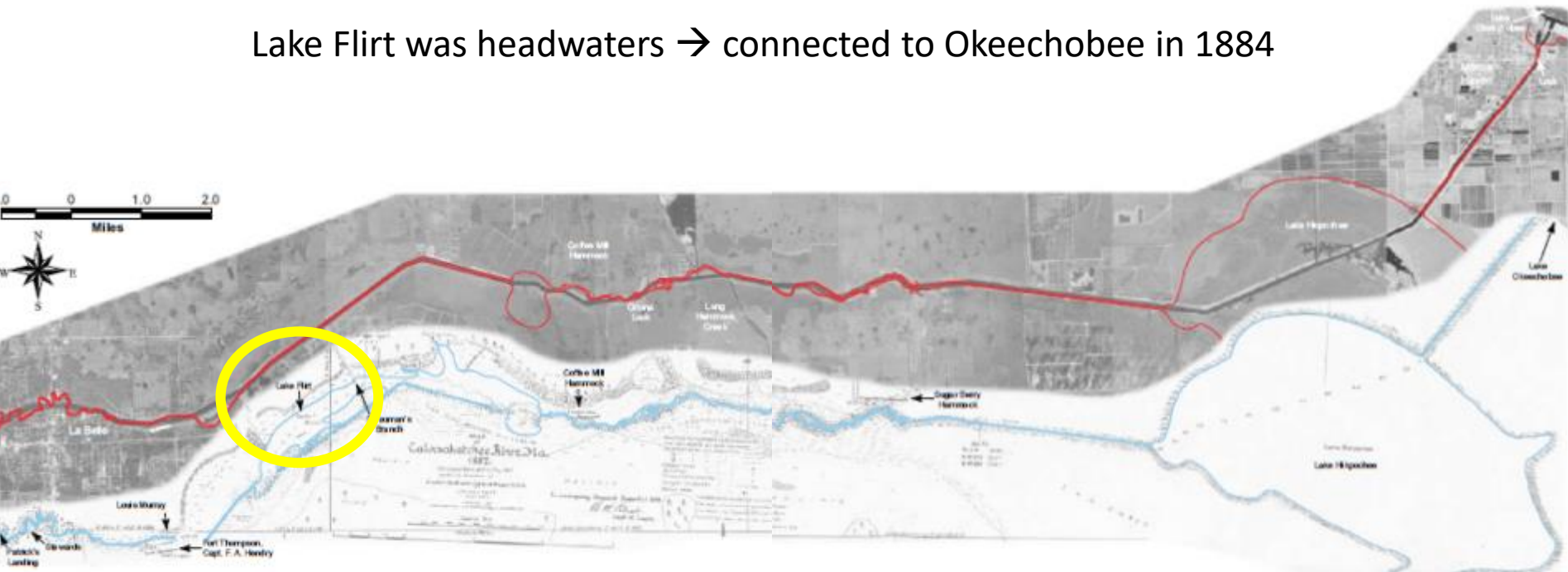
i. Agriculture and urban sources

Connection to Lake Okeechobee



Lake O

Lake Flirt was headwaters → connected to Okeechobee in 1884



Connection to
Lake Okeechobee
increased size of
the watershed
(i.e., drainage
basin)

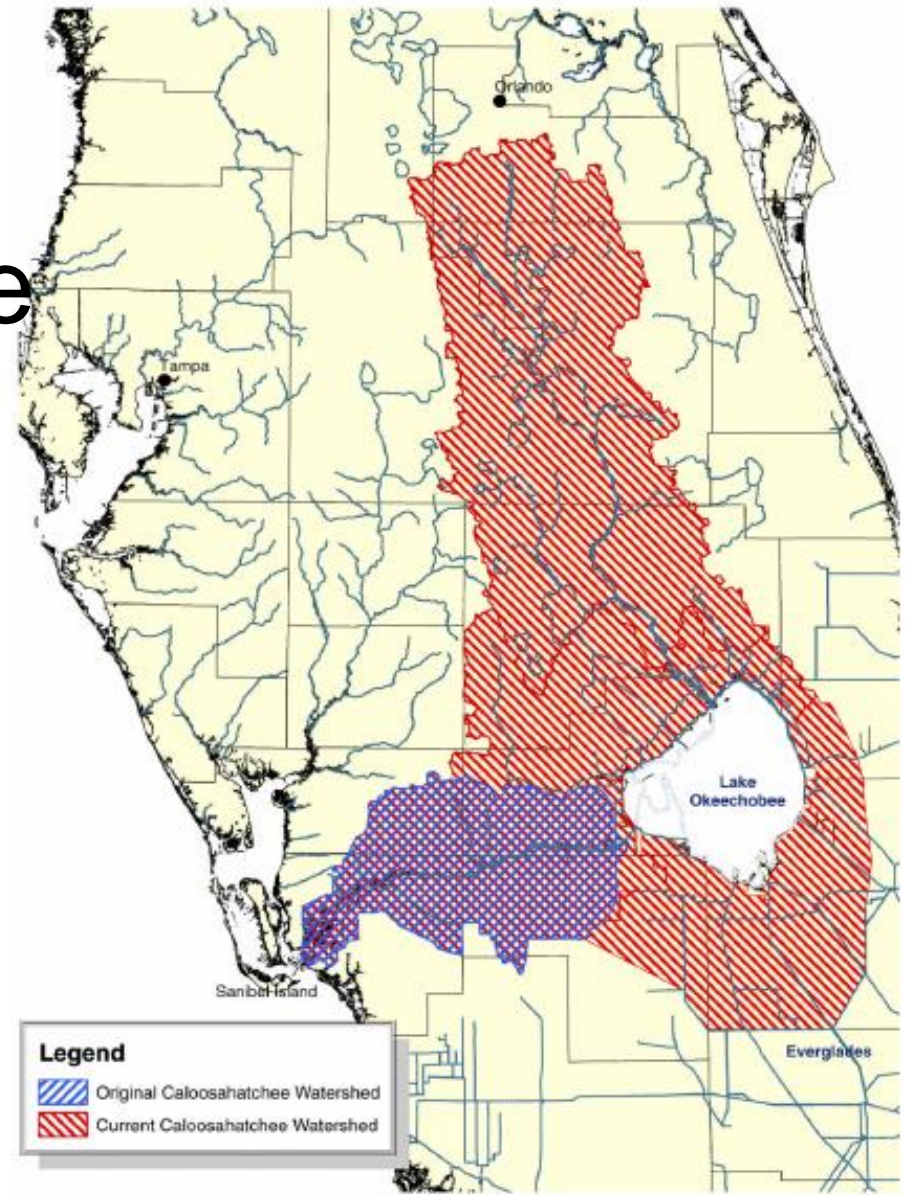


Fig. 3. Map of original Caloosahatchee River watershed and the current watershed after the connection to Lake Okeechobee was built. Data from SFWMD.

THE MARINE LABORATORY
University of Miami

54-14

Final Report

June, 1954

A PRELIMINARY SURVEY OF THE EFFECTS
OF RELEASING WATER FROM LAKE OKEECHOBEE
THROUGH THE ST. LUCIE & CALOOSAHATCHEE ESTUARIES

to

Corps of Engineers, U. S. Army

Contract No. DA-08-123-ENG-1376

by

James F. Murdock

- Concerns about the impact that water releases from Lake Okeechobee were having on the Caloosahatchee River Estuary (CRE) were voiced as early as 1954 (Murdock 1954).
- These early concerns focused mainly on altered salinity, increased color and lowered dissolved oxygen (DO)
- A follow-up survey concluded that discharges were having an adverse effect on the sport and commercial fisheries in the estuary (Gunter and Hall 1962).

Coral Gables,
Florida

ML 7745

F. G. Walton Smith
Director

Nutrient pollution in the Caloosahatchee River Estuary

- Nutrient pollution has been an concern in the Caloosahatchee River Estuary since **1980**, when the Florida Department of Environmental Regulation (FDER; currently known as the FDEP) concluded that it had reached its nutrient loading limits based on elevated chlorophyll a and depressed DO concentrations (DeGrove, 1981).
- Similarly, McPherson et al. (1990) concluded that increased nitrogen loading would result in undesirable increases in phytoplankton and benthic algae.
- Doering and Chamberlain (1998) and Janicki Environmental Inc., (2002) both found total nitrogen (TN) and total phosphorus (TP) to be elevated in the Caloosahatchee compared to statewide median concentrations, reference site concentrations and compared to historical data (for TP).
- DeGrove, B.D. 1981. Caloosahatchee River Wasteload Allocation Documentation. Florida Department of Environmental Regulation, Water Quality Tech. Ser. 2. 52 pp.

So is the Lake the problem?

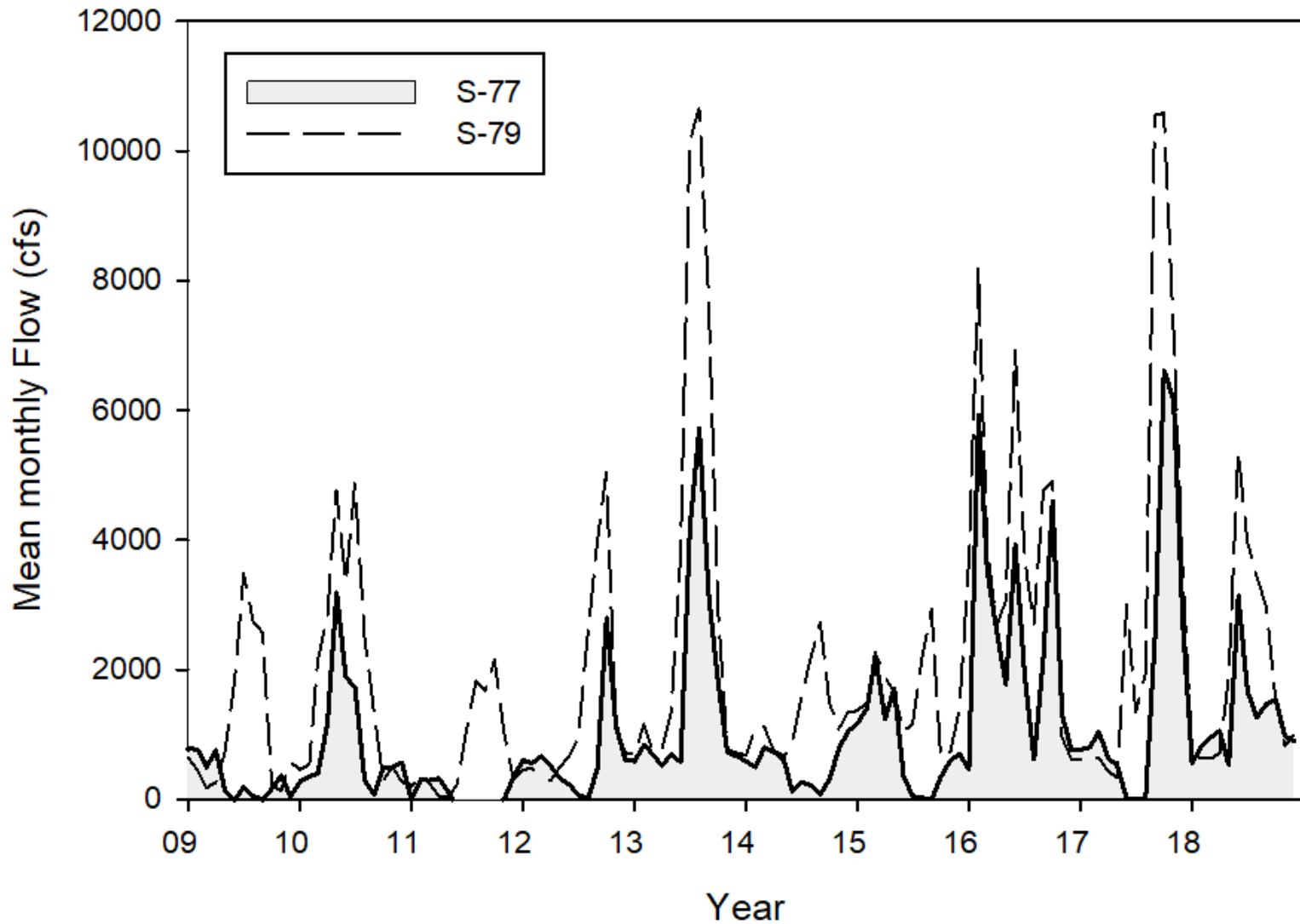
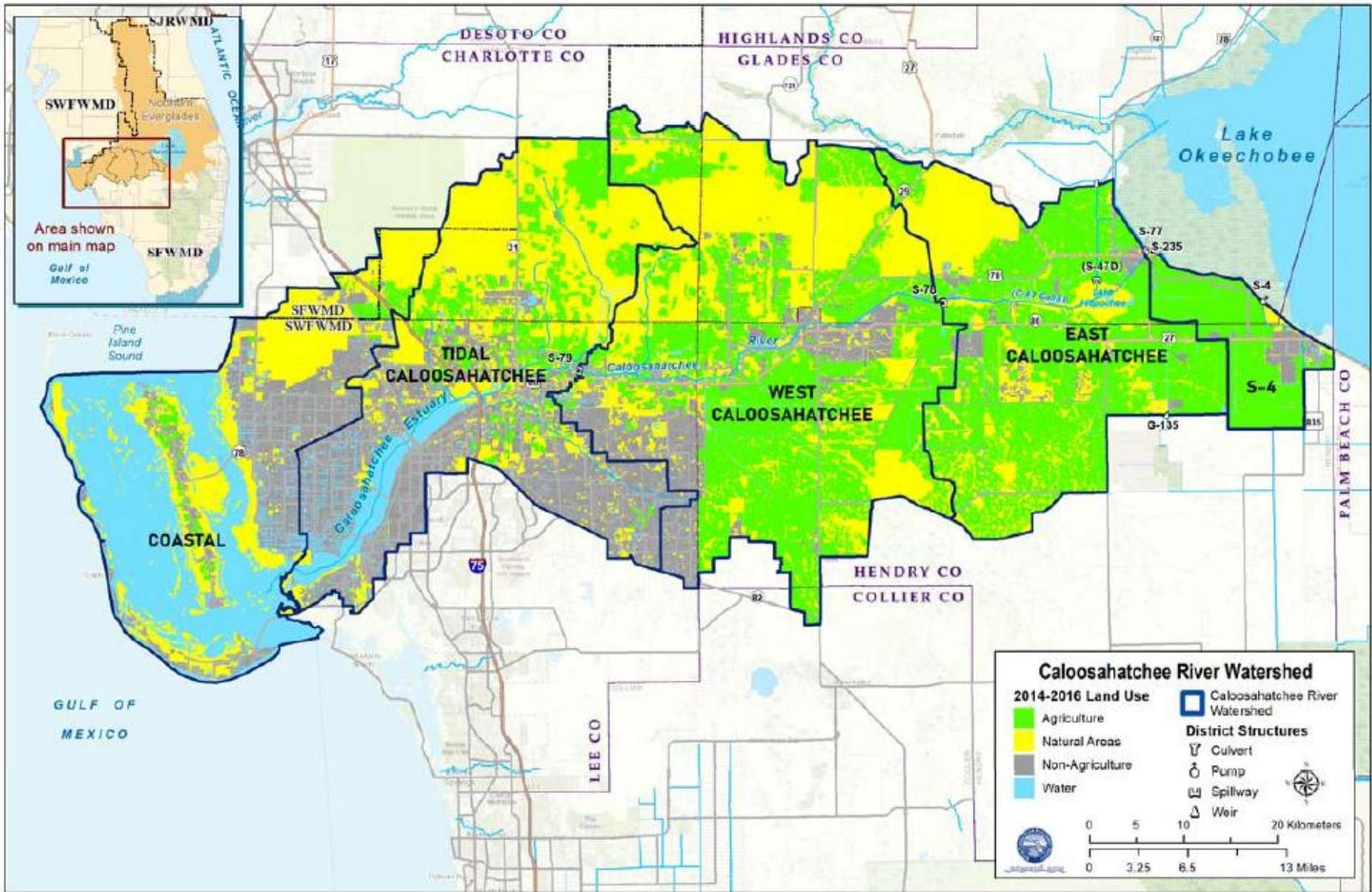


Figure 2. Mean monthly discharge (cfs) at the control structures at the outlet of Lake Okeechobee (S-77) and at the head of the Caloosahatchee River Estuary (Franklin Lock and Dam, S-79) from 2009-2018. The difference between the two curves represents flow from the C43 basin.



Source: SFWMD

Nutrient sources within the C43 and tidal basin also contribute

Caloosahatchee Water Quality Summary

5-year average (WY2014 – WY2018) of flow, nutrient loads and concentrations

	Flow (ac-ft)	P Load (metric tons)	P FWM (µg/L)	N Load (metric tons)	N FWM (mg/L)
Lake Okeechobee ^a	939,052 (38.4%)	112 (29.6%)	97	1576 (40.5%)	1.36
C-43/S-4 Basin	1,080,623 (44.1%)	220 (58.0%)	165	1797 (46.1%)	1.35
Tidal Basins	427,405 (17.5%)	47 (12.4%)	89	523 (13.4%)	0.92
Caloosahatchee Watershed	2,447,079	379	126	3,896	1.29

^a Lake Okeechobee Pass Through to the Estuary

- Highest flows and nutrient loads to the Caloosahatchee estuary are from the C-43/S-4 Basin
- Tidal basin has the lowest volumes and nutrient loads
- Similar nitrogen concentrations are observed for Lake Okeechobee and the C-43 Basin
- Phosphorus concentrations from the C-43 Basin are approximately two times higher than for the Lake and Tidal Basin

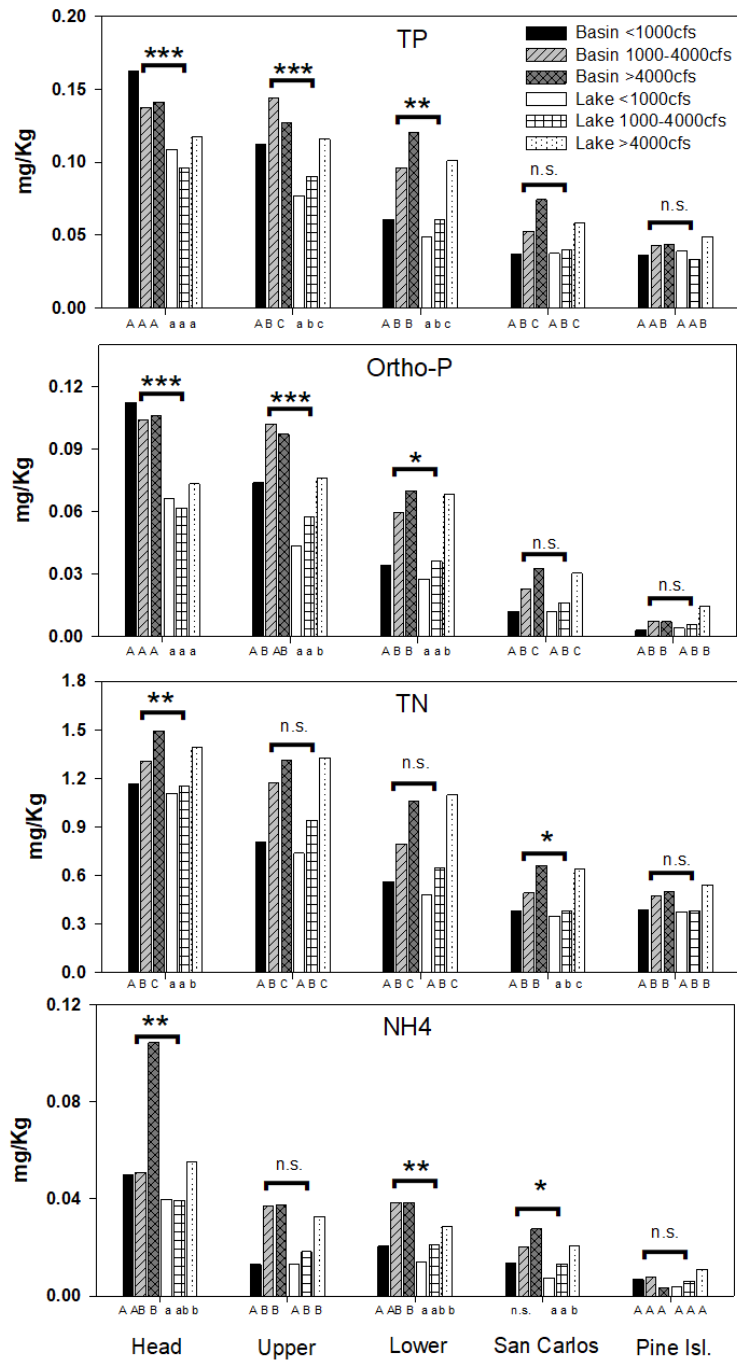


Figure 3. Median values of nutrients in different regions of the estuary as a function of source water (lake vs. basin) and discharge rate. Asterisks indicate significances due to source (* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$). Different letters and upper/lower cases indicate significant differences ($p < 0.05$) in concentration as a result of different discharge rates.

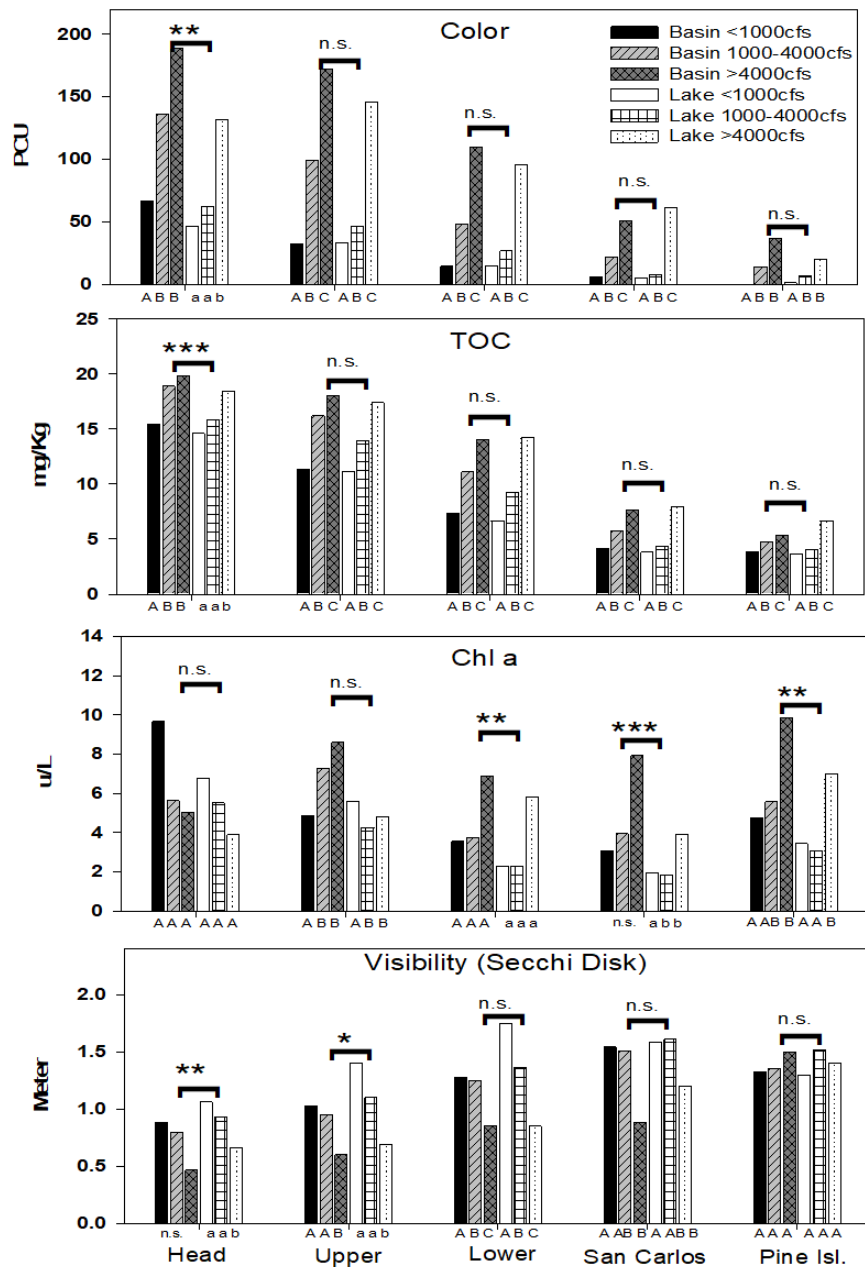


Figure 4. Median values of parameters related to light penetration in different regions of the estuary as a function of source water (lake vs. basin) and discharge rate. Asterisks indicate significances due to source (* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$). Different letters and upper/lower cases indicate significant differences ($p < 0.05$) in concentration as a result of different discharge rates.

Solutions



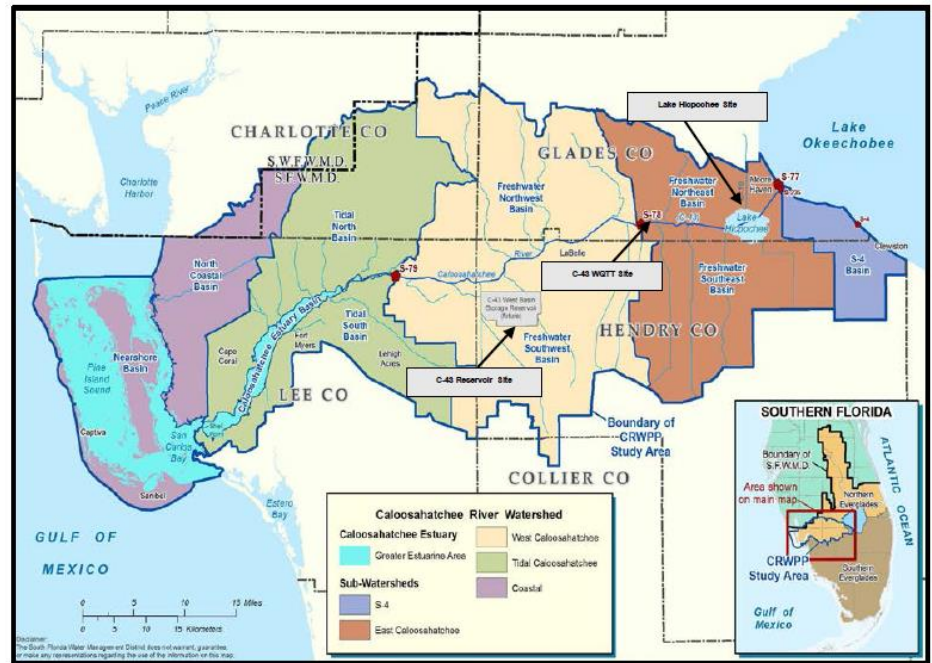
Caloosahatchee River Watershed Protection Plan

June 25, 2008



Caloosahatchee River Watershed Construction Project Activity

- C-43 West Basin Storage Reservoir
- C-43 Water Quality Treatment and Demonstration Project – BOMA
- Improvements to the BOMA property
- West Lake Hicpochee



Site Locations for District Projects within the Caloosahatchee River Watershed Protection Program Boundary

Completion dates -- 2022



Executive Order 19-12

Highlights

- **\$2.5 Billion to Everglades restoration** and protection of water resources
- Appoint **Chief Science Officer**
 - Prioritize scientific data, research, monitoring, and analysis needs to address Florida's environmental concerns
- Create **Office of Environmental Accountability and Transparency**
 - Align scientific research and analysis with key environmental priorities
- Establish **Blue-Green Algae Task Force**
 - Lead progress toward reducing impacts of blooms
- Add stormwater treatment to **C-43 Reservoir**
 - Provide additional treatment
 - Improve quality of water leaving storage component



C-43 Reservoir

Water Quality Feasibility Study

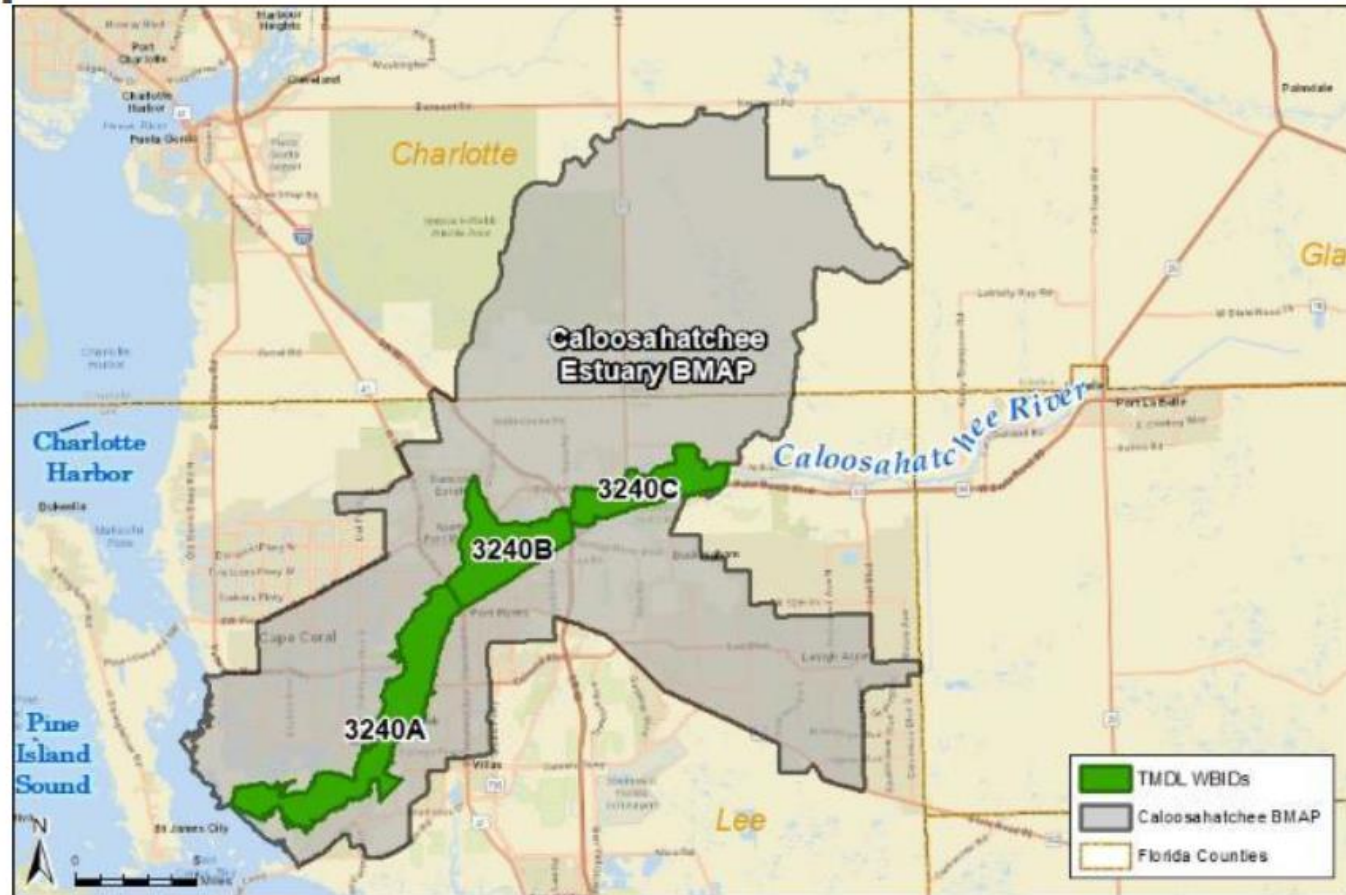
- Identifying Opportunities to provide additional treatment and improve the water quality leaving the C-43 Reservoir project is the Primary Objective
- Evaluate Treatment Options Including:
 - ✓ Pre-treatment (Prior To Entering Reservoir)
 - ✓ In-reservoir treatment
 - ✓ Post Storage treatment
- The Goal of the Study is to Identify at a Minimum Three Alternatives that are:
 - ✓ Cost-effective and technically feasible
 - ✓ Use conventional and/or innovative treatment methods
 - ✓ Consider biological, chemical and physical water quality treatment technologies
 - ✓ Scalable and “available” for long term
 - ✓ Compatible with the objectives of the C-43 Reservoir Project



Caloosahatchee Estuary Total Daily Maximum Load (TMDL)

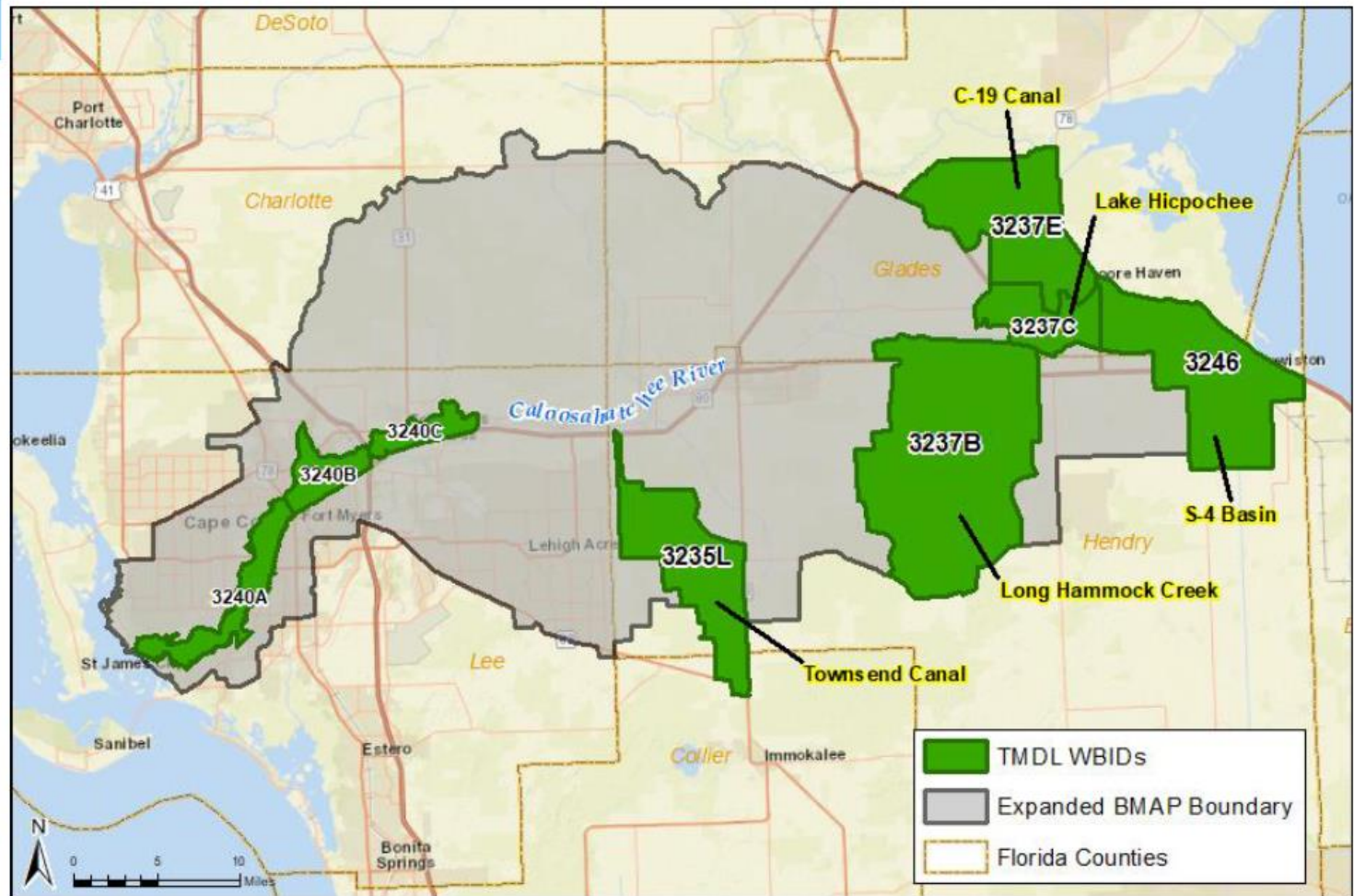
- TMDL adopted in 2009

- 3 WBIDs in the estuary
- 23% reduction in TN





Caloosahatchee Watershed TMDLs

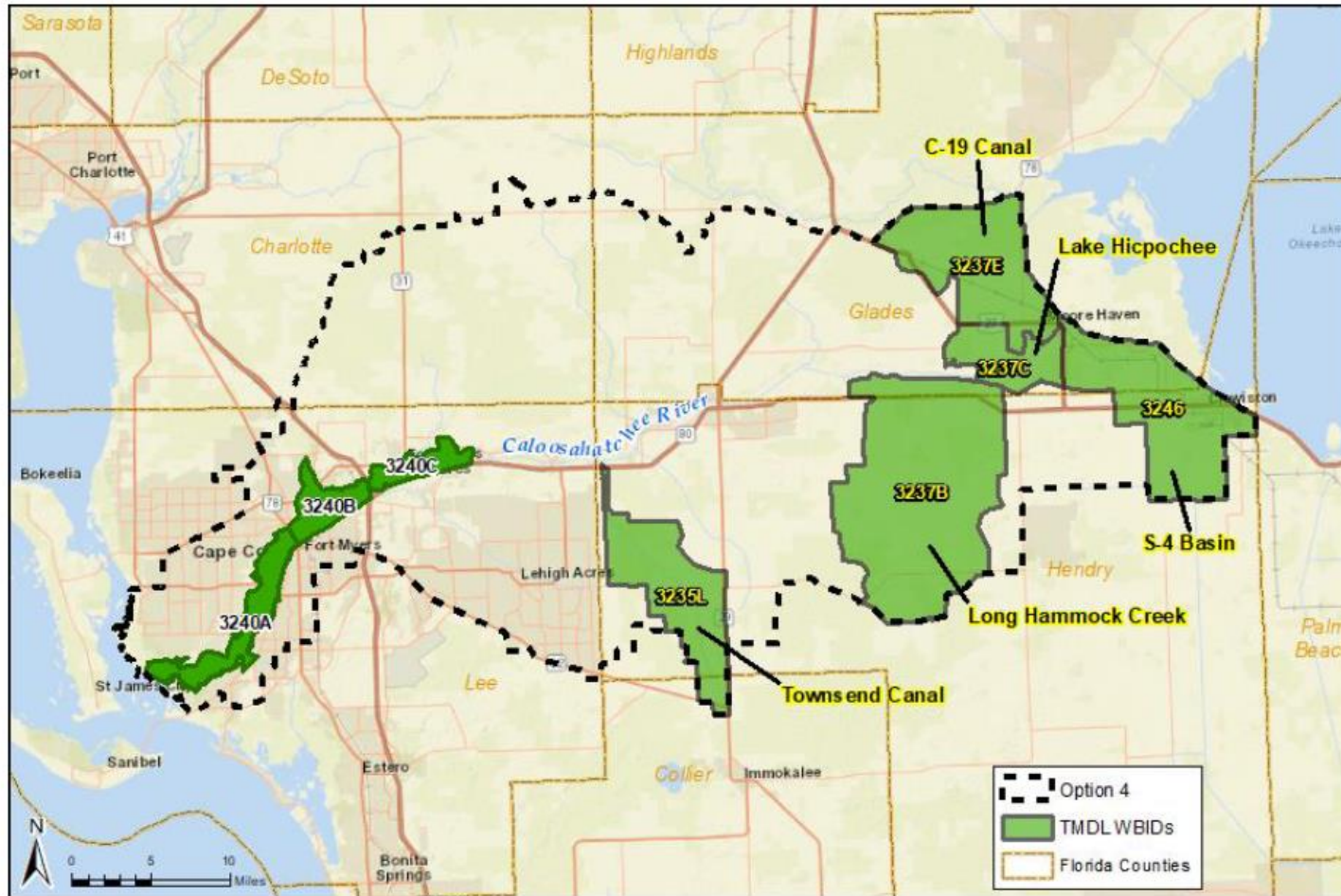


- Estuary TMDL (TN) - 2009
- Tributary TMDL (TN, TP, BOD) - 2019



Modeling and Allocations

BMAP Boundary Expansion



Option 4 – Expand to Lake Okeechobee

DeSantis signs red tide research bill at Mote Marine Laboratory



Image Gallery



By Aaron Mesmer, FOX 13 News

Posted Jun 20 2019 05:29PM EDT
Updated Jun 20 2019 05:54PM EDT

"The bill provides \$18 million over the next six years to develop, test and implement innovative, effective and environmentally sustainable technologies and approaches for controlling and mitigating the impacts of red tide," DeSantis said.

Quick fixes

- Copper sulfate to kill the red tide (done before in 1957 crop-dusting planes dusted 16 mi²)
- Disperse clay mineral over the ocean surface, which binds with red tide cells and the toxins they produce and carries them to the seafloor
- Seed areas affected with BG with other types of bacteria to compete for nutrients
- Use viruses as a new way to combat toxic BGs
- Mote Marine Lab's Ozone treatment – 300 gpm
- Hydrogen peroxide treatment --lakes
- use “dissolved air floatation” after adding polymer to bind the algae cells then skim BG after they have floated to the surface (supposedly can treat 100 million gallons a day)
- algae-sucking vacuum cleaner
- nano-bubble technology, which uses extremely small cleansing bubbles
- Polymer foam that soaks up oil, nutrients and toxins?

Take home Message

- There are many interlinked WQ problems in South Florida.
- attempting to manage each independently could exacerbate these problems
- We have delayed addressing the fundamental problems for decades but now appear ready to implement “Quick fixes” ASAP
- Caution is advised --beware of unintended consequences or we may become “**Intoxicated with our solution**”

Questions?