



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

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Presentation Outline

1. The problem
2. Source of the problem
3. Solutions
 - Quick fixes

Water Quality Problems

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

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 - Low dissolved oxygen from blooms of bacteria decomposing organic matter (DOM and dead plankton)
 - Vibrio (flesh-eating bacteria) infections
 - 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



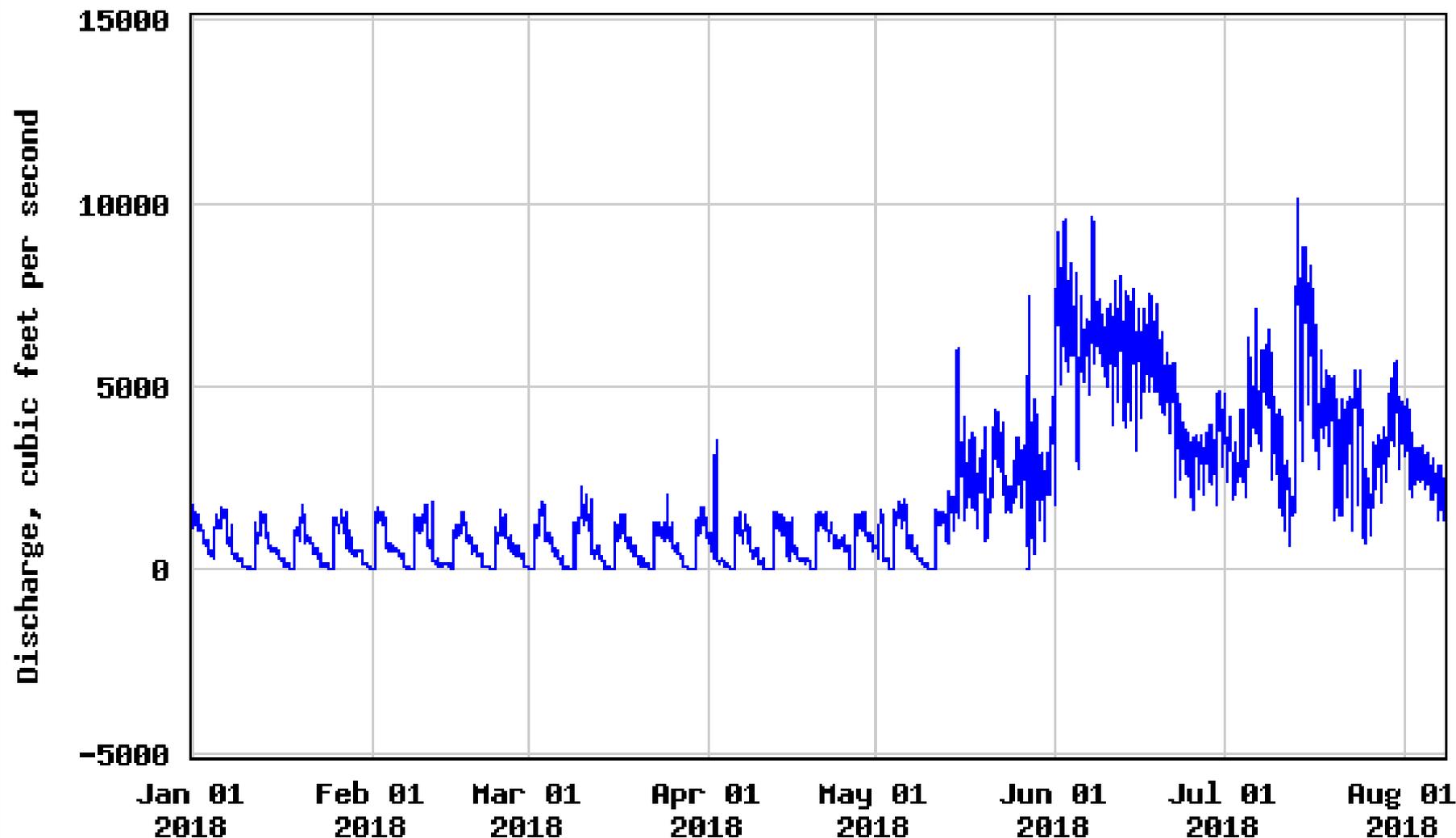
The “bloom” was noticed as early as June 18, 2018 and had significantly expanded by June 22nd.

The Florida Department of Environmental Protection (FDEP) sampled for cyanotoxins in the Caloosahatchee River on June 18 and again during June 23-27 at various locations and reported microcystin results on June 28, varying from 3.3 ug/l at Moorehaven to 463 ug/l at the Franklin Lock.





USGS 02292900 CALOOSA HATCHEE RIVER AT S-79, NR. OLGA, FLA



---- Provisional Data Subject to Revision ----



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 bioaccumulate
 - degrade in water through biodegradation and photolysis
- **β -N-methylamino-L-alanine (BMMA)**: neurotoxic amino acid from all 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

Red tides





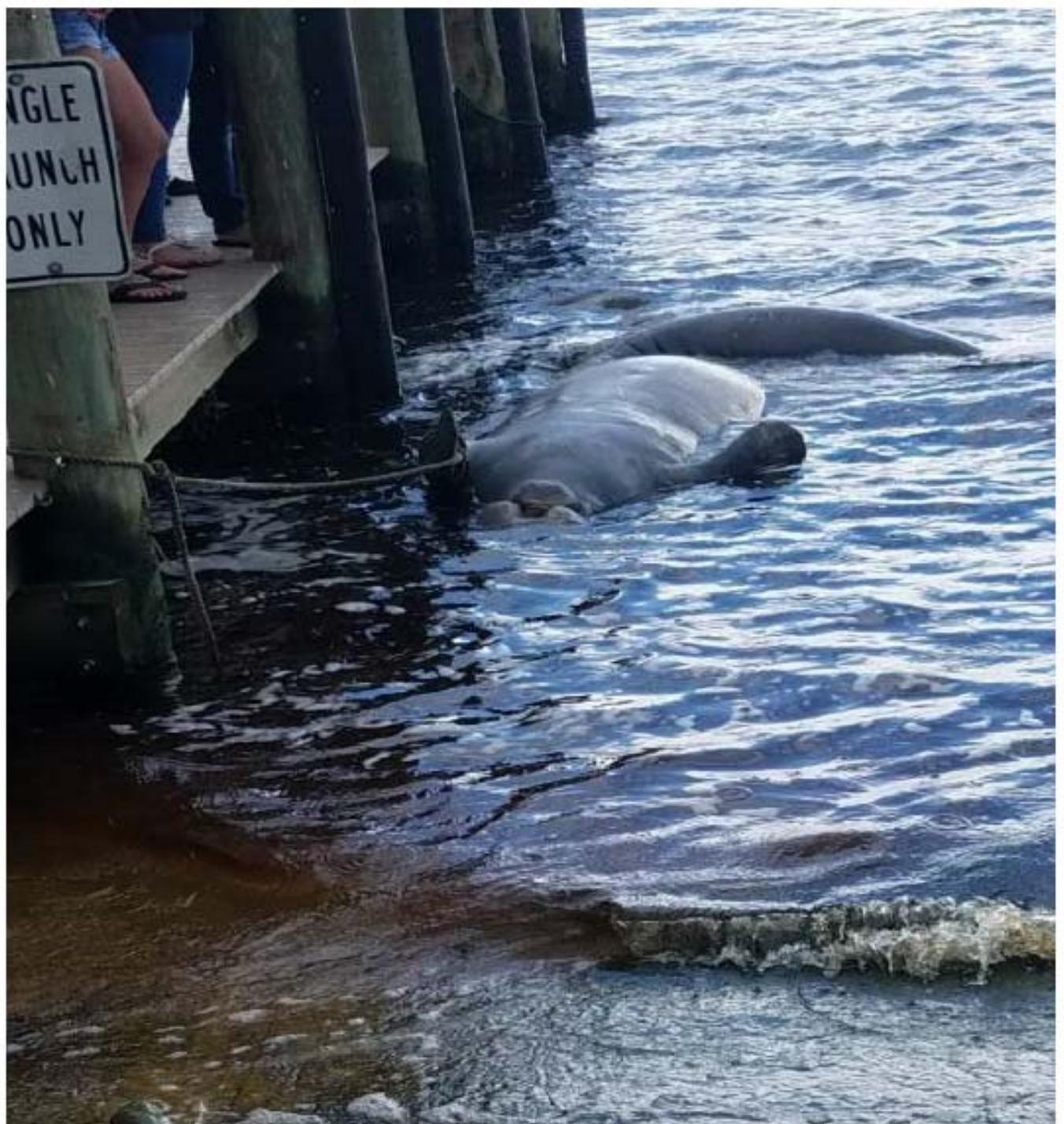


Source: The News-Press



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

Three
dead
manatees
being
collected
by FWC.
Photo
SCCF



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

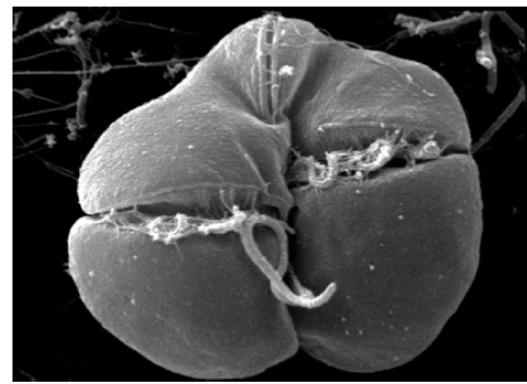
She always goes her own way, but this time she's going with dad

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

Red tides



- Causes by blooms of *Karenia brevis*, a single-celled, naturally occurring organism belonging to a group of algae called dinoflagellates; **does not do well in low salinity**
- naturally produces a neurotoxin, brevetoxin (BTXs)
 - 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.
 - can bioaccumulate and, ingestion of shellfish can lead to neurotoxic shellfish poisoning (NSP)



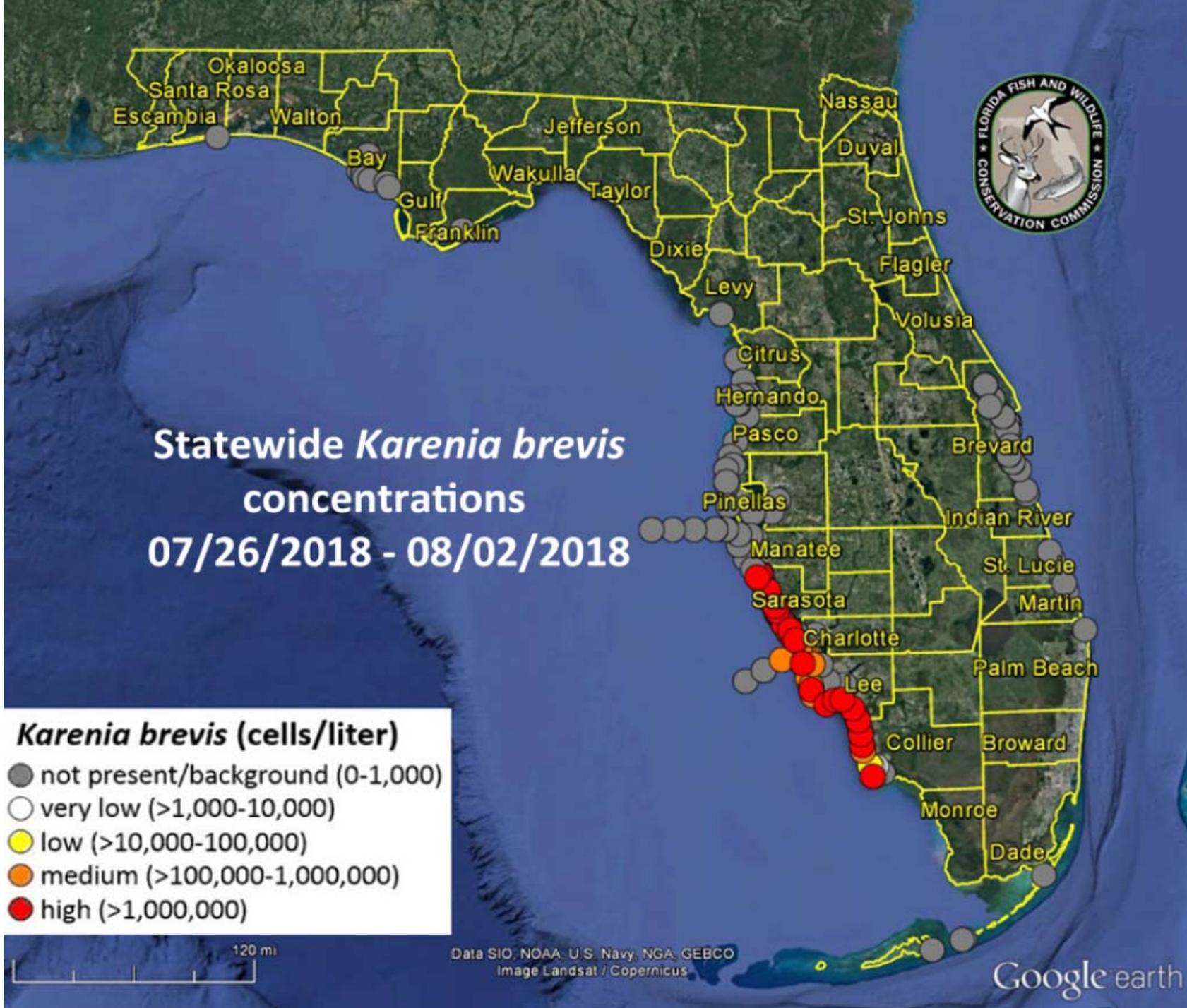
Statewide *Karenia brevis* concentrations 07/26/2018 - 08/02/2018

- Karenia brevis* (cells/liter)**
- not present/background (0-1,000)
 - very low (>1,000-10,000)
 - low (>10,000-100,000)
 - medium (>100,000-1,000,000)
 - high (>1,000,000)



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat / Copernicus

Google earth



Cell Counts

- An SCCF sample on 7/27/18 from the gulf side of Sanibel had 20 million cells/L
- Collier County sample had 28 million cells/L



2 liter bottle



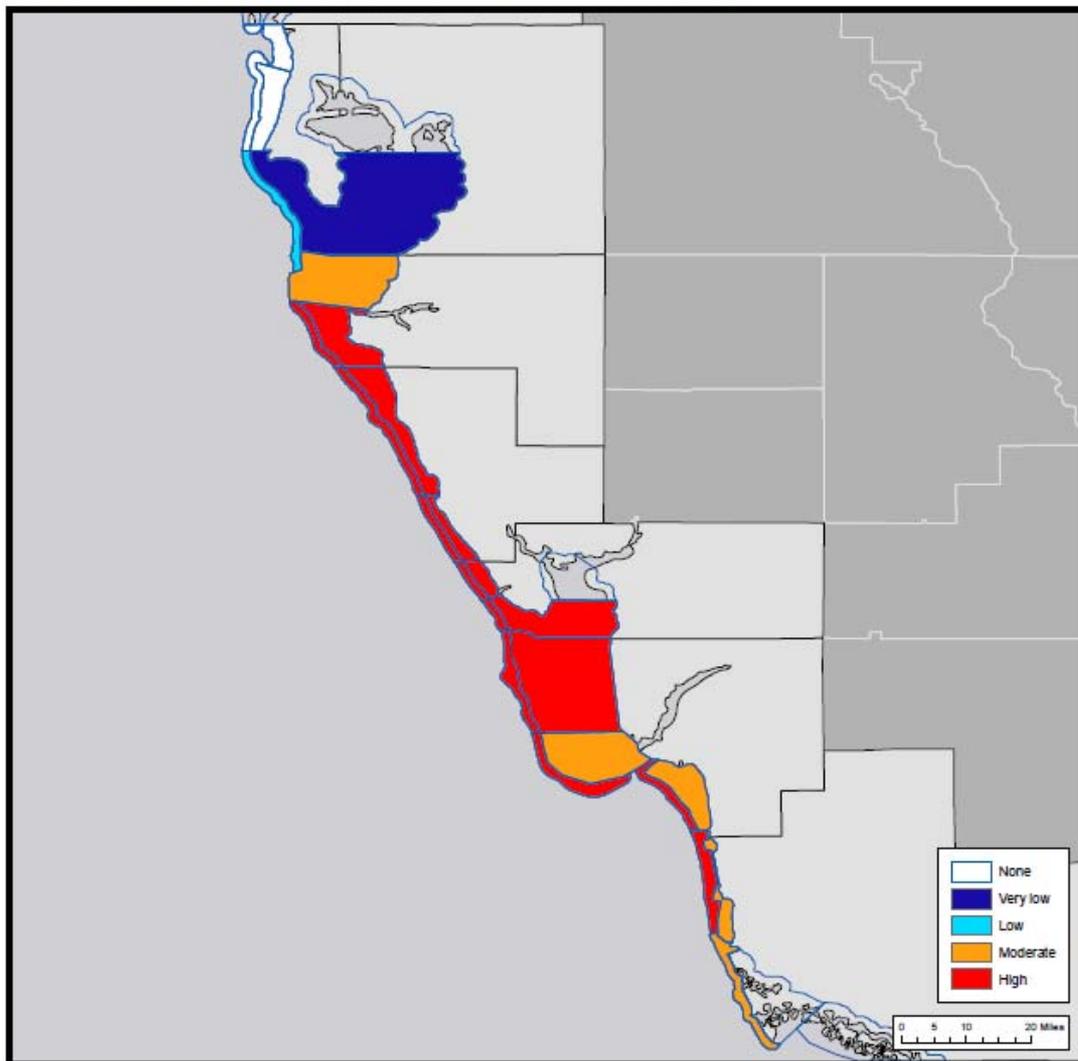
Gulf of Mexico Harmful Algal Bloom Bulletin

Monday, August 20, 2018
 NOAA National Ocean Service
 NOAA Satellite and Information Service
 NOAA National Weather Service

Region: Southwest Florida



Instructions for viewing this geospatial pdf are available at: <https://go.usa.gov/xn9g2>.



In the map above, the highest level of potential respiratory irritation forecast is displayed as a layer for each day from 08-20-18 to 08-23-18. See next page for a table of the respiratory irritation forecasts.

Conditions Report

Not present to high concentrations of *Karenia brevis* (commonly known as red tide) are present along- and offshore portions of southwest Florida, and not present in the Florida Keys. *K. brevis* concentrations are patchy in nature and levels of respiratory irritation will vary locally based upon nearby bloom concentrations, ocean currents, and wind speed and direction.

Recently Reported Impacts (Listed by County):

Respiratory irritation: Manatee, Sarasota, Lee, and Collier
Dead fish: Manatee, Sarasota, Charlotte, Lee, and Collier

Definition of respiratory irritation levels.

RESPIRATORY IRRITATION LEVEL	AFFECTED POPULATION				
	NONE	CHRONIC RESPIRATORY CONDITION	SENSITIVE TO RED TIDE	GENERAL PUBLIC (MILD SYMPTOMS)	GENERAL PUBLIC (INTENSE SYMPTOMS)
None	X				
Very low		X			
Low		X	X		
Moderate		X	X	X	
High		X	X	X	X

Additional Resources

Health Information:

Florida Department of Health:
<http://www.floridahealth.gov/environmental-health/aquatic-toxins/red-tide.html>
Other resources: <https://go.usa.gov/xQNWp>

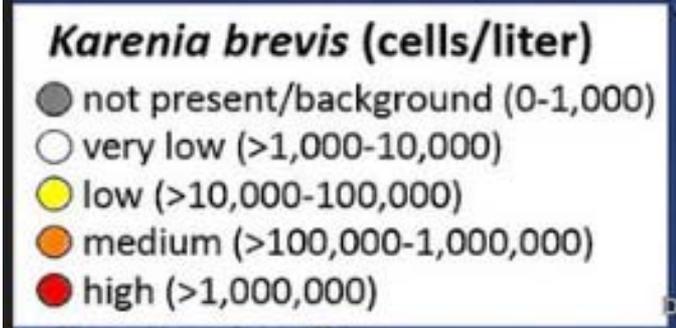
Recent, Local Observations and Data:

Mote Marine Laboratory Daily Beach Conditions:
<http://visitbeaches.org>
Florida Fish and Wildlife Conservation Commission:
<http://myfwc.com/redtidestatus>

This red tide event started back in October 2017

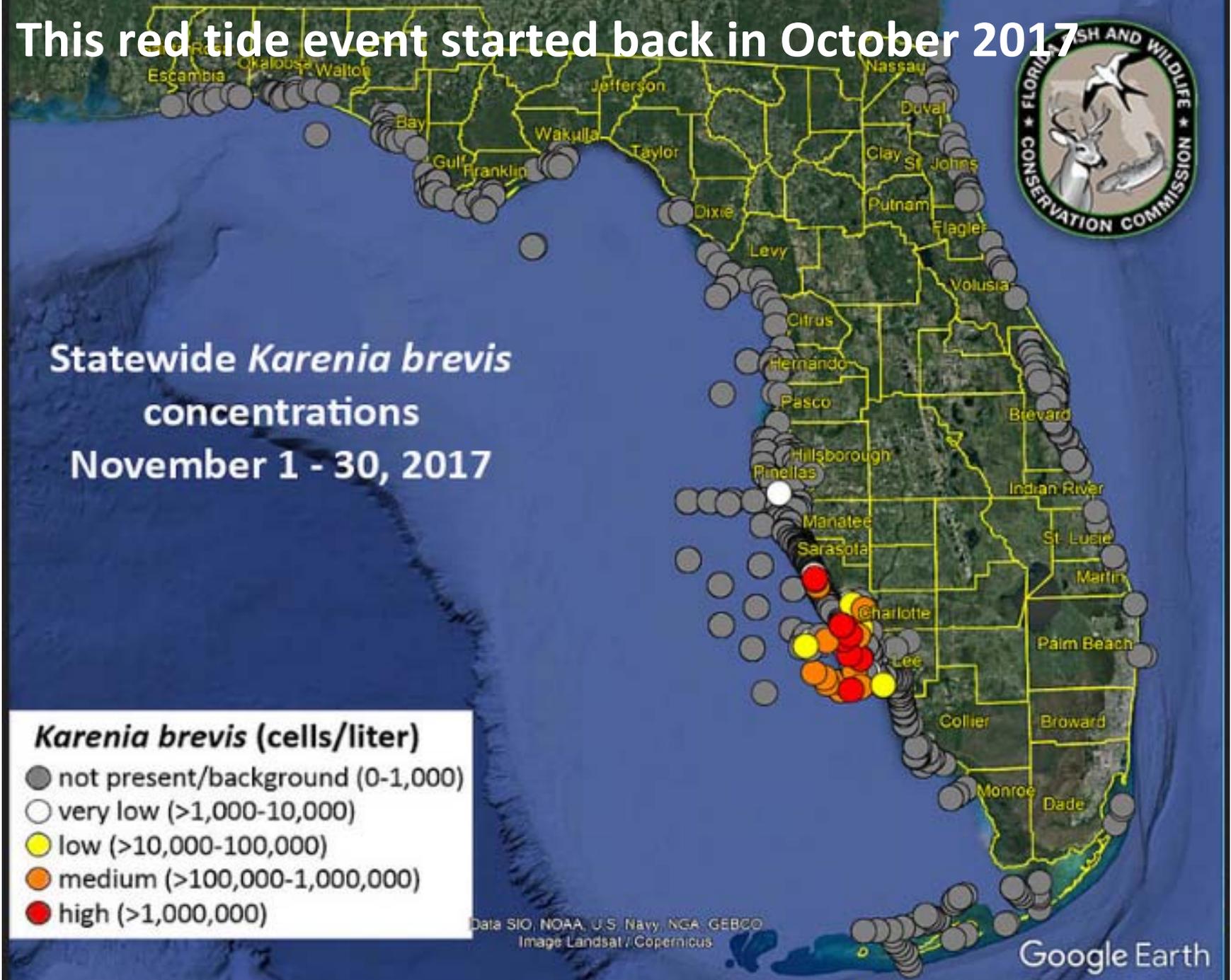


Statewide *Karenia brevis* concentrations November 1 - 30, 2017

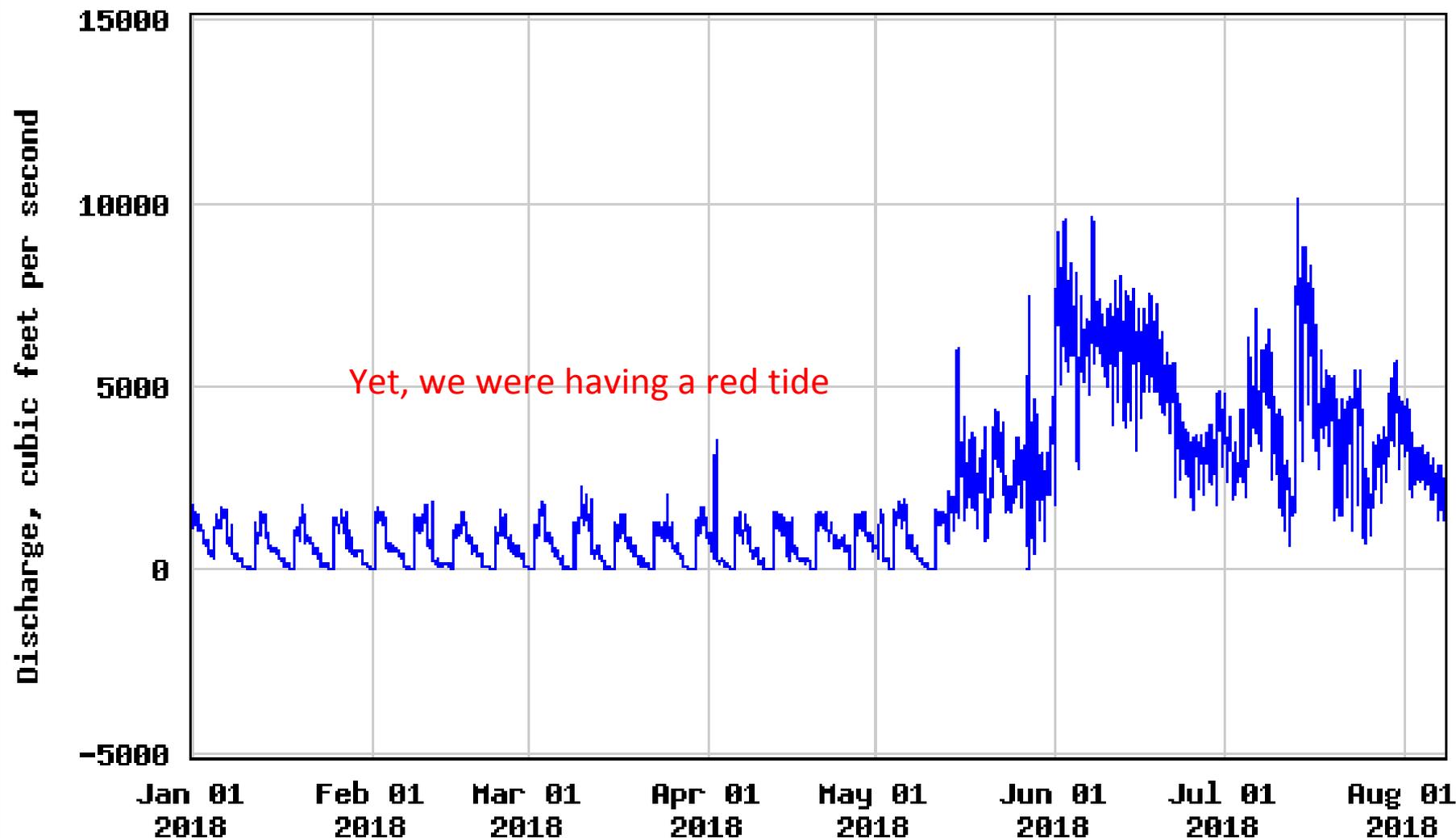


Data SIO, NOAA, U.S. Navy, NCA, GEBCO
Image Landsat / Copernicus

Google Earth



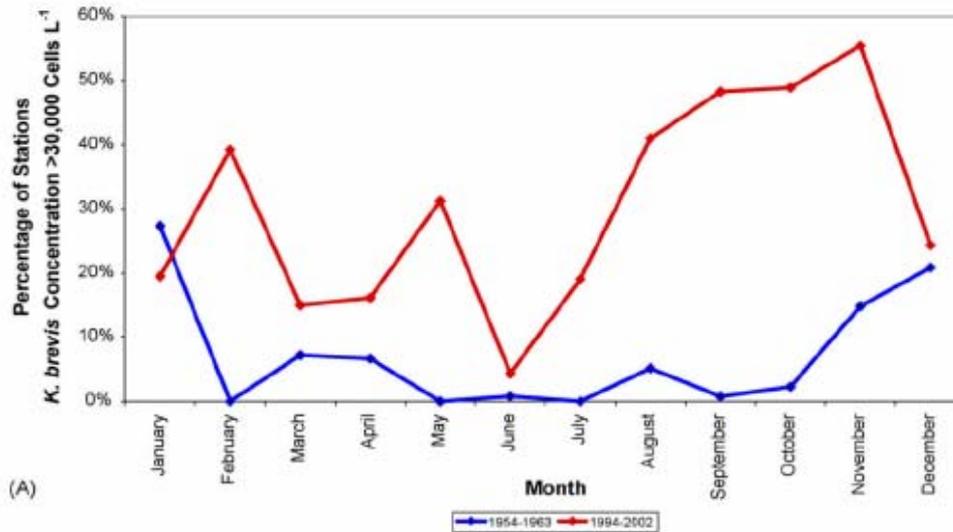
USGS 02292900 CALOOSA HATCHEE RIVER AT S-79, NR. OLGA, FLA



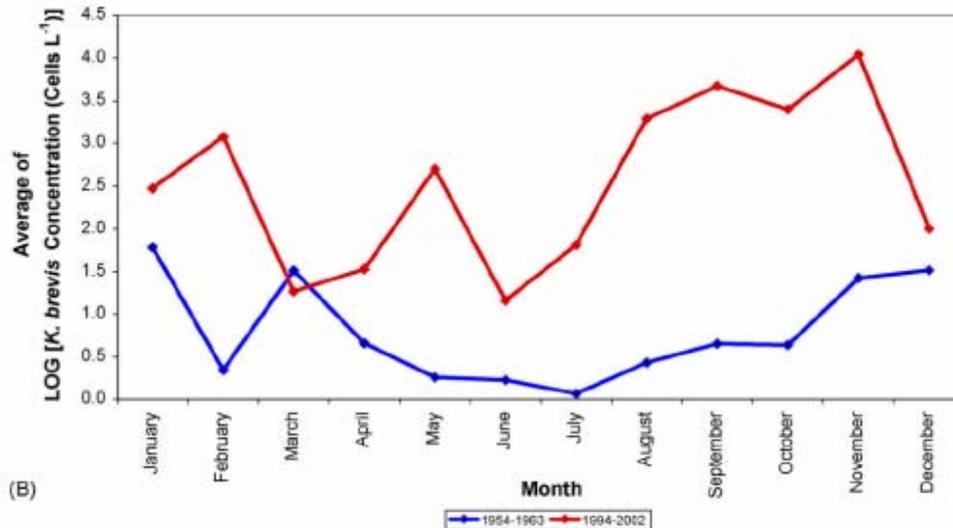
---- Provisional Data Subject to Revision ----

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).
- **In 1947**, Mr. J.N. “Ding” Darling brought UM researchers over to investigate a fish kill – they first **described *Gymnodinium brevis* as the cause**
- **red tides often begin offshore** (18 to 74 kilometers /11 to 46 miles)– **north of Lee County** waters
- **Offshore blooms are often linked to natural processes involving nitrogen-fixing cyanobacteria that leak usable nitrogen**
- **K. brevis can utilize several different forms of nitrogen**



(A)



(B)

Fig. 11. Comparison of seasonal occurrence and abundance of *K. brevis* in 1954-1963 and 1994-2002 in the 0-5 km strip of the area shown in Fig. 4. Data from Florida Fish and Wildlife Research Institute (2002). (A) Average monthly frequency of *K. brevis* concentrations over 3×10^4 cells L⁻¹. (B) Monthly mean of logarithmically transformed concentrations of *K. brevis*.

“ *K. brevis* was approximately 13 to 18 fold more abundant in 1994-2002 than 1954-1963”

However, many researchers have concerns with the how the data were processed.

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City Of Sanibel, Lighthouse Beach Park, 8/12/17, 11:45 AM, Low Tide, Via A 1012 AM



Dark water off Sanibel Lighthouse beach at low tide on 8/12/17. SCCF Photo City of Sanibel

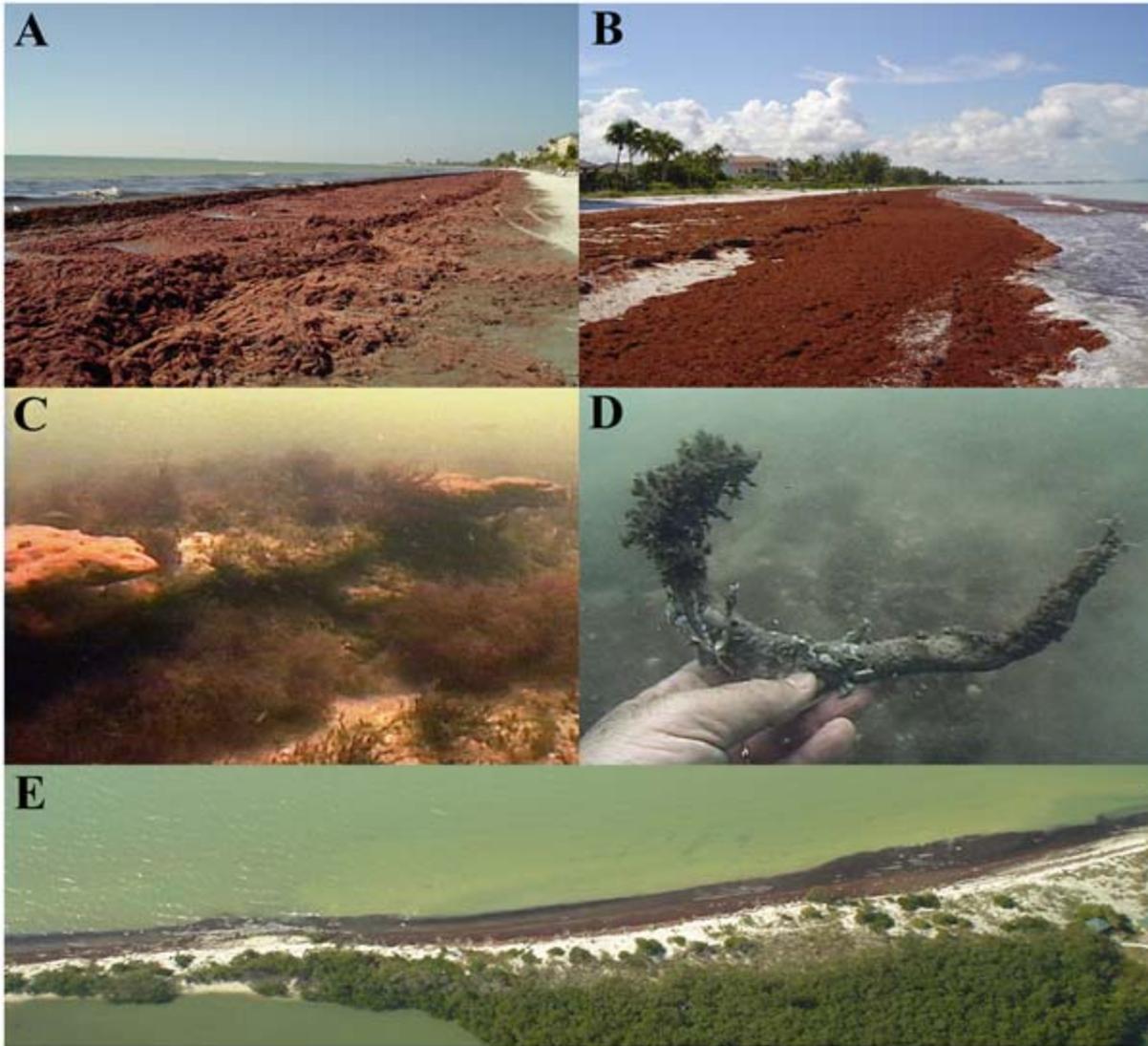


6/14/05



Red drift macroalgae washing up mid-island on Fort Myers Beach, 2/4/17. Photo Town of Fort Myers Bch

SCCF



During the winter of 2003-2004, large masses of red macroalgae (Division Rhodophyta algae: *Chondria atropurpurea*, *Gracilaria caudata*, *Hypnea spinella*, and *Soleria filiformis*) accumulated in unprecedented amounts on the beaches of Sanibel Island and then in southern Charlotte Harbor, San Carlos Bay, and Estero Bay (Dawes, 2004; Lapointe and Bedford, 2006)

Brian E. Lapointe
and
Bradley J. Bedford

Red drift macroalgae in coastal waters of Lee County, FL: A.) rhodophytes, Bonita Springs Beach, January, 2004; B.) rhodophytes, Bonita Springs Beach, July, 2004; C.) rhodophytes, 17th Street Reef, August, 2004; D.) worm tube with attached rhodophyte, Bonita Springs Beach, August, 2005; E.) rhodophytes in shallow water along beaches in southern Lee County.

Grows offshore – breaks off and washes in; lot of plant biomass

Source of the problem

- People want simple answers and quick fixes
 - Not always satisfactory

Source of the problem

1. Poor water management

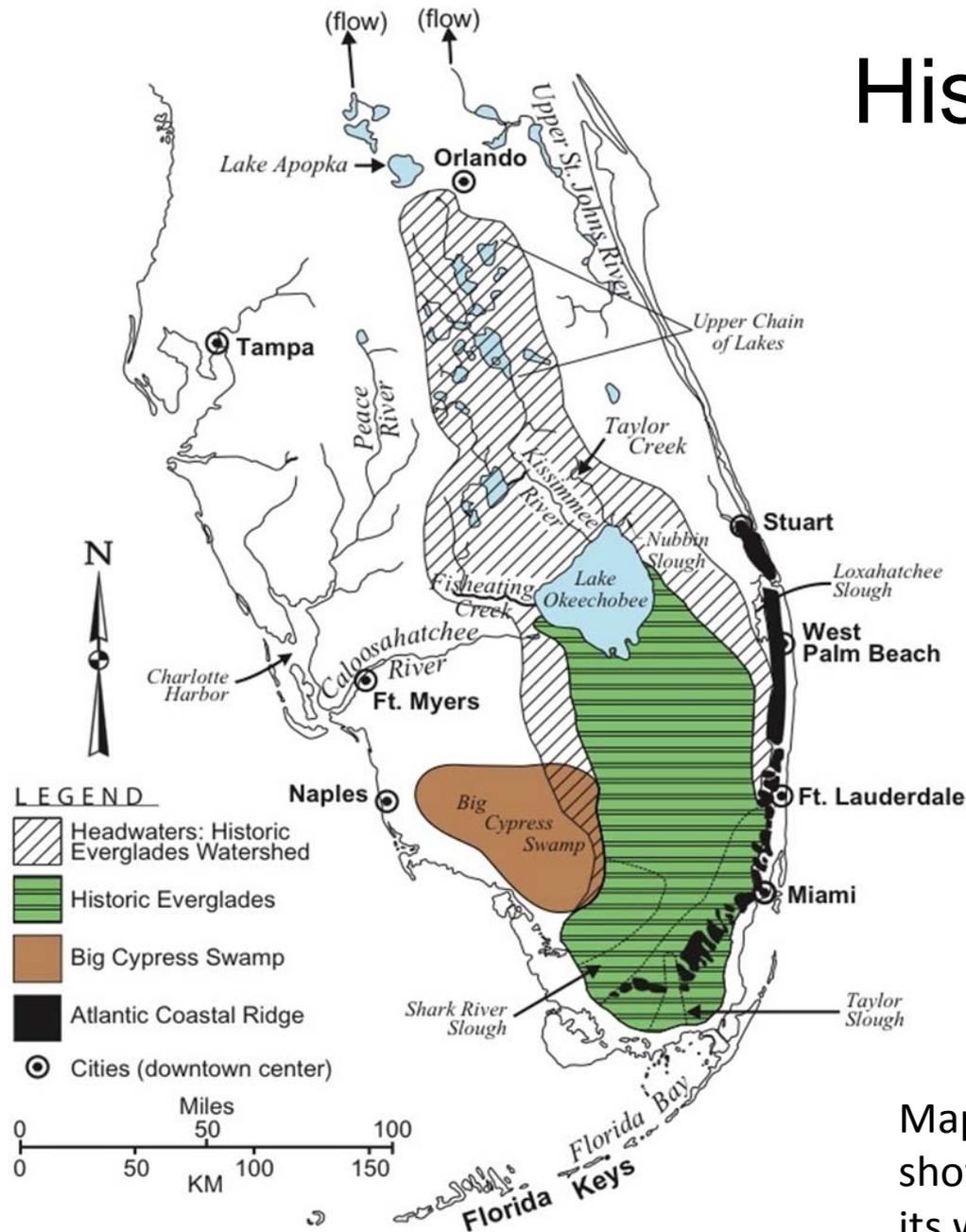
= Quantity, Quality, Timing and Distribution (QQTD)

I. Over drainage / flashy watershed

II. Excessive nutrient inputs

i. Agriculture and urban sources

Historic flows



Map of the Florida peninsula showing the historic Everglades and its watershed as described in the text. (Source: Lodge, 2017)

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

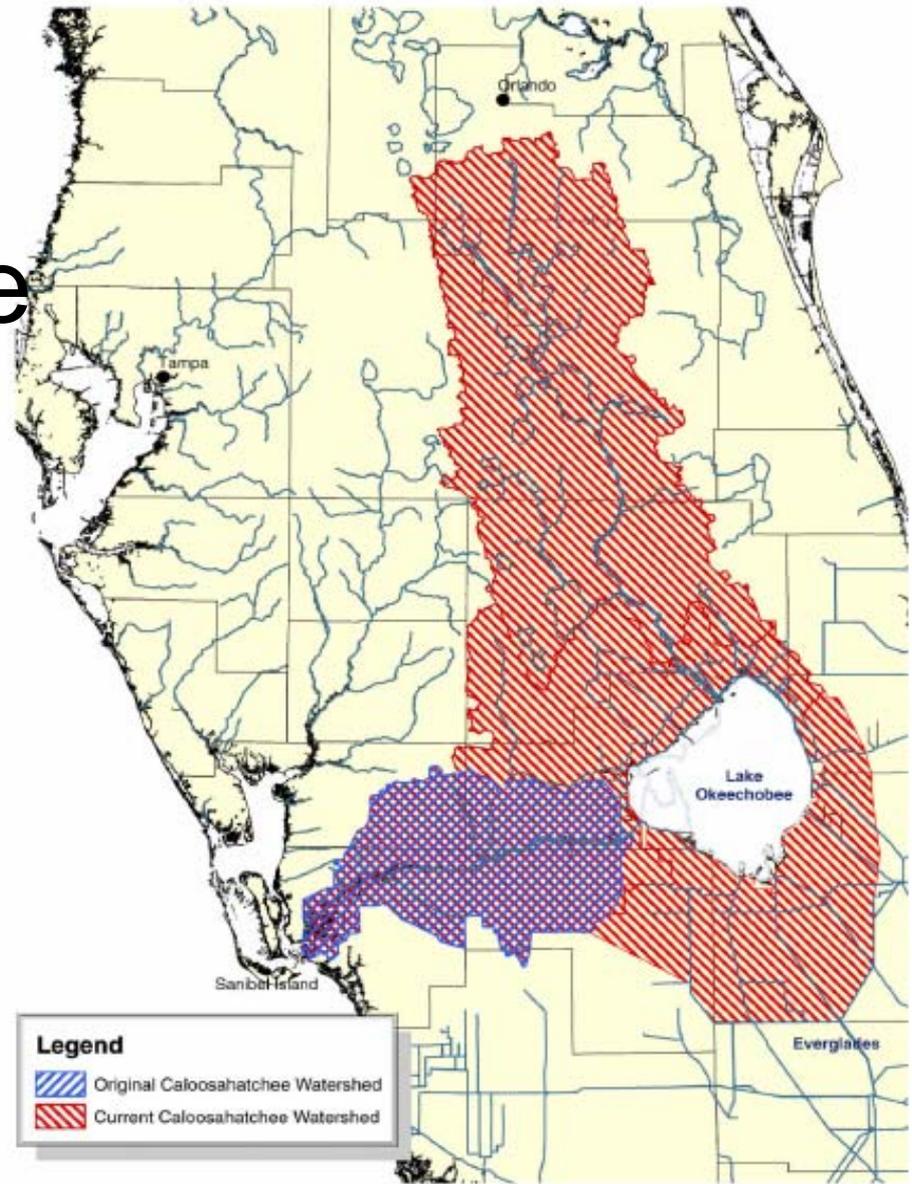


Fig. 3.
Map of original Caloosahatchee River watershed and the current watershed after the connection
to Lake Okeechobee was built. Data from SFWMD.

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

Coral Gables,
Florida

F. G. Walton Smith
Director

ML 7745

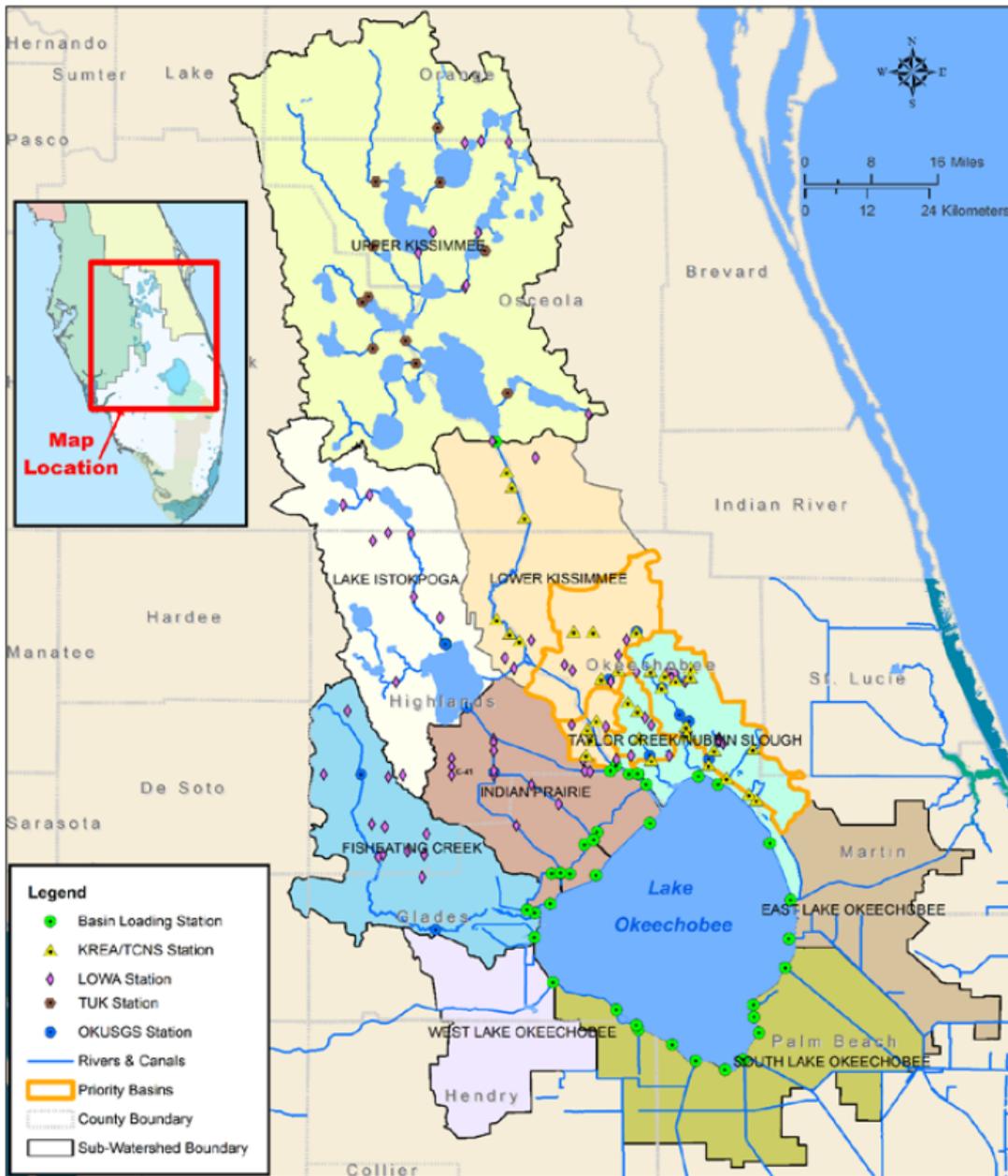


Figure 8B-3. Locations of WY2017 water quality sampling stations under the KREA, TCNS, LOWA, TUK, OKUSGS, and basin loading projects in the LOW.

Source: SFWMD

In the past, Lake O received excessive nutrient inputs from cattle ranches, dairy farms and urban areas north of lake

Additionally, the northern one-third of Everglades Agricultural Area south of the lake was routinely **back-pumped into the lake** up until 1979.

Emergency back-pumping from south of the lake occurred in 2016 and 2017

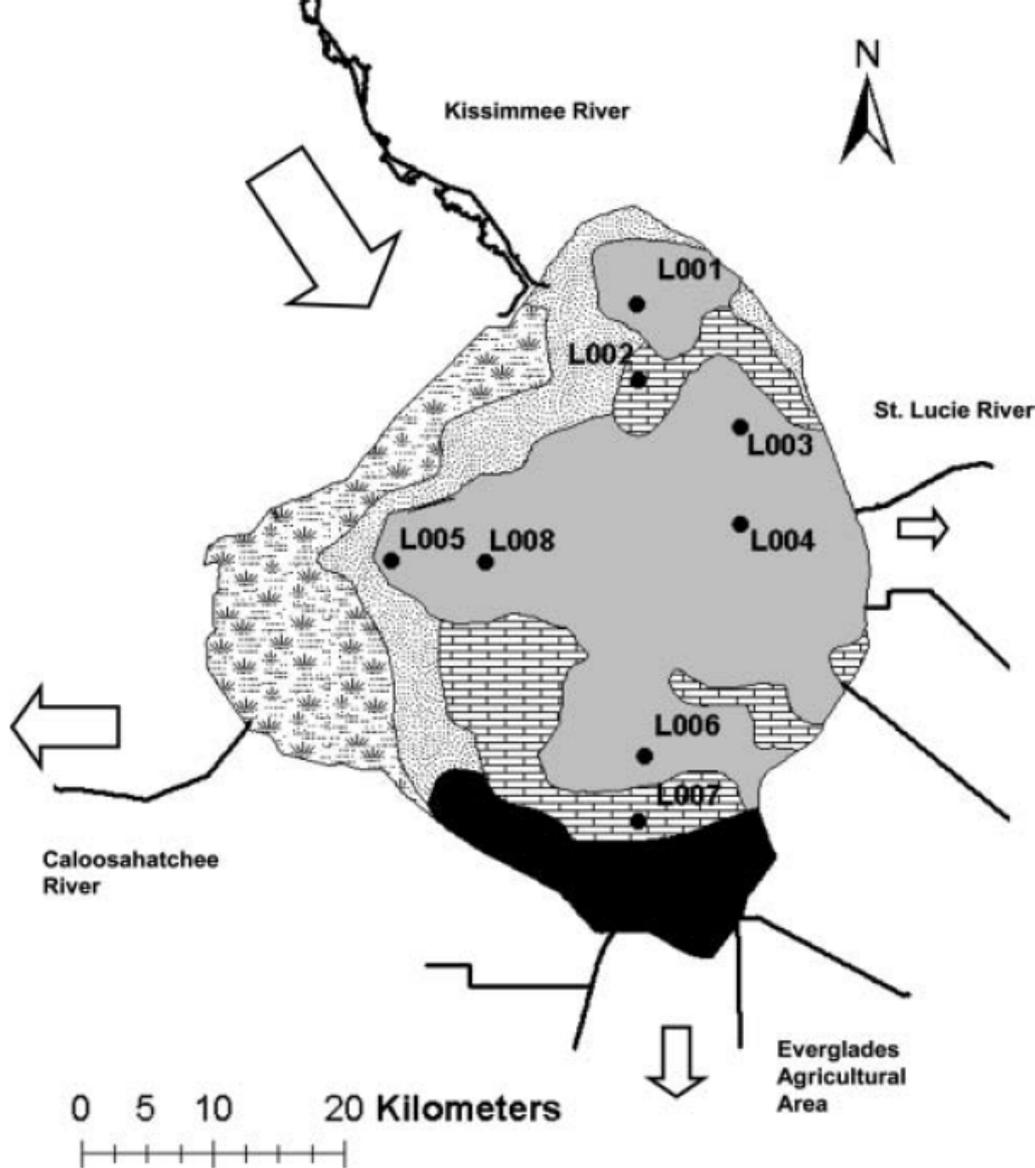


Figure 1.-Lake Okeechobee with major tributaries, long-term water quality monitoring stations and sediment types (littoral = plants, sand = speckled, shell/marl/rock = brick, mud = grey, peat = black).

Pollman and James 2011

Historical drainage resulted in muck accumulation

“mud” sediments cover a very large area (>50%) of the lake bed - about ~200 million m³; depth ranging from <5 to 85 cm.

Phosphorus accumulation rates in sediments increased approximately 4-fold during the 1900s, with most of the increases occurring from 1940 to 1950 (Brezonik and Engstrom 1998)

Modeling indicates that internal fluxes of P exceed external inputs on average by a factor of 2.6.

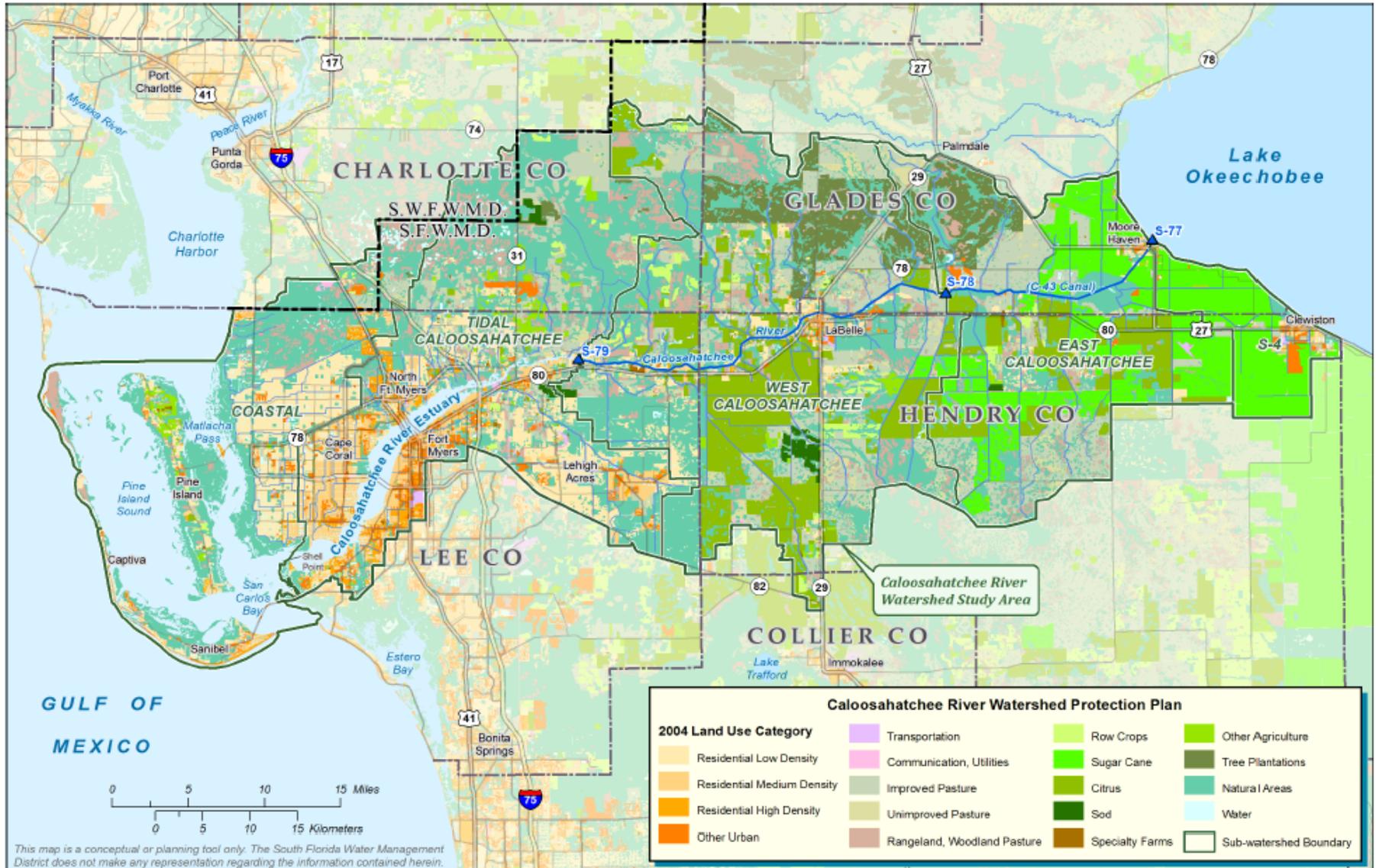


Figure 6. Land use within the Caloosahatchee River Watershed as of 2004. Source: SFWMD

Nutrient sources within the C43 and tidal basin also contribute

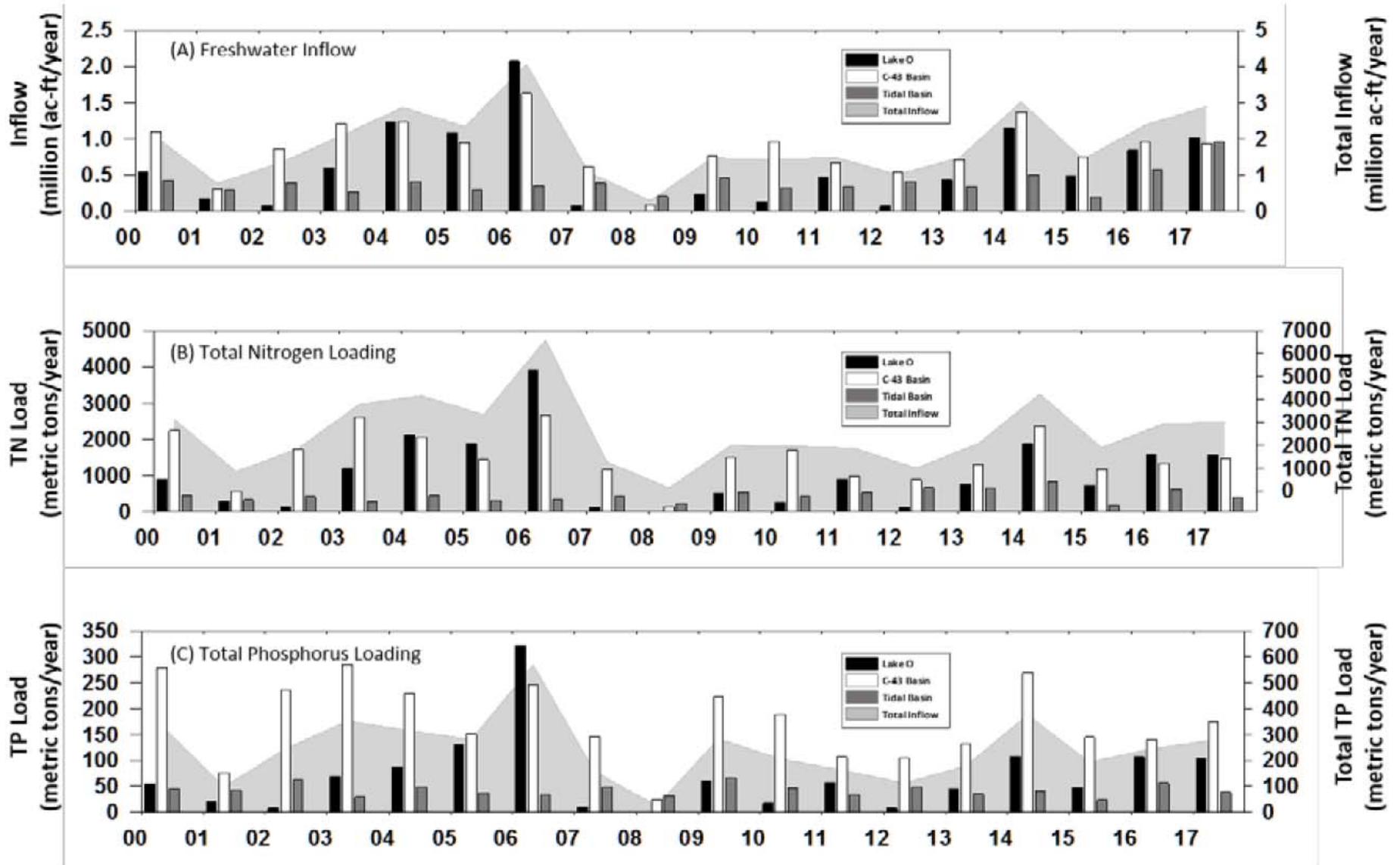
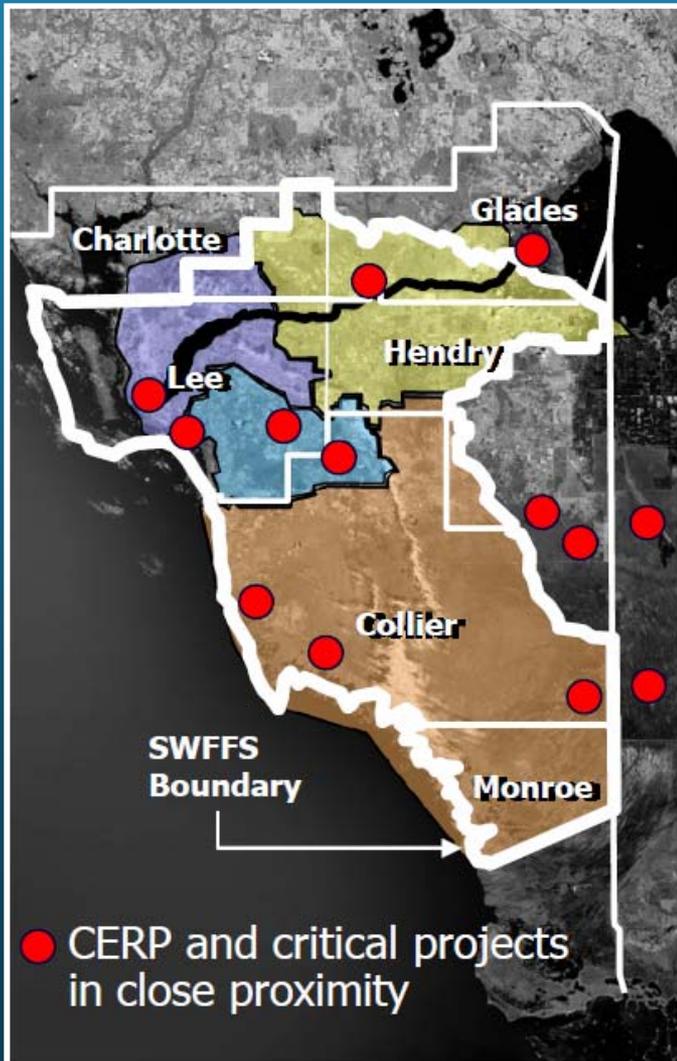


Figure 8C-18. Time series of (A) annual freshwater inflow, (B) TN loading, and (C) TP loading to the CRE for the period WY2000–WY2017. The left y-axis in each corresponds to the annually grouped bars categorizing the inflow among the Lake Okeechobee (black fill), St. Lucie Basin (white fill), and Tidal Basin (dark grey fill) Contributing Areas. The right y-axis is the total annual inflow or nutrient loads (light grey area fill).

Solutions

Southwest Florida Feasibility Study (SWFFS): 2002-2009



The Restudy recommended a separate Comprehensive watershed study for Southwest Florida with the following purposes

- Health of aquatic ecosystems
- Water flows
- **Water quality (including appropriate pollution reduction targets)**
- Water supply (Lower West Coast Water Supply Plan)
- Flood damage reduction
- Wildlife and biological diversity
- Natural habitat
- Recreation (opportunity)



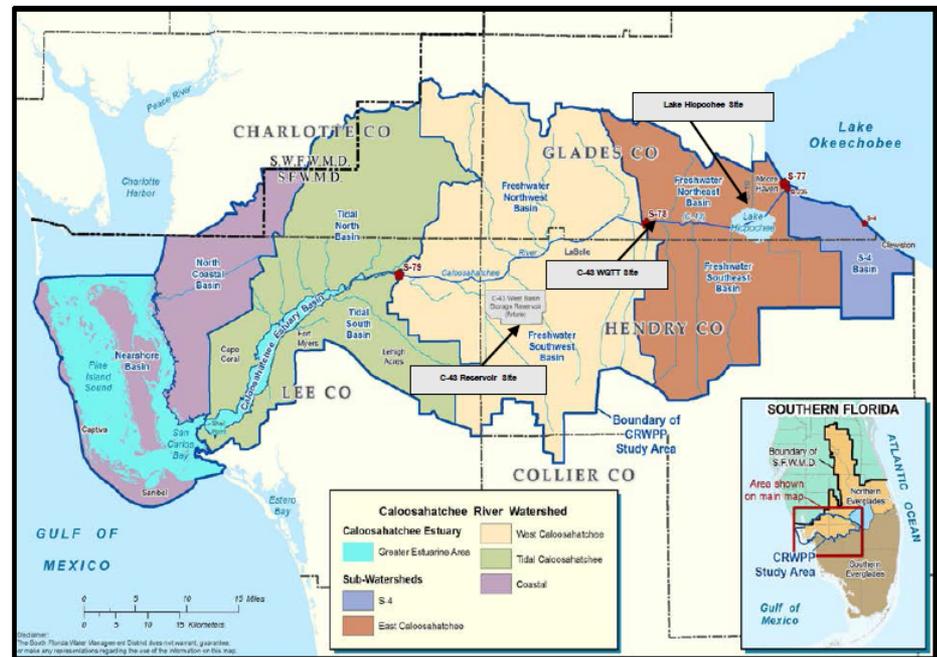
Caloosahatchee River Watershed Protection Plan

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

TOTAL MAXIMUM DAILY LOAD (TMDL) OBLIGATION

CALOOSAHATCHEE ESTUARY

- TMDL FOR TOTAL NITROGEN ESTABLISHED IN DECEMBER 2009, BASED ON LIGHT PENETRATION AND CHLOROPHYLL A LEVELS AT SAN CARLOS BAY
- REQUIRES 140,853 LB TN REDUCTION (ANNUALLY)
- BASIN MANAGEMENT ACTION PLAN (BMAP) – NOVEMBER 2012
- REDUCED TO DATE 46,118 LBS (ANNUALLY) (33%), REPRESENTED BY 40 PROJECTS
- REMAINING OBLIGATION 94,735 LBS (ANNUALLY) BY 2032 (20 YEARS, 5 YEARS ADDED)
- FDEP TRACKS PROGRESS THROUGH ANNUAL REPORTS AND 5 YEAR PLANNING EFFORTS
- REQUIREMENTS ARE ENFORCED THROUGH SECRETARIAL ORDER AND NPDES MS4 PERMIT

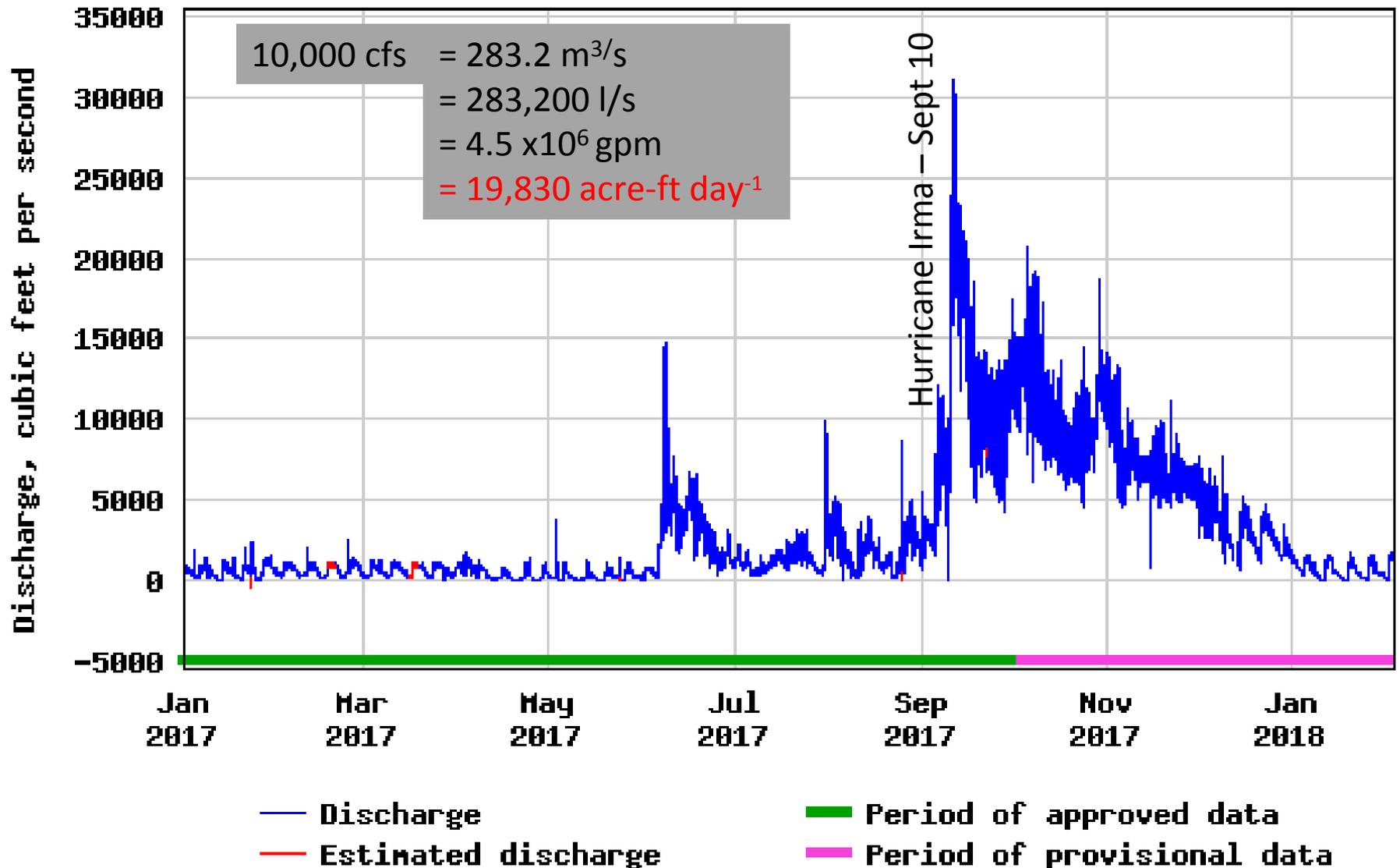
- Source: presentation by Lee County Natural Resources in 2017

Quick fixes

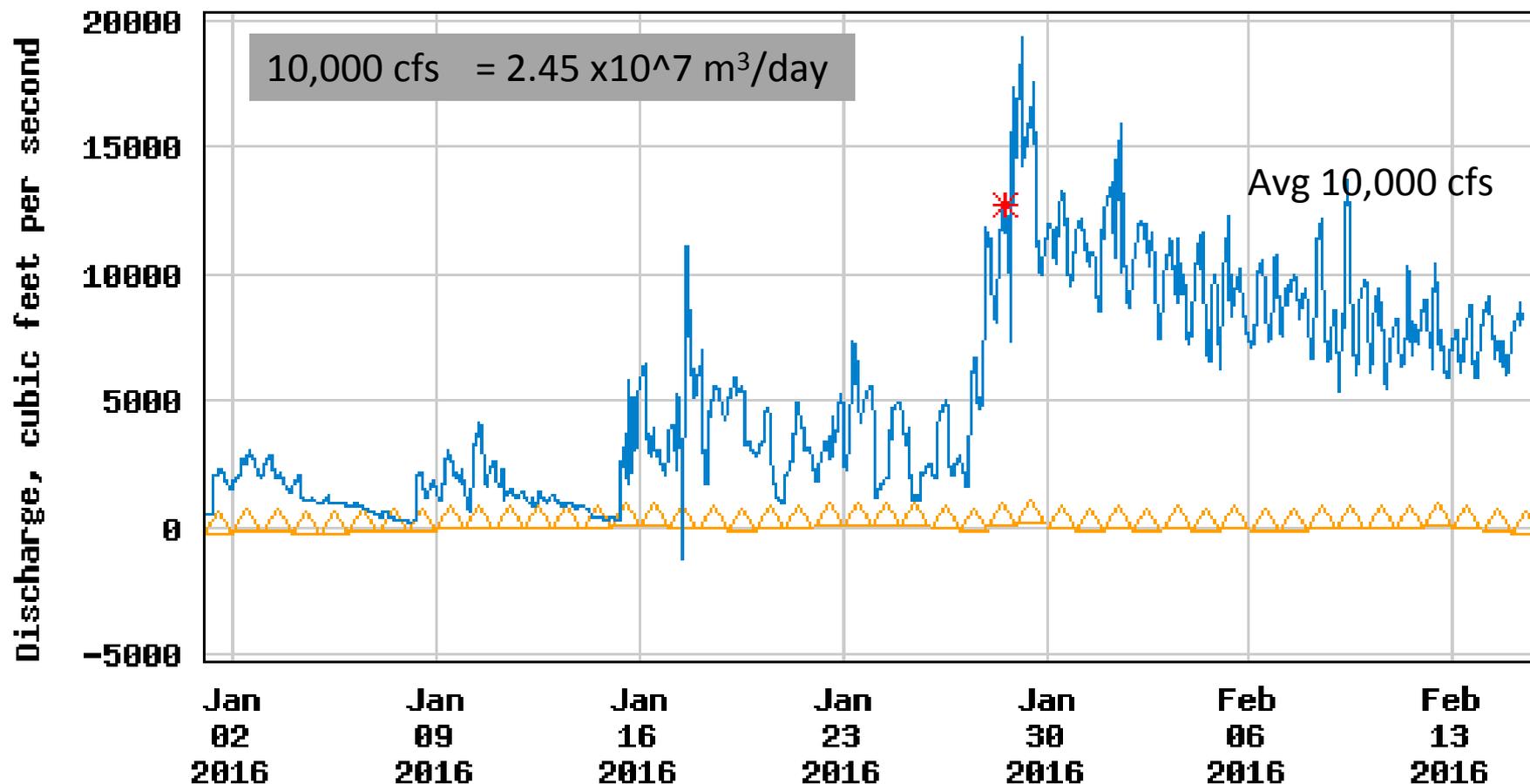
- Copper sulfate to kill the algae: 1957 crop-dusting planes dusted 16 mi²
- Mote Marine Lab's Ozone treatment – 300 gpm
- FGCU working on Hydrogen peroxide treatment --lakes
- algae-sucking vacuum cleaner
- vacuum cleaner– send water to reverse osmosis plant
- Polymer foam the soaks up oil, nutrients and toxins?

Questions?

USGS 02292900 CALOOSA HATCHEE RIVER AT S-79, NR. OLGA, FLA



USGS 02292900 CALOOSA HATCHEE RIVER AT S-79, NR. OLGA, FLA



---- Provisional Data Subject to Revision ----

- △ Median daily statistic (48 years)
- Discharge
- ✱ Measured discharge

467,000 acres

700,000

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

19.5 mi

Google earth

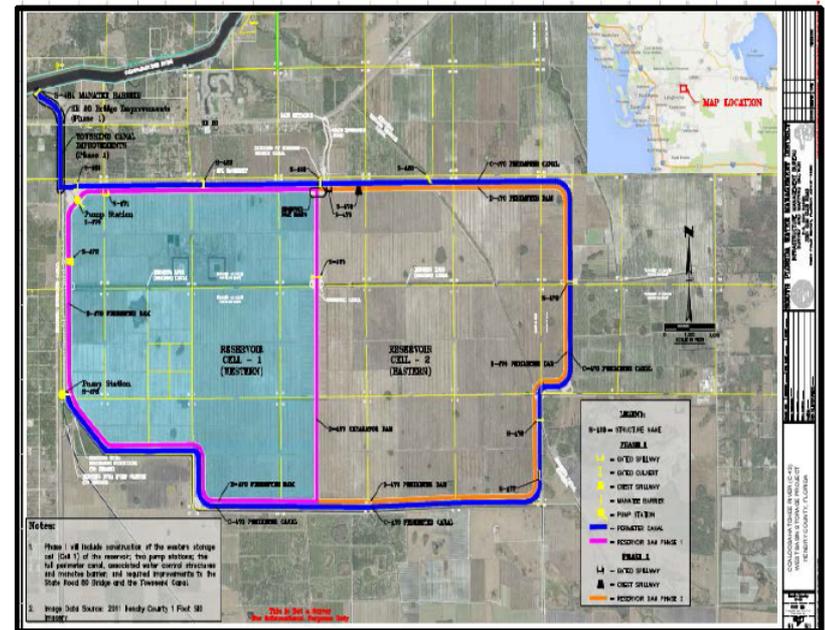




Caloosahatchee River (C-43) West Basin Storage Reservoir (CERP)

Freshwater storage (from watershed and Lake Okeechobee) and supply (to estuary) to maintain salinity envelope in the Caloosahatchee Estuary

- 2-Cell, 10,500 acre reservoir
- Up to 170,000 ac-ft storage
- Status: Under Construction
 - Began November, 2015
 - Completion expected November, 2022



General site plan for the C-43 Reservoir project



467,000 acres

700,000

How many days to draw down 1 acre ft?

Lower Lake 1 ft = 23 days at 20,000 ac-ft/d

Lower Lake and EAA = 59 days

19.5 mi

Data SIO, NOAA, U.S. Navy, NGA, GEBCO
Image Landsat

Google earth

Everglades Agricultural Area (EAA) – Storage Reservoir

A Section 203 study was conducted by the South Florida Water Management District (SFWMD) on the Everglades Agricultural Area (EAA) Storage Reservoir and was submitted to the ASA(CW) on March 30, 2018 for review and consideration for Federal participation. The Corps, Jacksonville District, was delegated the authority to complete the National Environmental Policy Act (NEPA) compliance actions for this study. The Corps, Jacksonville District, has completed a Draft Environmental Impact Statement (EIS), which was released for public review and comment on June 8, 2018. Public comments are due to



the Jacksonville District on July 24, 2018. If Congressional authorization is obtained for this recommended plan in the Section 203 study, it will represent a Post Authorization Change of the Central Everglades Planning Project, which was authorized as a Federal project by Congress in 2016.

Summary of Project Background

- In 2014, the U.S. Army Corps of Engineers, Jacksonville District, and SFWMD completed planning for the Central Everglades Planning Project.
- In 2016, Congress authorized Central Everglades Planning Project, which includes construction of a Flow Equalization Basin (FEB) on the A-2 parcel.
- In 2017, the Florida legislature passed Senate Bill 10, which called for a SFWMD study of a 240,000 acre-foot storage reservoir on the A-2 parcel or a 360,000 acre-foot reservoir on the A-1 and A-2 parcels
- In 2018, the SFWMD submitted the Section 203 report to ASA(CW) for Federal participation in a 240,000 acres-foot storage reservoir and treatment wetlands on the A-2 parcel.