Protecting Public Health Through Innovation and Citizen Science

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DANGER
KEEP OUT

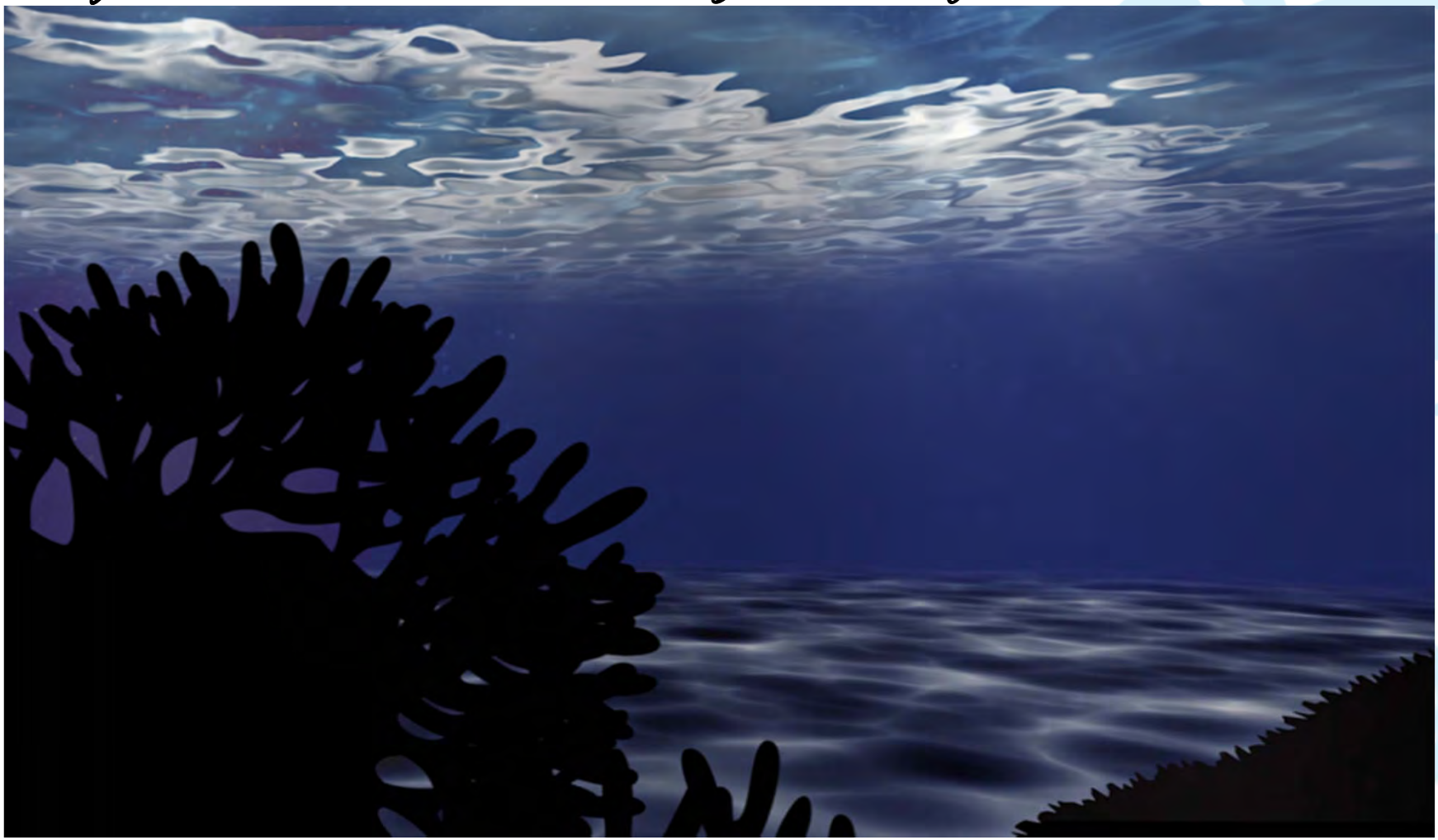
World's Leading Killer

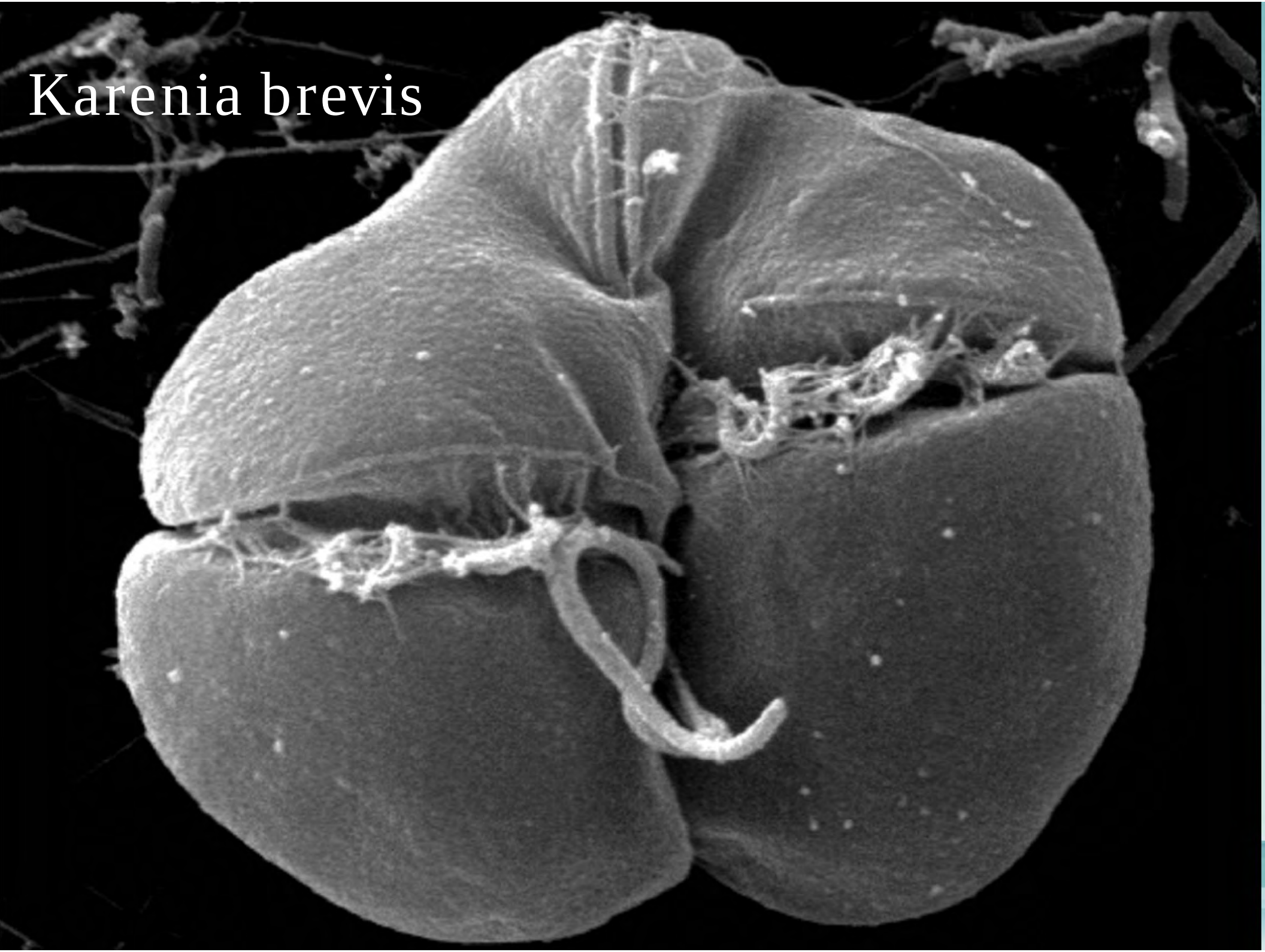
- Worldwide, 780 million people do not have access to a clean water source
- An estimated 2.5 billion people lack access to improved sanitation (more than 35% of the world's population)
- An estimated 4,000 children/day perish due to unsafe drinking water each year, mostly in developing countries

Silent Superhero Status: Environmental Engineer

FLORIDA RED TIDE

For centuries man has told tales of a menacing ocean mystery phenomenon wreaking havoc from the deep.




Karenia brevis

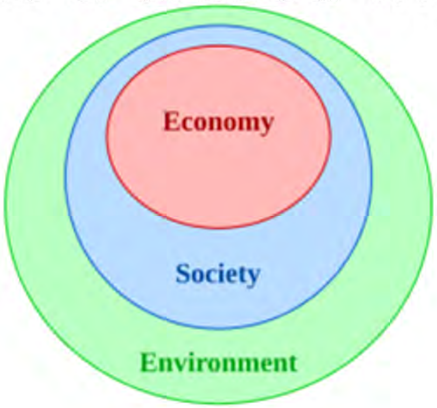
Red Tide Effects

- Respiratory Irritation
- Dead Fish
- Water Discoloration

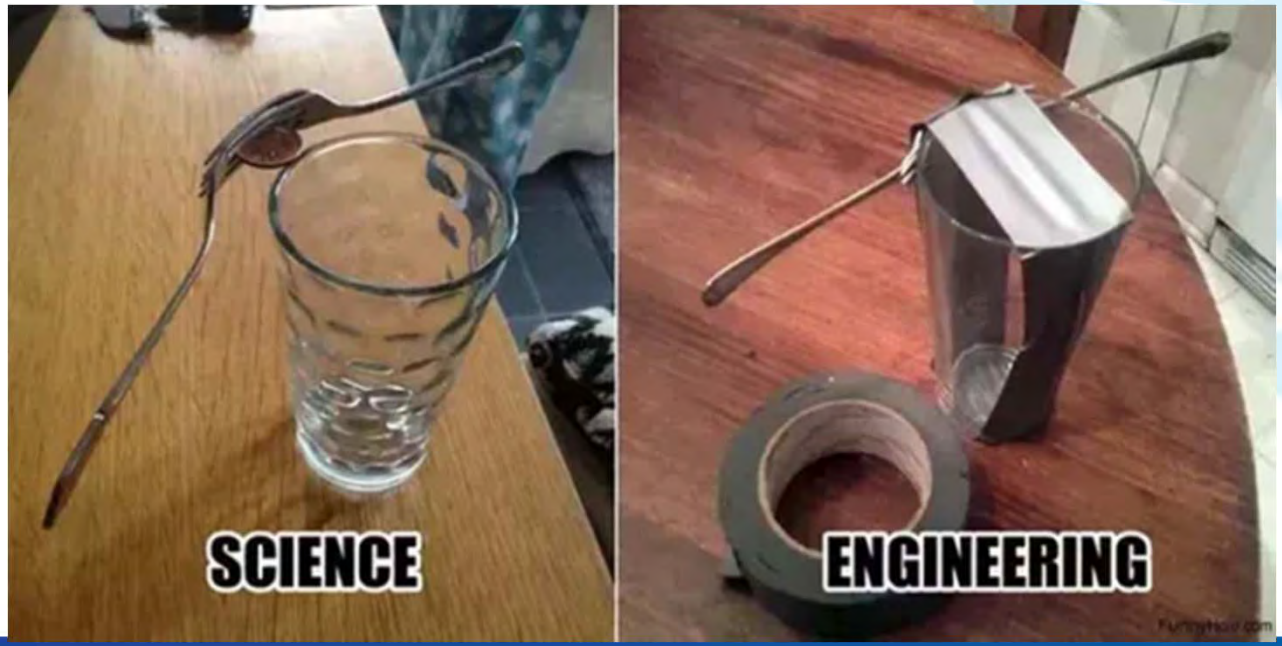
Mote Environmental Health Program

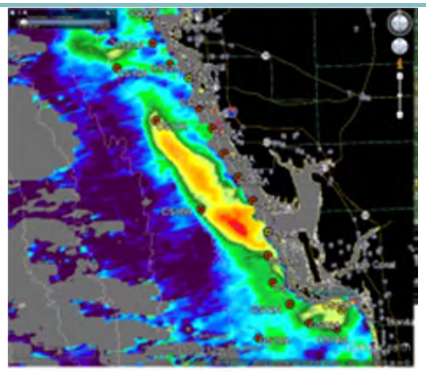
Integration: Combining many parts so that they function as a unified whole

Science: is enhancing our knowledge about the universe and our surroundings in a rational and logical manner



Engineering: is the application of this scientific knowledge to create new solutions and designs





Integrated Research Florida Red Tide Co-Op and Ocean Observing System

Phytoplankton Ecology

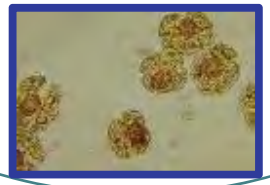
Monitoring, Laboratory Analysis to Determine Red Tide Predators and Prey

Ocean Technology

Detection of the optical signature of Karenia brevis, providing advance warning of red tides

Red Tide

Karenia brevis



Ecotoxicology

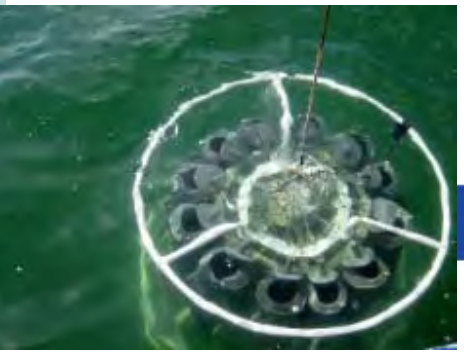
Quantification of impact and neurotoxin persistence in lobster, clam, and oyster

Chemical and Physical Ecology

Statistical analyses of the nutrient regimes associated with blooms

Environmental Health

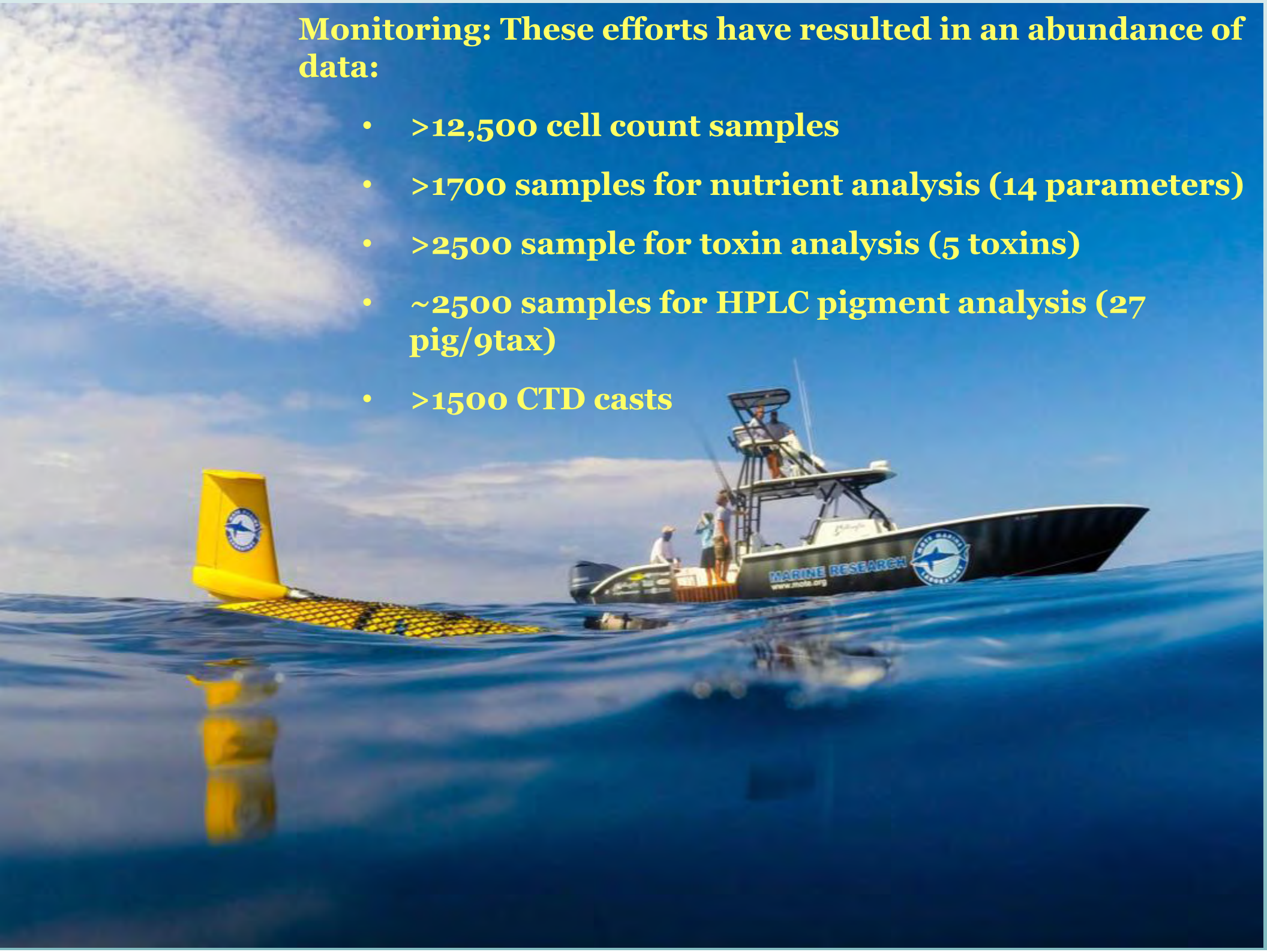
Brevetoxin Research and Dissemination of Information



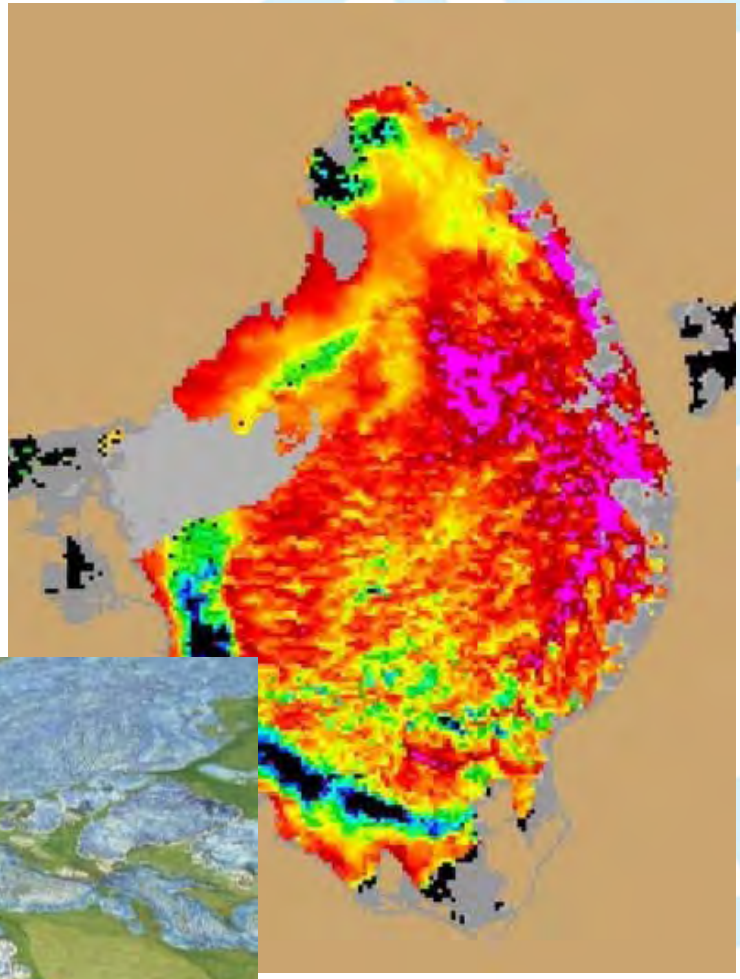
FWC/FWRI-Mote Cooperative Red Tide Program
Monitoring, Research, and Mitigation

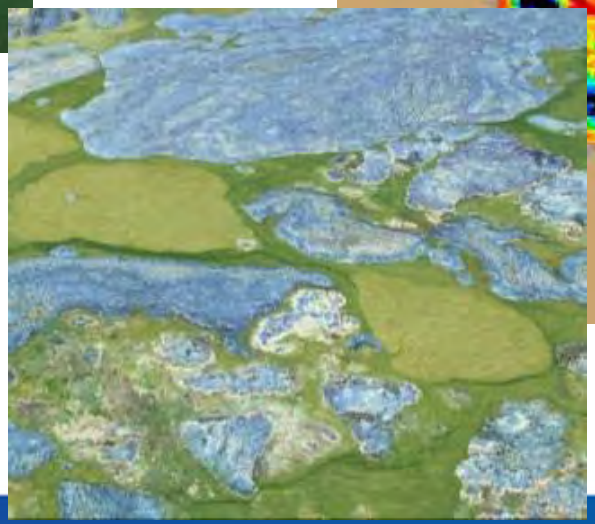
Monitoring: These efforts have resulted in an abundance of data:

- **>12,500 cell count samples**
- **>1700 samples for nutrient analysis (14 parameters)**
- **>2500 sample for toxin analysis (5 toxins)**
- **~2500 samples for HPLC pigment analysis (27 pig/9tax)**
- **>1500 CTD casts**



In 2018, Florida was Declared in a State of Emergency Due to 2 Harmful Algal Blooms





Communication Was Never More Important

Mote Marine scientist says US Sugar is misusing her words for an agenda

A lot of fingers are pointing at big sugar and releases from Lake Okeechobee as ca
historically bad red tide.

WATER

Mote Marine scientist dishes on dirty details of red tide outbreak

Phytoplankton Ecologist Dr. Vince Lovko explains algae bloom

By Nadeen Yanes - Reporter

Posted: 6:20 PM, August 24, 2016

MORE: Gov. Scott issues state of emergency or

The words appeared two weeks ago in a newspa
Dr. Fanara is quoted as saying the Lake Okeechc
bloom.

Researchers may be on brink of solving deadly red tides

Sugar farmers say they're being unfairly attacked for water quality issues in SWFL

US Sugar is speaking out after they say they're being unfairly attacked for water quality issues in Southwest Florida.

Florida Gulf Coast University professor Dr. Bill Mitsch is doing an experiment to see if the Lake Okeechobee discharges are supercharging our red tide bloom.

Sugarcane farmer Ardis Hammock says it's just another attempt to push the anti-farming agenda because there's no research out there that shows direct correlation.

"We are all in this together," Hammock said, "So why [Dr. Mitsch] thinks there some kind of smoking gun of what's going on. I would like to look at what source is paying him to look at that issue."

Dr. Tracy Fanara is a staff scientist at Mote Marine Laboratory and she says this experiment could help answer important questions, "If a bloom is close enough to shore, it very well can use surface water and nutrients to sustain."

Speak, but Some People Won't Listen

By NANCY SMITH

August 14, 2018 - 6:00am

Finally, the scientists.

The only question is, did they show up in time to dispel the ecoterrorist myths and other politically driven bullcrackers about Florida red tide?

If you're looking for answers about the pall of death that's
end the hour it takes to view Mote Marine Laboratory's forum from last
intentional confusion out there.

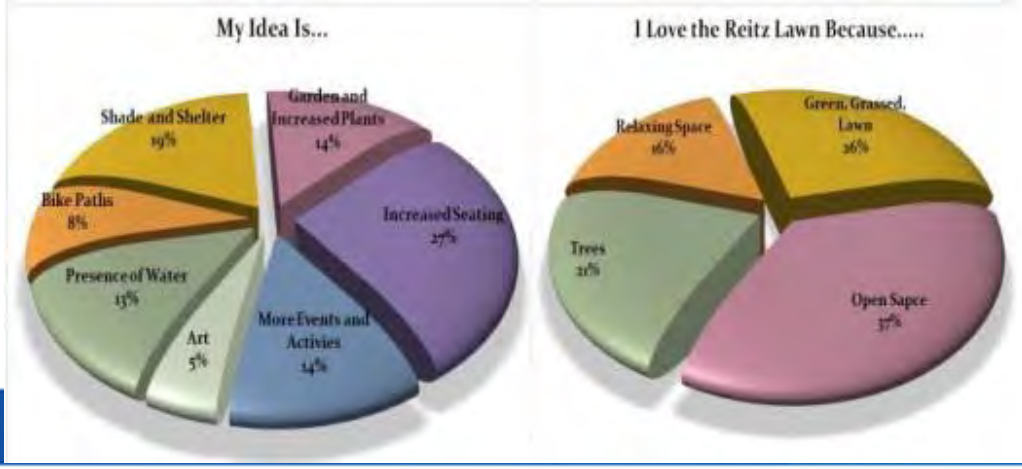
What You Can Do

- Get Communities Involved
- Get involved with and spread the word about Citizen Science Programs
- Learn!
  - Understand Nutrient Sources
  - Understand the Water Cycle and Recognize it
- Take charge of what you can
  - Retrofit your home
  - Retrofit your actions

Getting Communities Involved- Communication and Education

Participatory Research: The Student Voice. Our Team set up four stations under the colonnade to the Student Union and engaged nearly 100 students over a four -hour period in dialogue about stormwater and the Reitz Lawn.

- Surveys to find circulation routes used most, what the public likes, and what they would like to see on campus



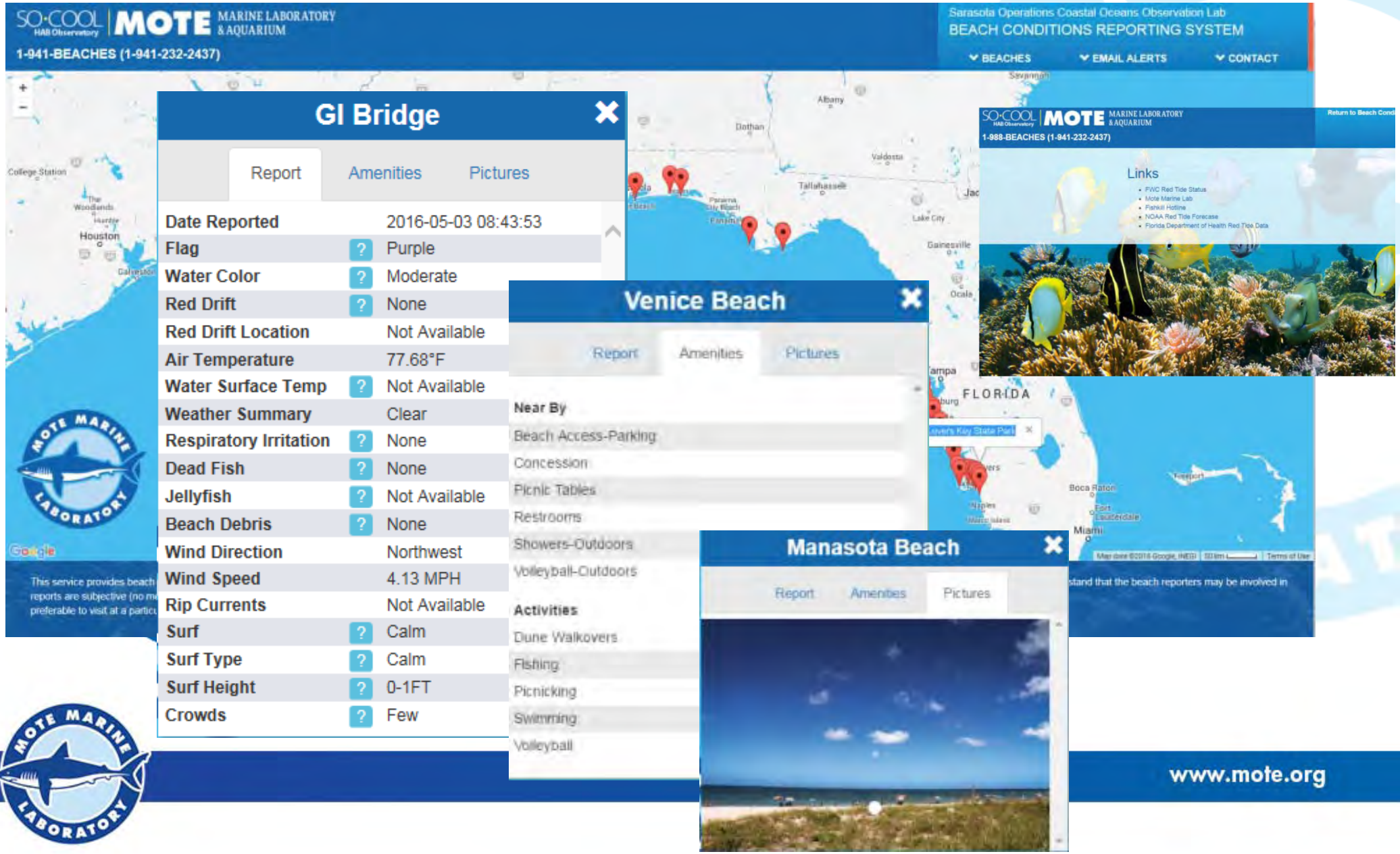
The Beach Conditions Reporting System

BCRS: Protection of Human Health and Economy

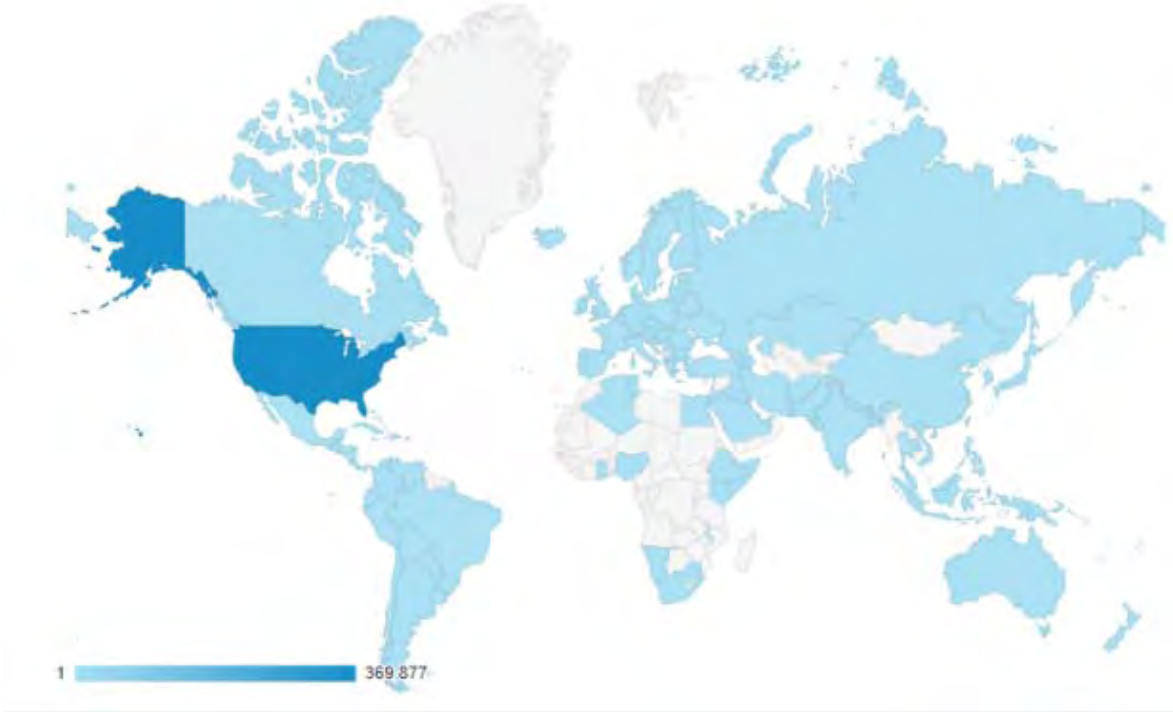
- Reports from 37 Beaches Along the Gulf
- Reports are made by trained beach sentinels
- Main Focus is to Alert the Public of Red Tide Effects
- Information is disseminated through BCRS and NOAA Websites
- Data Used for Research as Well As Outreach

BCRS- VisitBeaches.Org

- Redevelopment was Launched in November 2015



VisitBeaches.Org Results

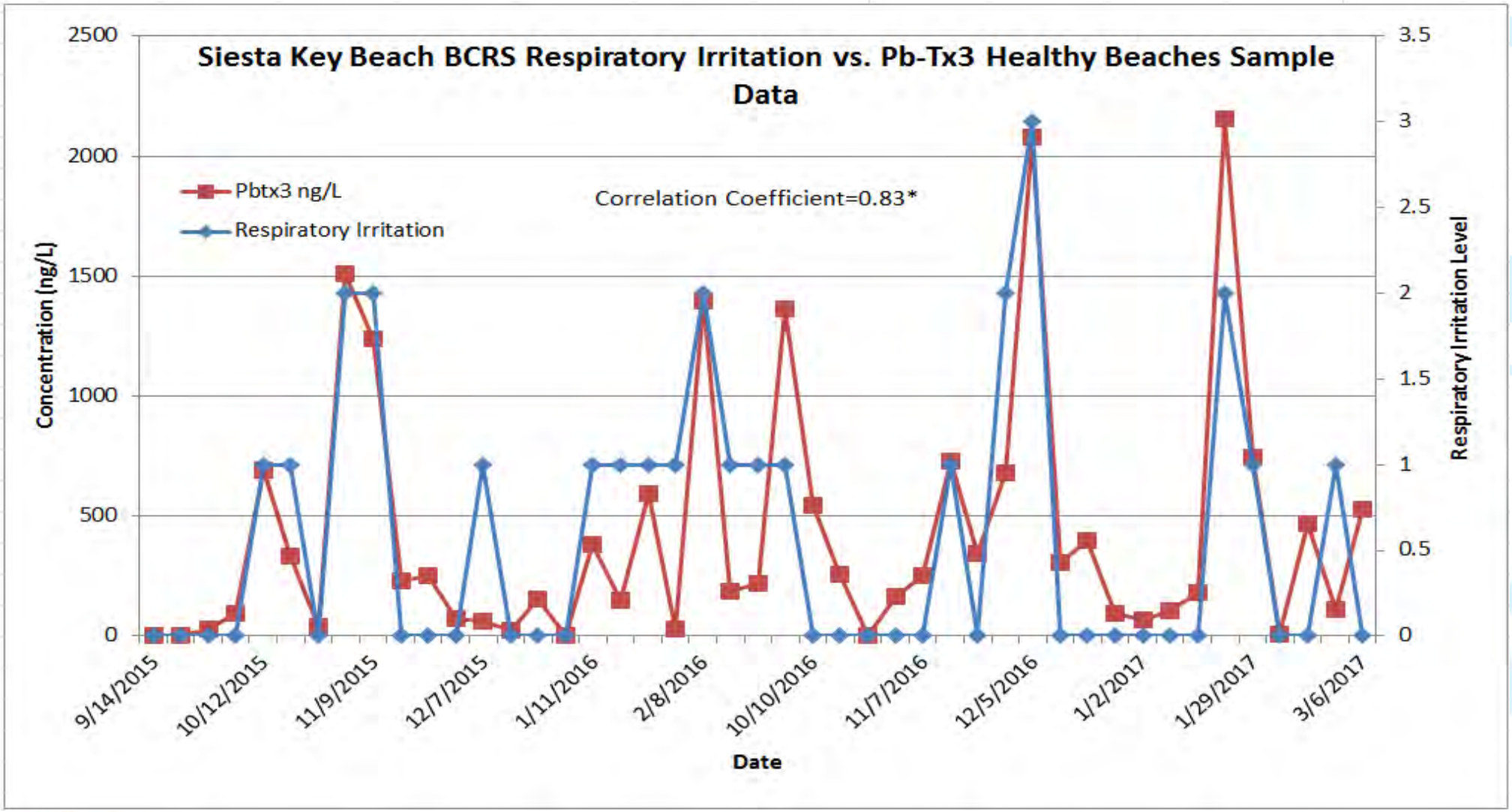


Since October 15, 2017

Unique Users: 1.2Million

Page Views: >4Million

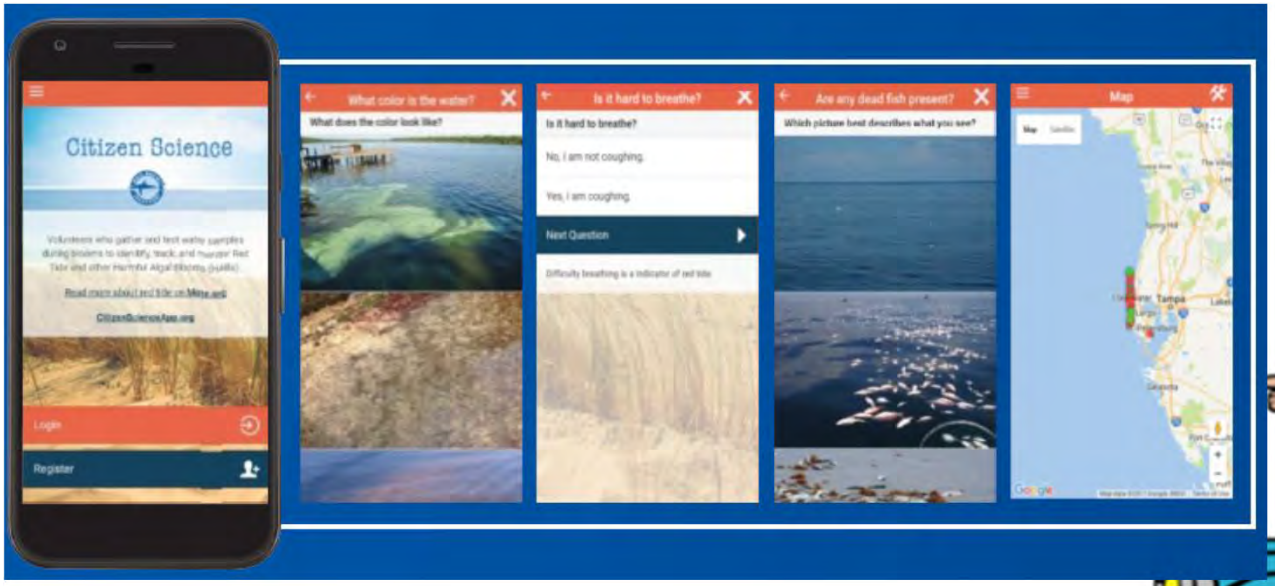
Citizen Science Validation



Citizen Science- CSIC

Citizen Science- Reporting by Anyone With a Cell Phone, Anywhere.

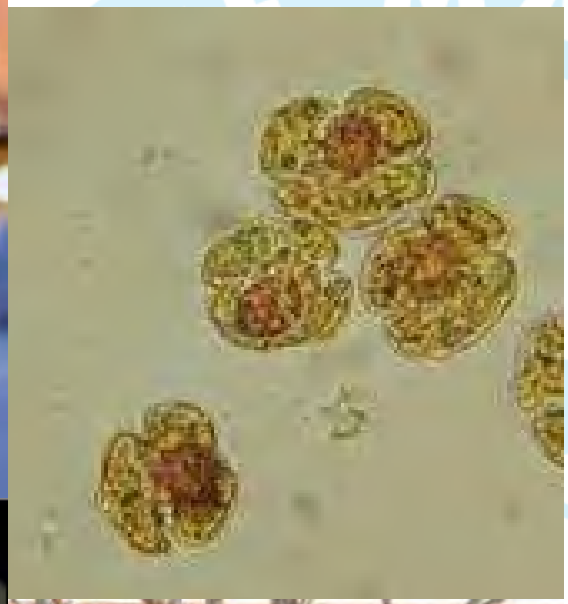
- Help report environmental conditions so scientists can investigate

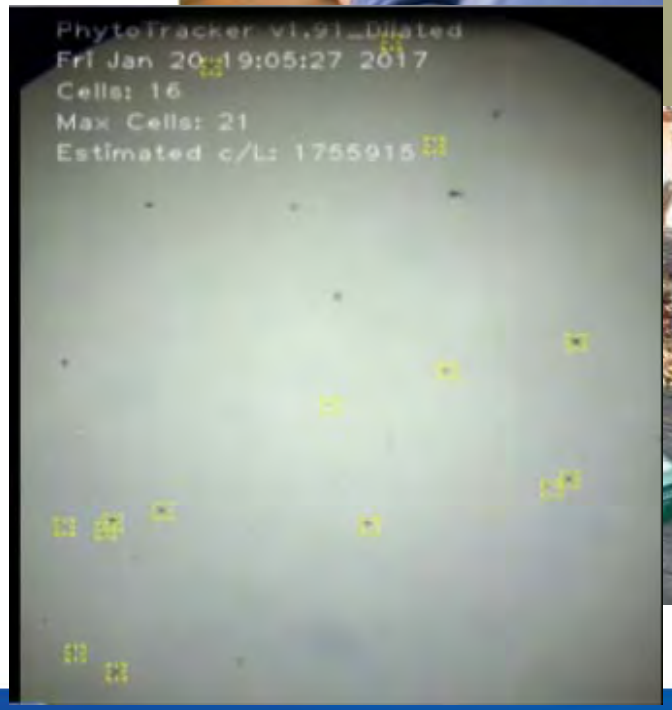


Citizen Science- HABscope

Improved Forecasts of Respiratory Illness Hazard from Gulf of Mexico Red Tide-

- NASA funded Project with NOAA and GCOOS
- Microscope Camera for Red Tide Detection to BCRS and Citizen Science
- Quantifies BCRS Reports
- Will Provide Hourly Predictions Of Respiratory Irritation



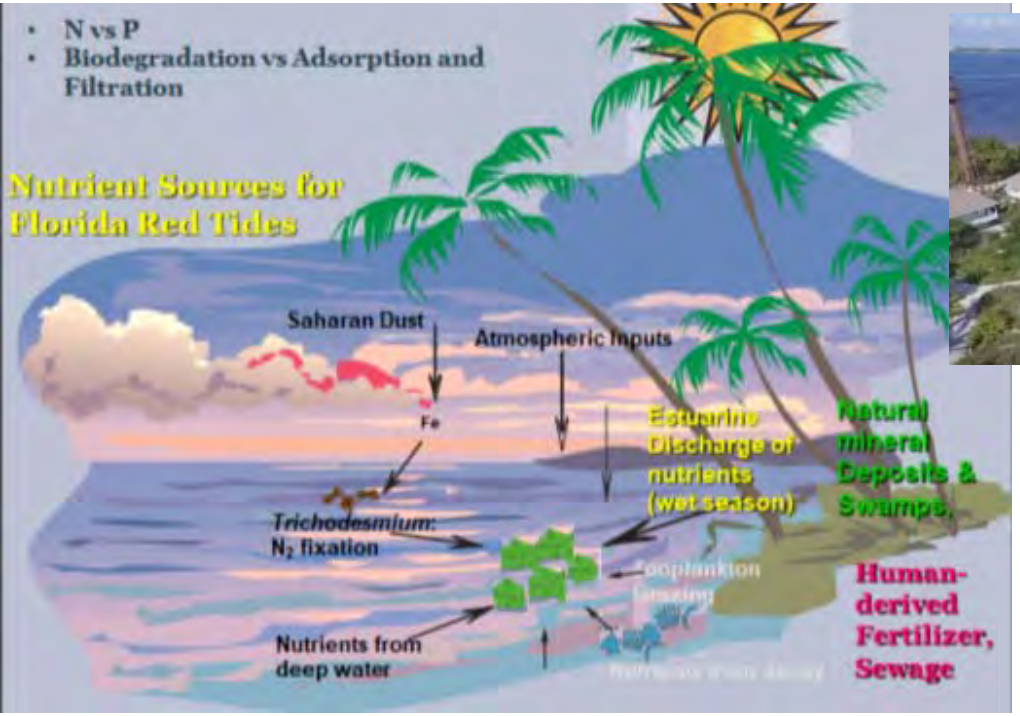


Citizen Science

- **Biofiltration**

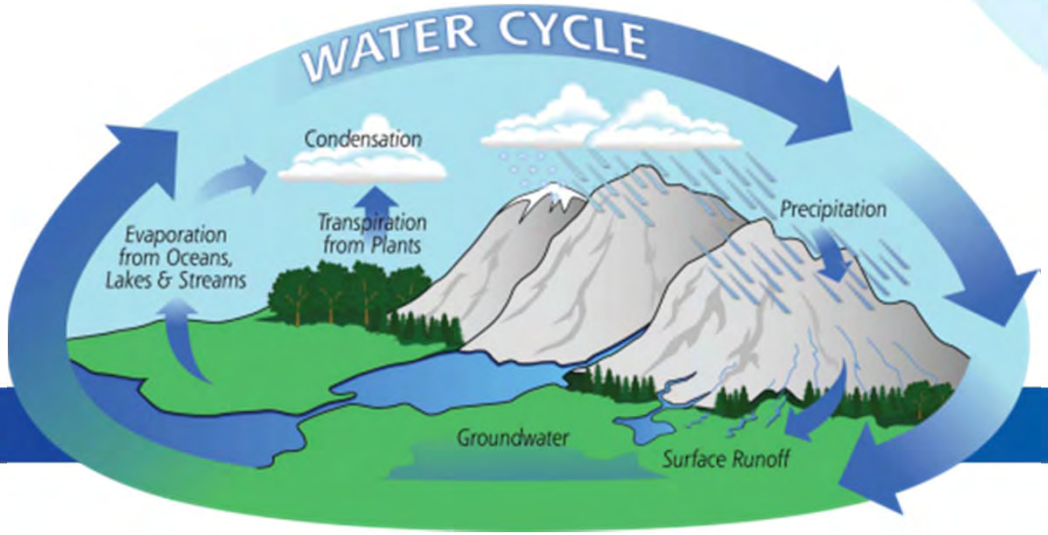
Learn:

Nutrients and Treatment



Florida Red Tide vs Freshwater Cyanobacteria

Understanding the Water Cycle



Lake Okeechobee Releases

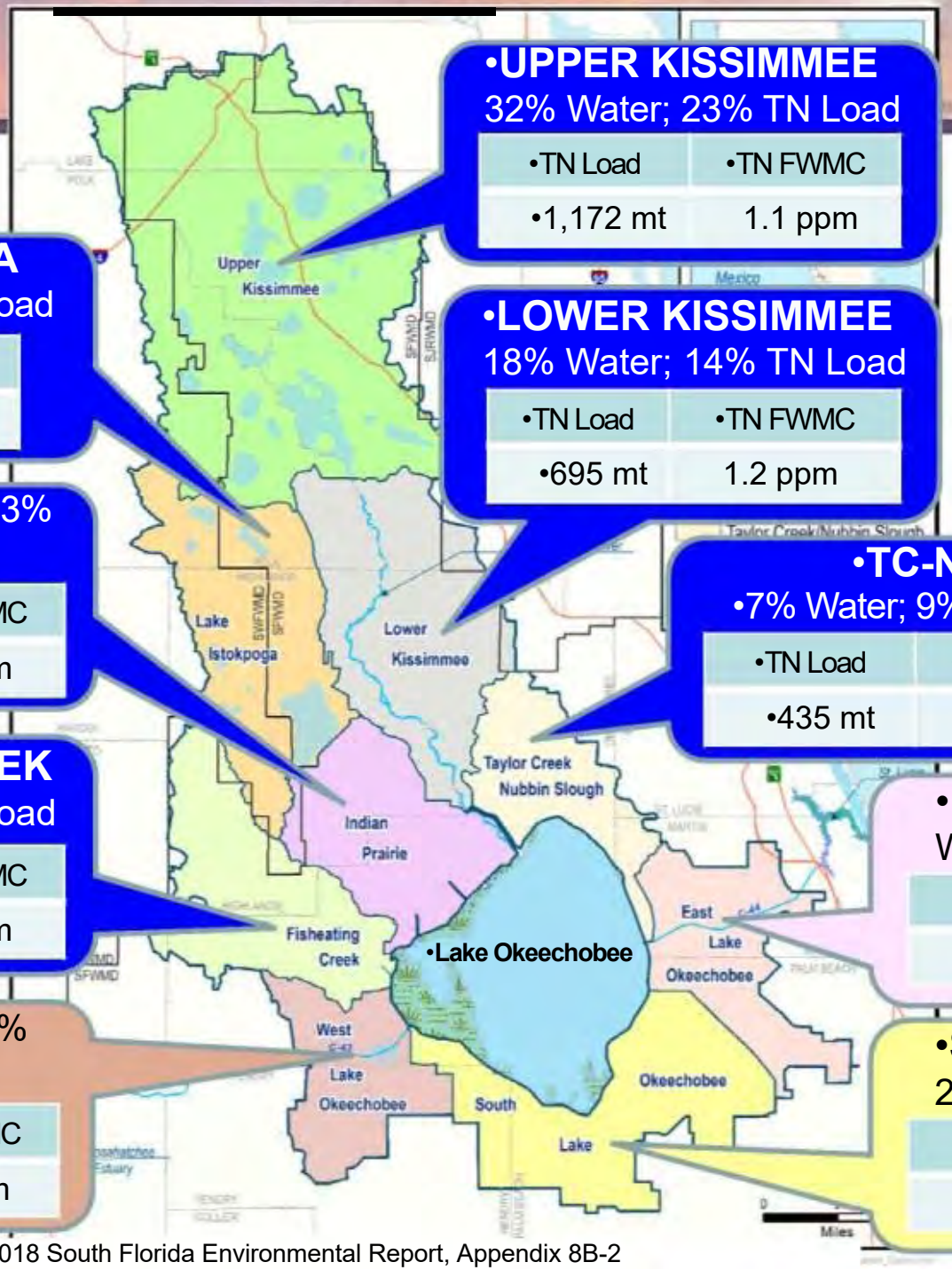
- **Outflows directed to the Caloosahatchee River** and St. Lucie River/San Carlos Bay (12% of total flow), along with runoff from the watershed increased flow to the Caloosahatchee River (4.2 bgd)

The introduction of organic matter, tannins, and other chemicals from runoff was captured in **an aerial photograph of Sanibel showing dark water entering the ocean that quickly became popular on social media**

•Lake Okeechobee Inflow

•WY2013-WY2017

•Nitrogen



•UPPER KISSIMMEE

32% Water; 23% TN Load

•TN Load	•TN FWMC
•1,172 mt	1.1 ppm

•LAKE ISTOKPOGA

13% Water; 14% TN Load

•TN Load	•TN FWMC
•710 mt	1.6 ppm

•LOWER KISSIMMEE

18% Water; 14% TN Load

•TN Load	•TN FWMC
•695 mt	1.2 ppm

•Northern watershed contributes:

~ 95% of flow and

~ 89% TN load

•INDIAN PRAIRIE 13% Water; 19% TN Load

•TN Load	•TN FWMC
•949 mt	2.2 ppm

•TC-NS

•7% Water; 9% TN Load

•TN Load	•TN FWMC
•435 mt	1.9 ppm

•FISHEATING CREEK

12% Water; 11% TN Load

•TN Load	•TN FWMC
•574 mt	1.5 ppm

•EAST LAKE O. 3% Water; 3% TN Load

•TN Load	•TN FWMC
•176 mt	1.9 ppm

•WEST LAKE O. <1% Water; <1% TN Load

•TN Load	•TN FWMC
•1.9 mt	1.4 ppm

•SOUTH LAKE O.

2% Water; 7% TN Load

•TN Load	•TN FWMC
•357 mt	4.4 ppm

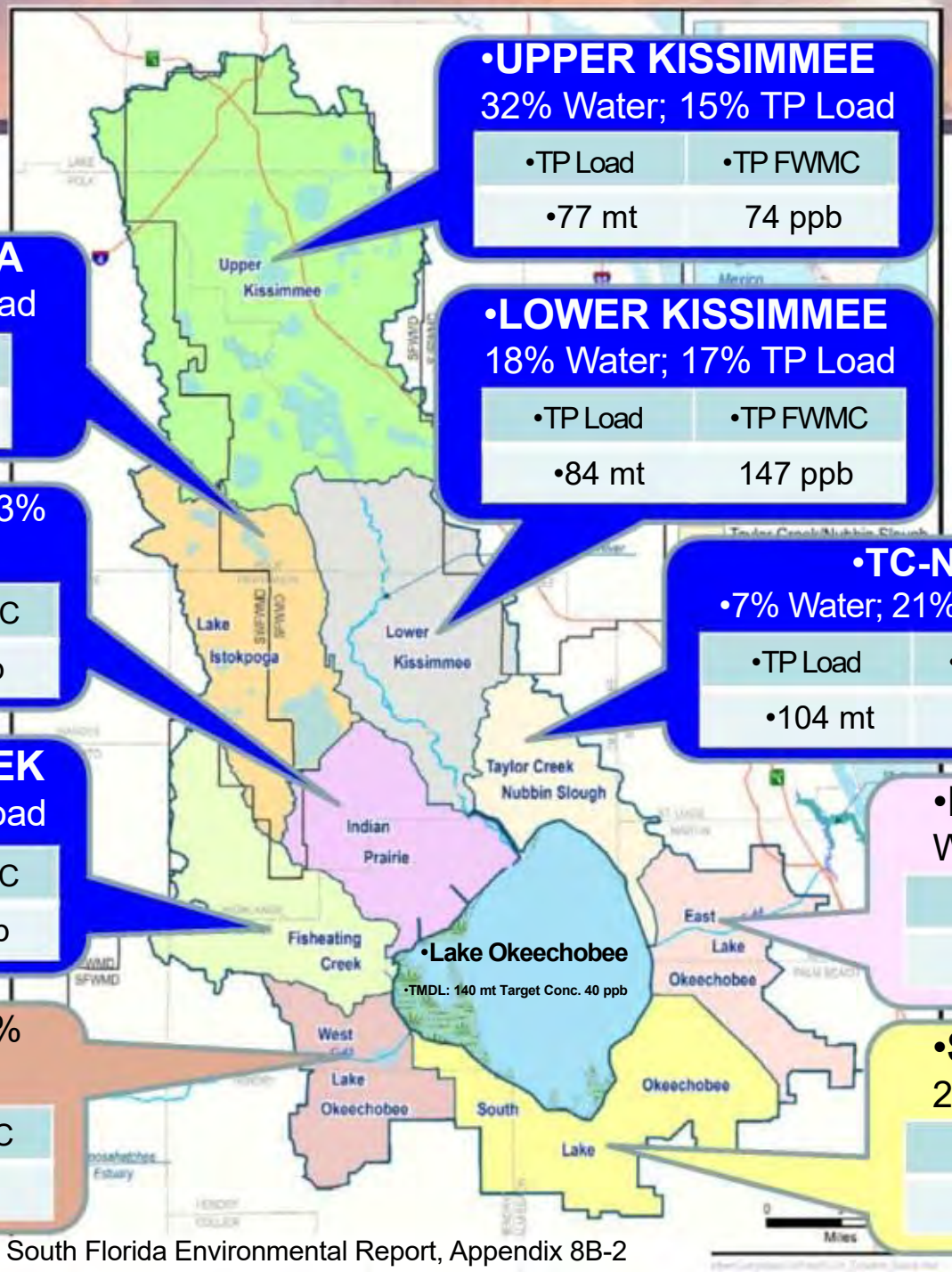
•Source: Draft 2018 South Florida Environmental Report, Appendix 8B-2

•SOUTH FLORIDA WATER MANAGEMENT DISTRICT

•Lake Okeechobee Inflow

•WY2013-WY2017

•Phosphorus



•UPPER KISSIMMEE
32% Water; 15% TP Load

•TP Load	•TP FWMC
•77 mt	74 ppb

•LAKE ISTOKPOGA
13% Water; 8% TP Load

•TP Load	•TP FWMC
•41 mt	95 ppb

•LOWER KISSIMMEE
18% Water; 17% TP Load

•TP Load	•TP FWMC
•84 mt	147 ppb

•INDIAN PRAIRIE 13%
Water; 19% TP Load

•TP Load	•TP FWMC
•95 mt	217 ppb

•TC-NS
•7% Water; 21% TP Load

•TP Load	•TP FWMC
•104 mt	450 ppb

•FISHEATING CREEK
12% Water; 12% TP Load

•TP Load	•TP FWMC
•60 mt	157 ppb

•EAST LAKE O. 3%
Water; 3% TP Load

•TP Load	•TP FWMC
•15 mt	159 ppb

•WEST LAKE O. <1%
Water; <1% TP Load

•TP Load	•TP FWMC
•0.1 mt	74 ppb

•SOUTH LAKE O.
2% Water; 4% TP Load

•TP Load	•TP FWMC
•21 mt	256 ppb

•Northern watershed contributes:

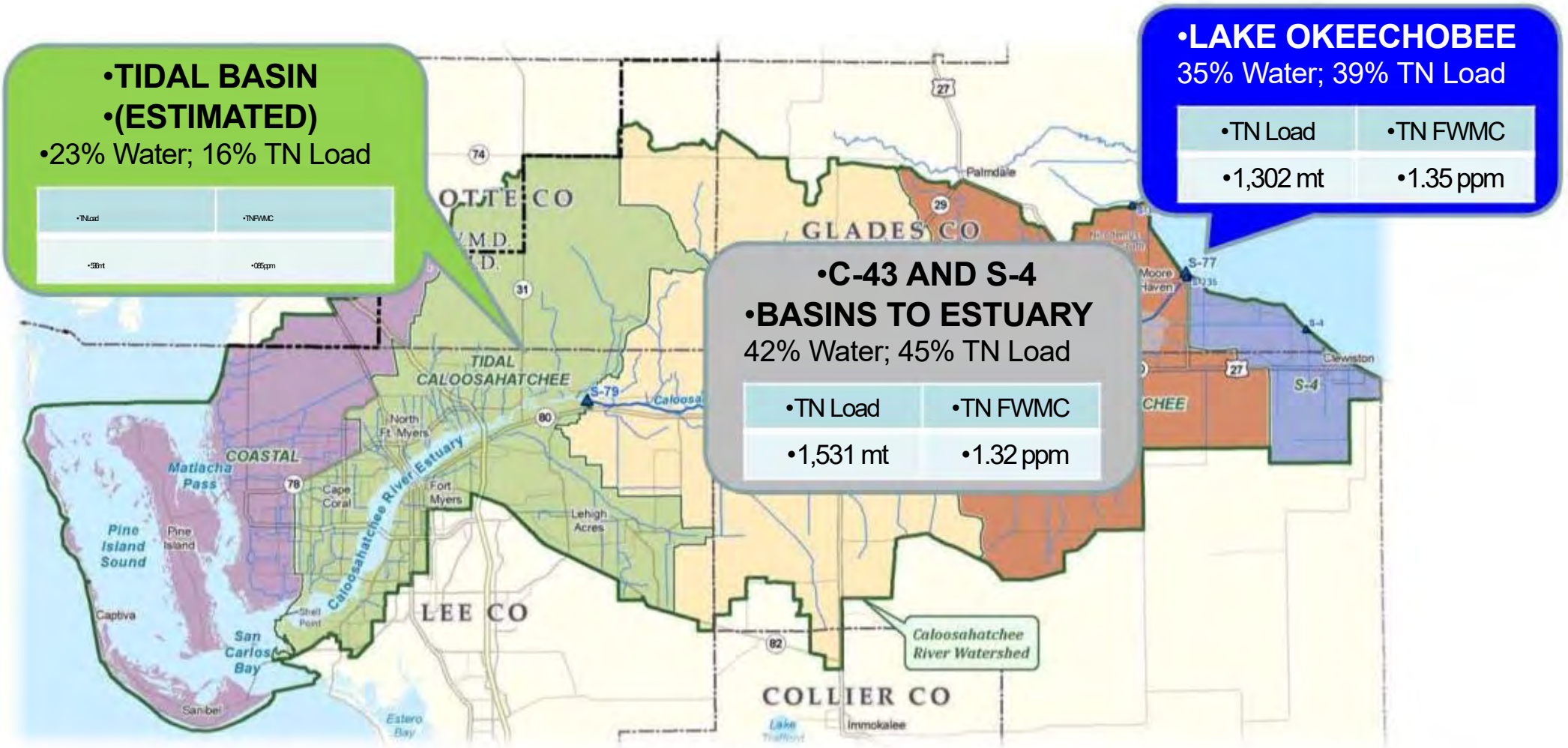
~ 95% of flow and

~ 93% TP load

•Source: Draft 2018 South Florida Environmental Report, Appendix 8B-2

•Caloosahatchee Estuary Inflows
•Nitrogen WY2013-WY2017

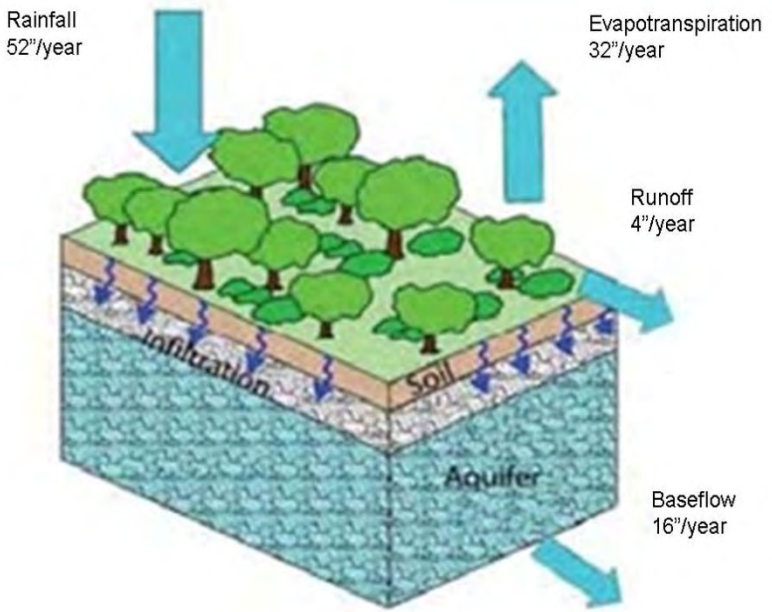
•**Local Basin Runoff accounted for about 65% of flow and 61% of TN load to Estuary**

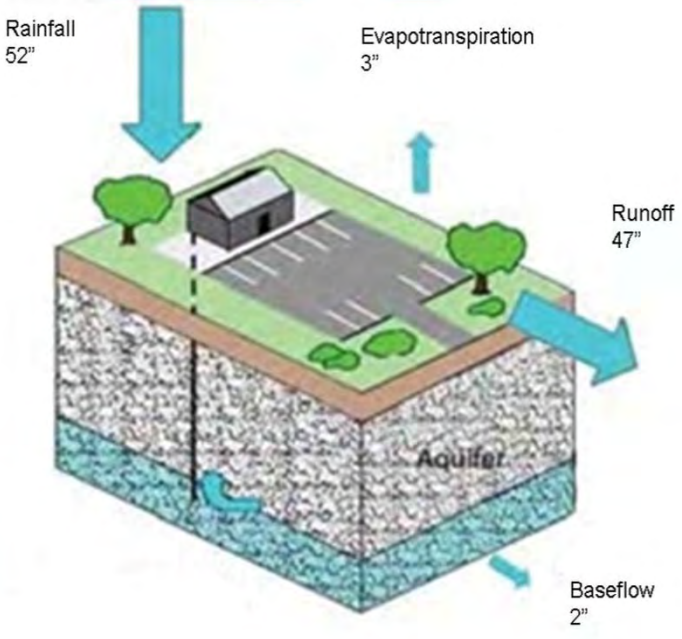


•Note: Coastal Basin runoff (west of Shell Point) is not included as Estuary contribution.

•Source: Draft 2018 South Florida Environmental Report, Appendix 8C-1

The Water Cycle and Our Impacts

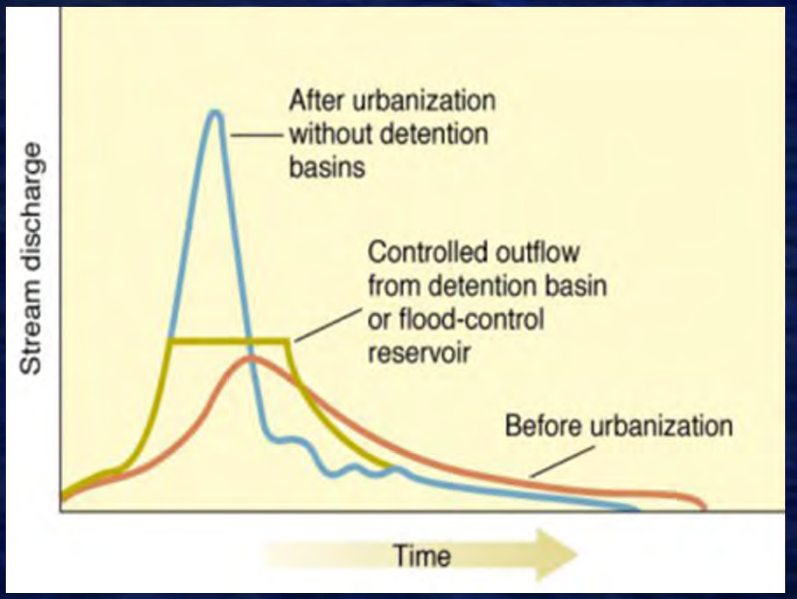


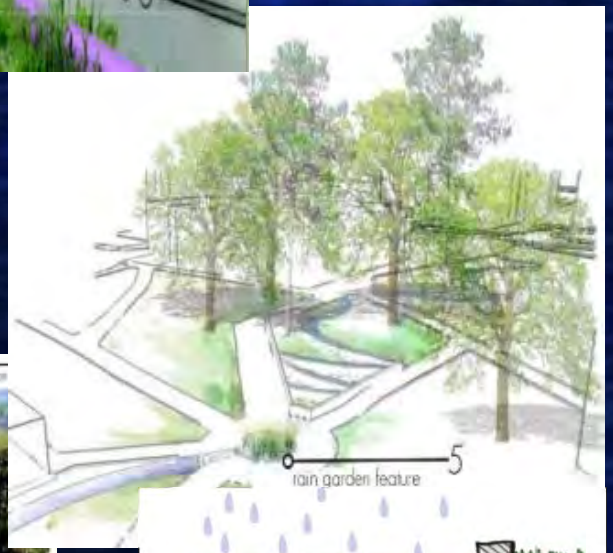


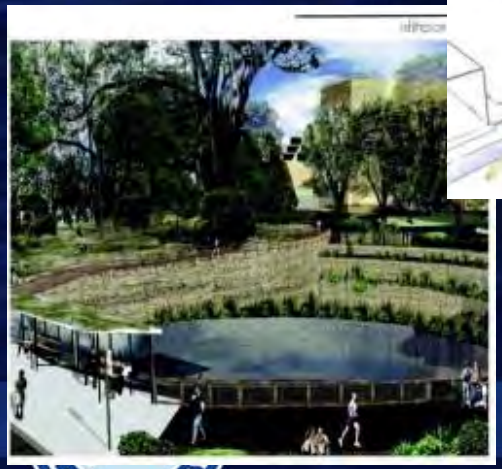
Florida Red Tide Would be Here, Even if We Weren't

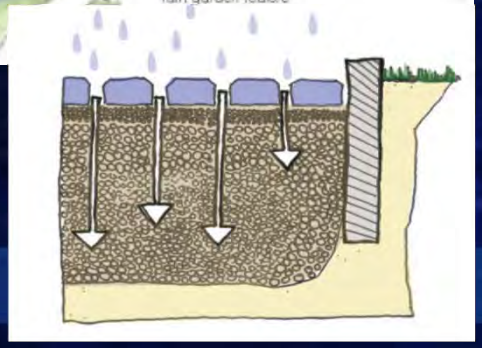
- But limiting nutrient loads and restoring hydrology should always be a goal
  - To prevent freshwater algae blooms
  - To prevent erosion
  - To recharge ground water tables
  - To allow for natural degradation of pollutants
  - AND to prevent any possible exacerbation of existing Florida red tide blooms

How do we fix what has been done?







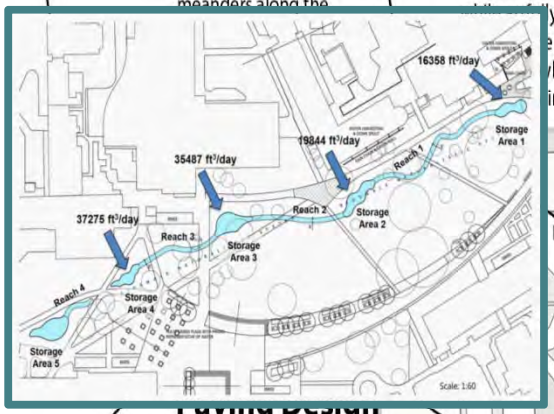


LOW IMPACT DEVELOPMENT: A stormwater management approach using natural systems to reduce runoff and pollutant loadings by managing the runoff as close to its source(s) as possible, with A goal of maintaining or closely replicating the predevelopment hydrology of the site.

FOUR POINTS OF ROOF-TOP STORMWATER COLLECTION

Bioswale

A naturalistic vegetated swale slows the flow of stormwater which collects in occasional ponds, and meanders along the



Green Wall & Water Collection

Alternating panels of Green Screen and rain chains line the southern wall of Williamson Hall to lower energy costs for the building [illegible] celebrating rainwater as it [illegible] planting beds and on to the [illegible] where it is naturally filtered [illegible] inuing it journey to the Ravine.

Dining Under a Tin Roof

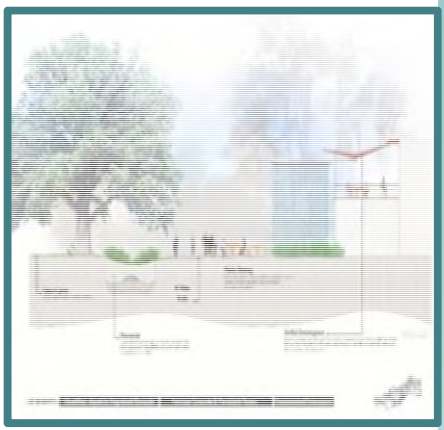
Users can dine atop the Hub and listen to the rain spilling into an artful downspout, flowing over a rain chain before watering the planting bed and continuing its journey through a series of naturalistic bioswales to the off-site ravine.

Green Roof on the Hub

Excess stormwater flows from the green roof to a runnel which conveys it to a series of artful pools as water continues its journey along the architectural form of the Arc.

Marston Headwaters

Stormwater is collected from the roof and begins it's journey here, cascading down the slope of the Marston Science Library into a series of rain gardens before being conveyed to the Campus Garden and Dairy Pond. A submersible pump allows the headwaters to continually circulate.



Paving Design

Where structure prohibits the exposure of waterflow beyond the Arc, paving interprets its journey to the natural sink, Green Pond, south of the Union.

Dairy Pond

This natural feature receives stormwater from Marston Headwaters and is now exposed and traversed by users as they enter the Reitz Lawn via a wooden bridge. A limerock platform, which begins as embedded paving along the path, compels users to gather for breaks near the water.

Rain Gardens

Flowing from Marston Headwaters, stormwater is slowed for filtration in two vegetated depressions or rain gardens before conveyance to the Dairy Pond or Campus Garden.

Campus Garden

Appropriately situated outside the Colllege of Agriculture and Life Sciences, this garden provides opportuntiy to extend curriculum outdoors and is irrigated by Marston Headwaters.

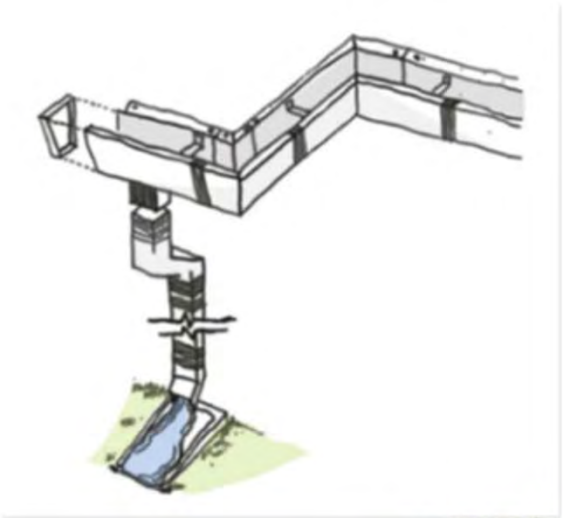
The Arc & Blue Gator Campaign.

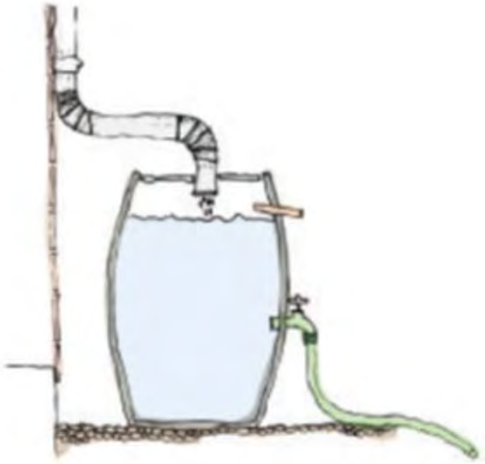
A celebrated prominade from the Hub to the Union increases in breadth over the journey, just as streams and rivers increase in

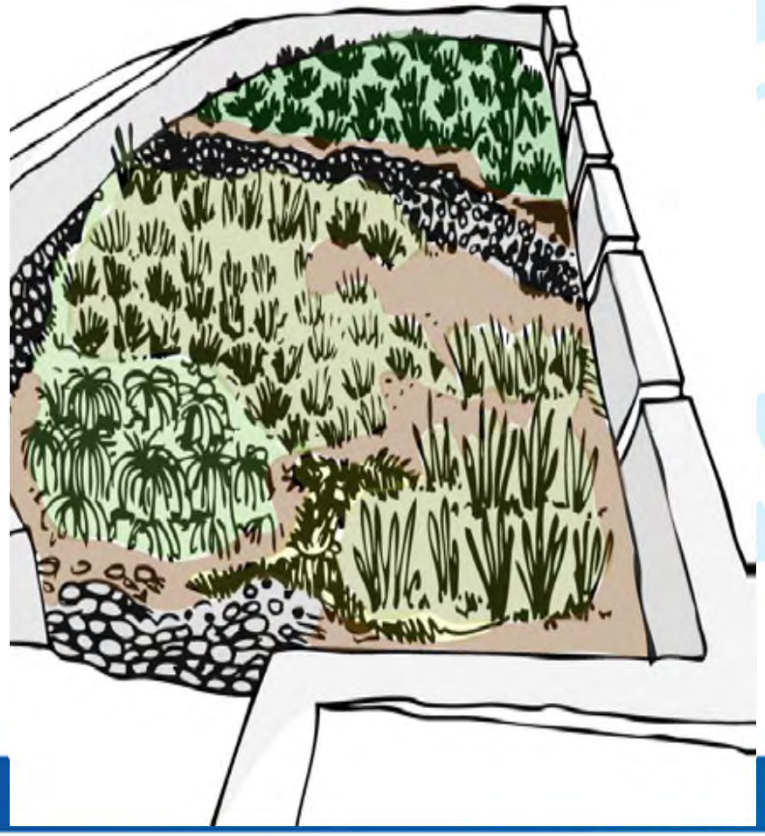
Inputs and Receiving Waterbodies

- Dairy Pond
- The Ravine
- Green Pond

But I want to do something now!







Rules of being a change-maker

1. Make your message simple to understand
2. Connect impacts with people- family, health, or finances
3. Give them an achievable solution
4. Get them involved
5. Sometimes, you can't change someone's mind, but you have 2 choices

Big changes are made through regulation and market- educate to change the market, science to change regulation

Dr. Tracy Fanara (@Inspector Planet)
tfanara@mote.org

- **Mote Beach Conditions Report: www.visitbeaches.org**
- **Updates and info from FWC: http://myfwc.com/redtide**
- **HAB Bulletin from NOAA: http://tidesandcurrents.noaa.gov/hab/**
- **Mote, FAQs, & Beach Conditions Report: http://mote.org/news/environment-updates#RedTide**
- **Learn about red tide on Facebook from this FWC-Mote page about Florida's harmful algal blooms: www.facebook.com/flhabs**
- **Latest model forecasts from USF-FWC Collaboration for Prediction of Red Tides at: http://cprweb.marine.usf.edu/**

INSPECTOR PLANET

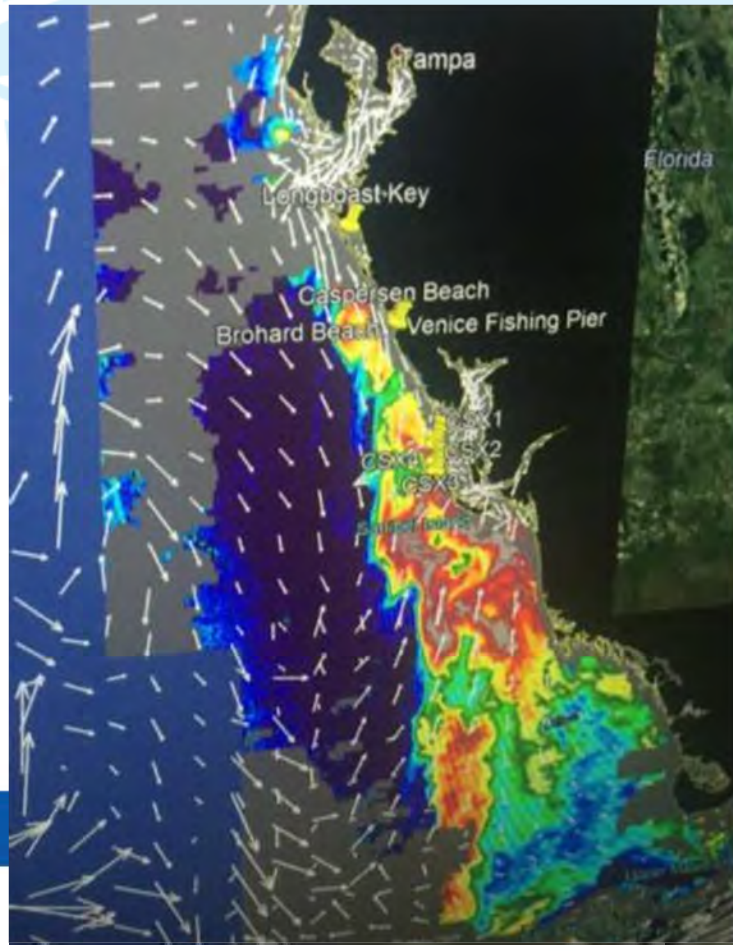
Plants recommended for Florida Landscaping (i.e. solid root structure, resistant to pests, freeze resistant):

- Annuals: Violet, Marigold, Sweet Alyssum, Ageratum, Rudbeckia
- Perennials: Cinnamon Fern, Firespike, Wild sage, Heliconia, Climate-specific Agave
- Ferns: Holly fern, Florida Thatch Palm, Cabbage Palmetto, Date Palms, Jelly Palm
- Grasses: Crown Grass, Muhly Grass, Elliot's Lovegrass
- Ground Covers: Sunshine Mimosa, Holly Fern
- Vines: Mandevilla, Algerian Ivy, Morning Glory, Pipevine
- Shrubs: Ternstroemia, Weeping Fern Pine, Yaupon Holly
- Trees: Yellow Elder, Sand Live Oak, Twinberry, Gumbo Limbo, Satinleaf, Bluff Oak, Sweet Bay Magnolia, Red Maple

KEEP healthy plants in place and plant around them

Common Questions

- How to blooms initiate?
- How does weather impact blooms?
- Can we predict blooms
- How can we mitigate blooms?
- What role does nutrients play



South Florida Environmental Stressors

Stressors:

- Urbanization
- Agricultural Chemical Use
- Increased Water Demand
- Pollutant Loads: Phosphorus, Nitrogen, Mercury, Copper, Wastewater, Pesticide, Fungicide, and Fertilizer Chemicals
- **Rainfall**

Implications:

- Eutrophication and Harmful Algae Blooms
- Ecological Impacts of lakes, wetlands, estuaries
- Impacts to Aquatic Life
- Impacts to Drinking Water Sources
- Impacts to Groundwater and Soil Quality
- Dark water

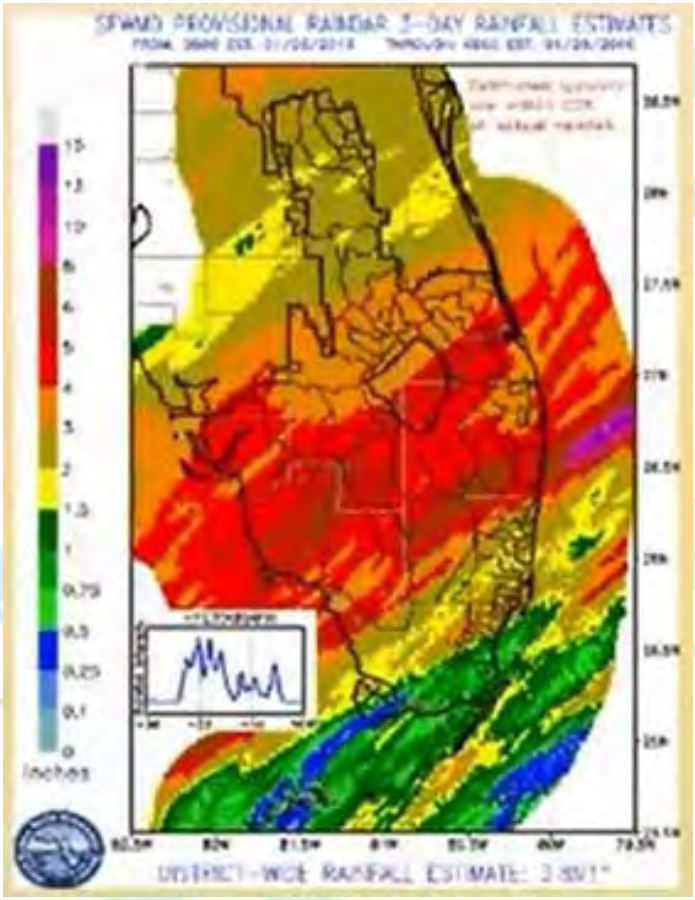
***Stormwater is the #1 non-point source of pollution**

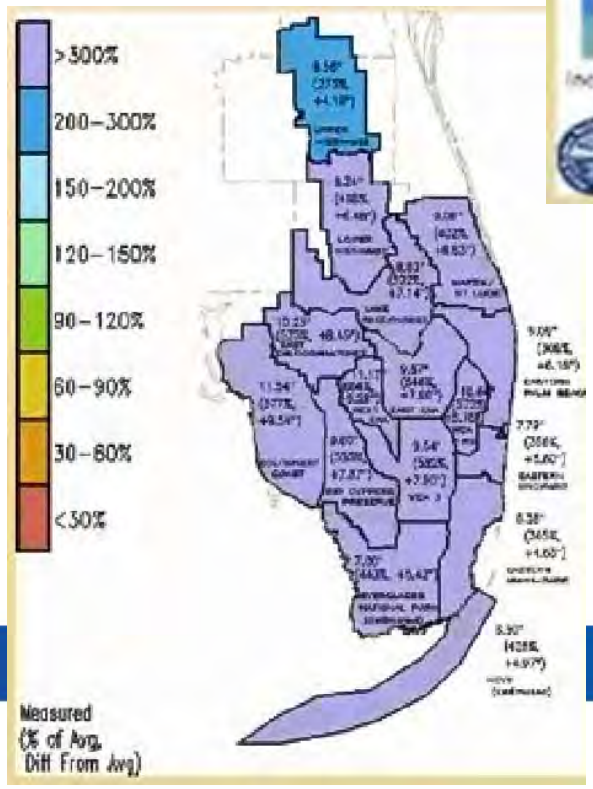
What Needs to be Done:

- Full Chemical Monitoring
- Implementation of Low Impact Development
- Develop and Use Chemical Removal Techniques for Pesticides, Fertilizer, and other Stressors
- Treat at Source

Lake Okeechobee Releases

- **January 2016, SFWMD saw 9.18” of rainfall** ~476% Ave Jan. Rainfall
- **Southwest Coast of Florida received 11.54”** of rainfall ~counties over 300% Ave.
- **3.9”** were experienced within **three days** (January 26th-29th)
- **To prevent flooding, runoff was back-pumped to Lake O** to protect local communities and agriculture to the south
- **Lake O raised 10” in** water level





Brief History of Florida Red Tide

1542 — Alvar Nuñez Cabeza de Vaca published tales of toxic "red water" from Florida Indians in this region

1844 — The first scientifically documented “red-tide” occurs along the West Florida Shelf and off the Panhandle near Panama City

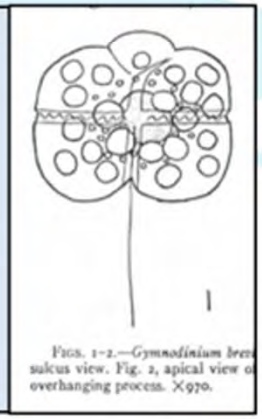
1878 — Florida's first recorded protracted period of “red-tide” begins, continuing for ~ 10 years

Brief History of Florida Red Tide

1880 — A widespread episode of bird mortality, attributed to red tide, affects the Florida Gulf

1884 — The first incident of human sickness from red-tide-infected shellfish is recorded in Florida

1947 — Bloom lasts nearly a year damages commercial fishing and Tarpon Springs sponge beds. Led to the identification *Karenia brevis*



1953 — The longest single red-tide episode recorded to that date begins an 18-month stay along the Florida Gulf Coast

1994-1996 — 20-month bloom extends from Pinellas County to Key West. Blamed for deaths of 10% of the total manatee population

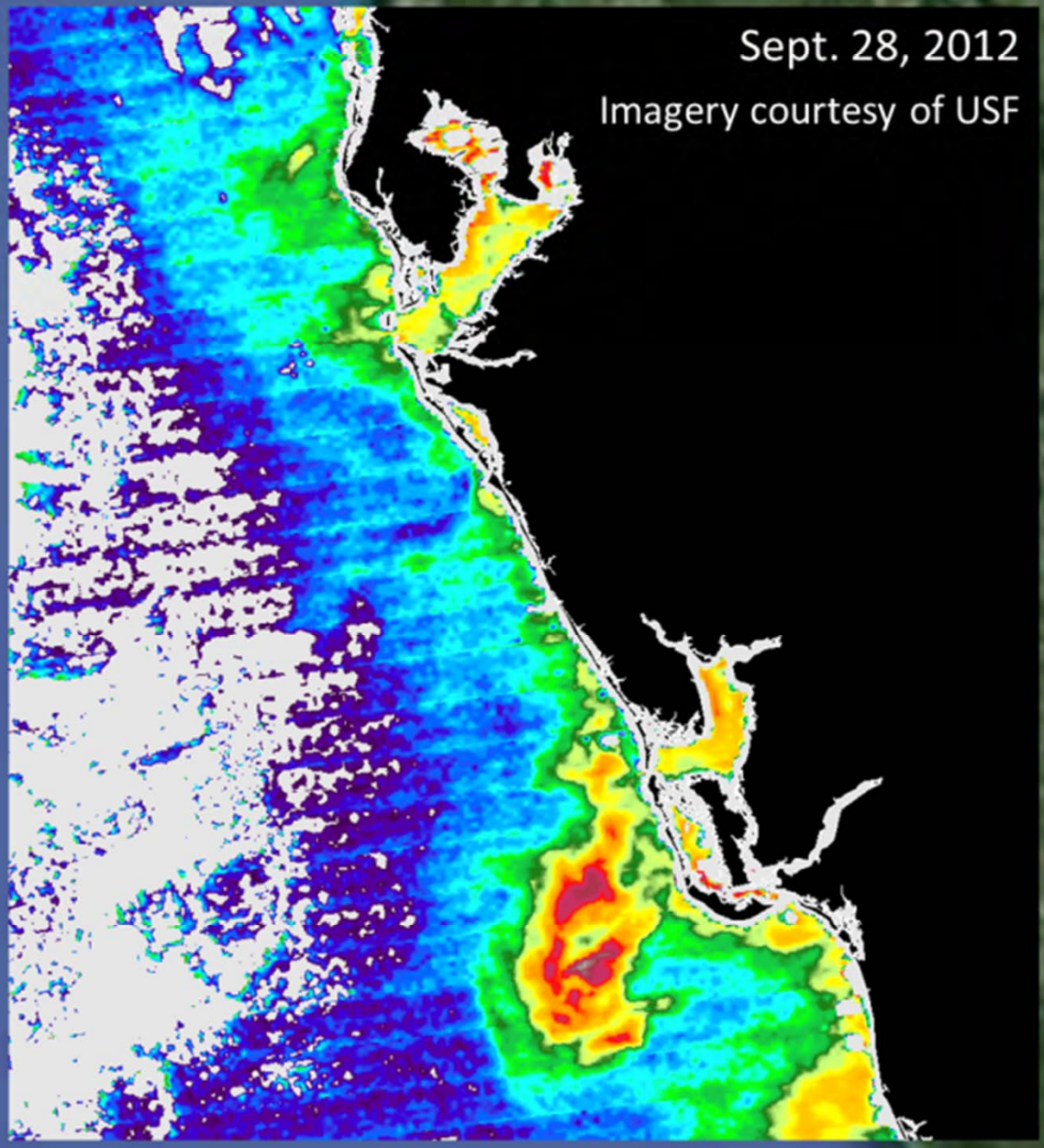
Bloom of 2012-13

Massive bloom lasted more than 6 months

At its maximum, stretched ~140 mi north to south, from Tampa Bay to Naples, and ~30 mi east-west

Resulted in massive fish kills and record manatee deaths

Respiratory effects on beaches

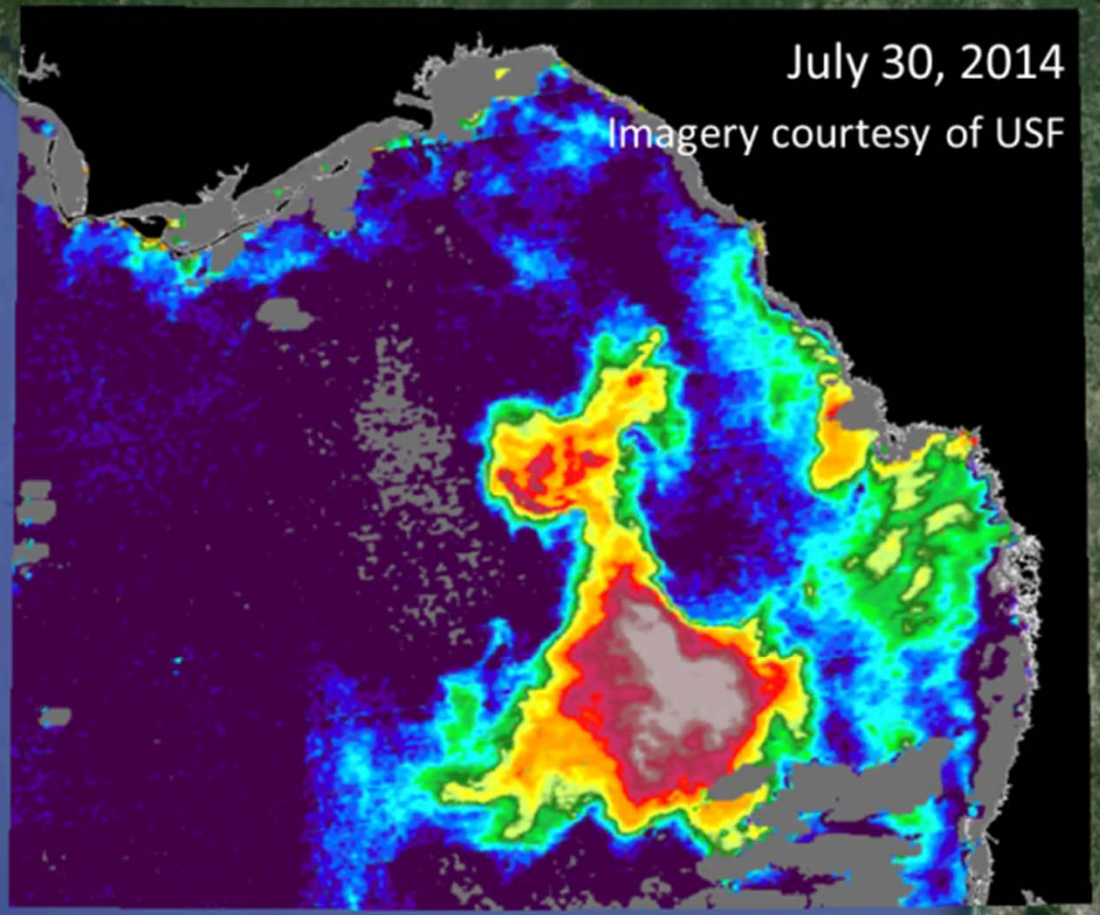


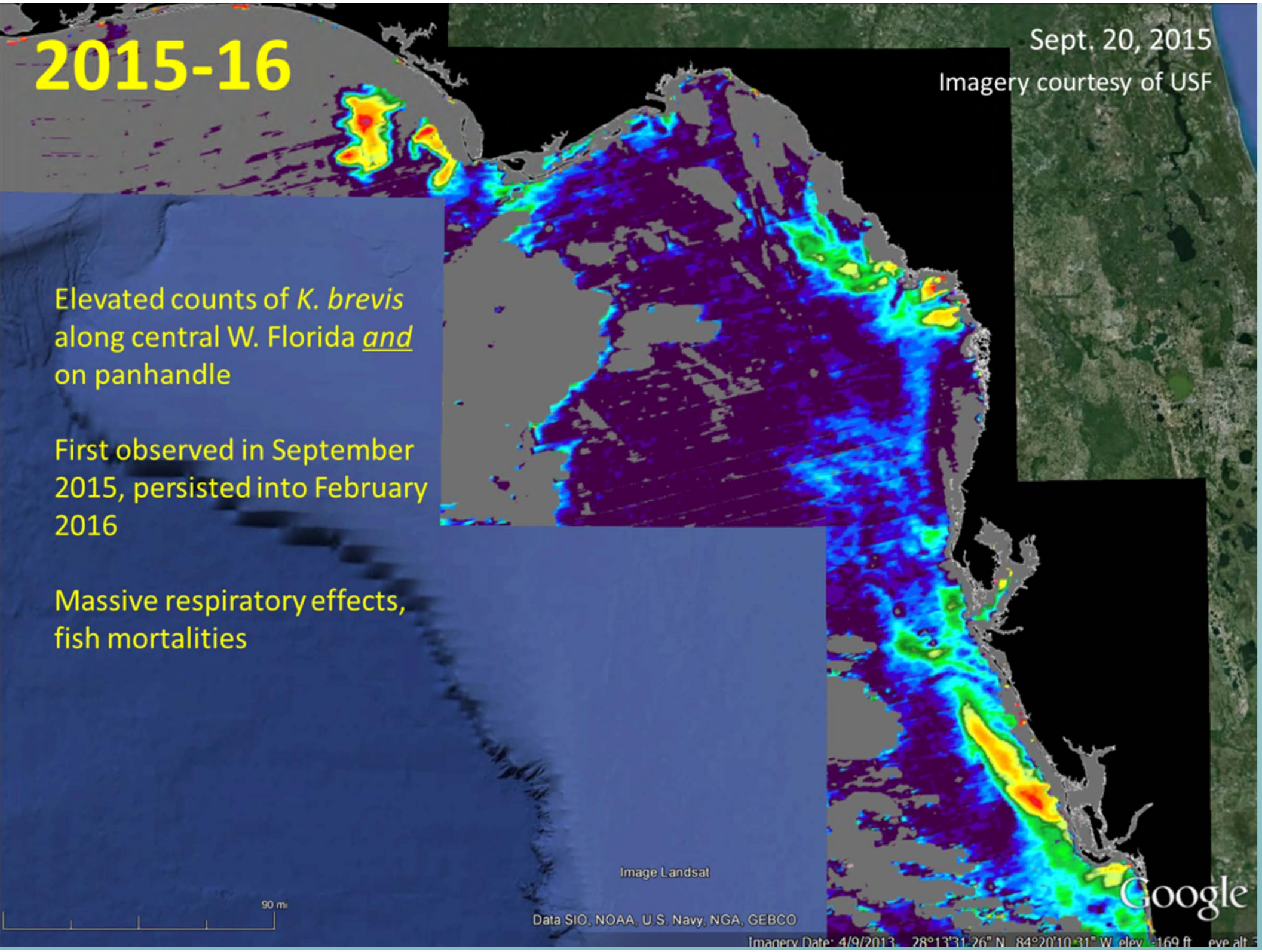
Bloom July 2014

Very large bloom in the Big Bend area of Florida – spanned more than 80 mi across

Die off of reef organisms, including fish, sharks, turtles, eels

Remained mostly offshore, few effects on coastal areas



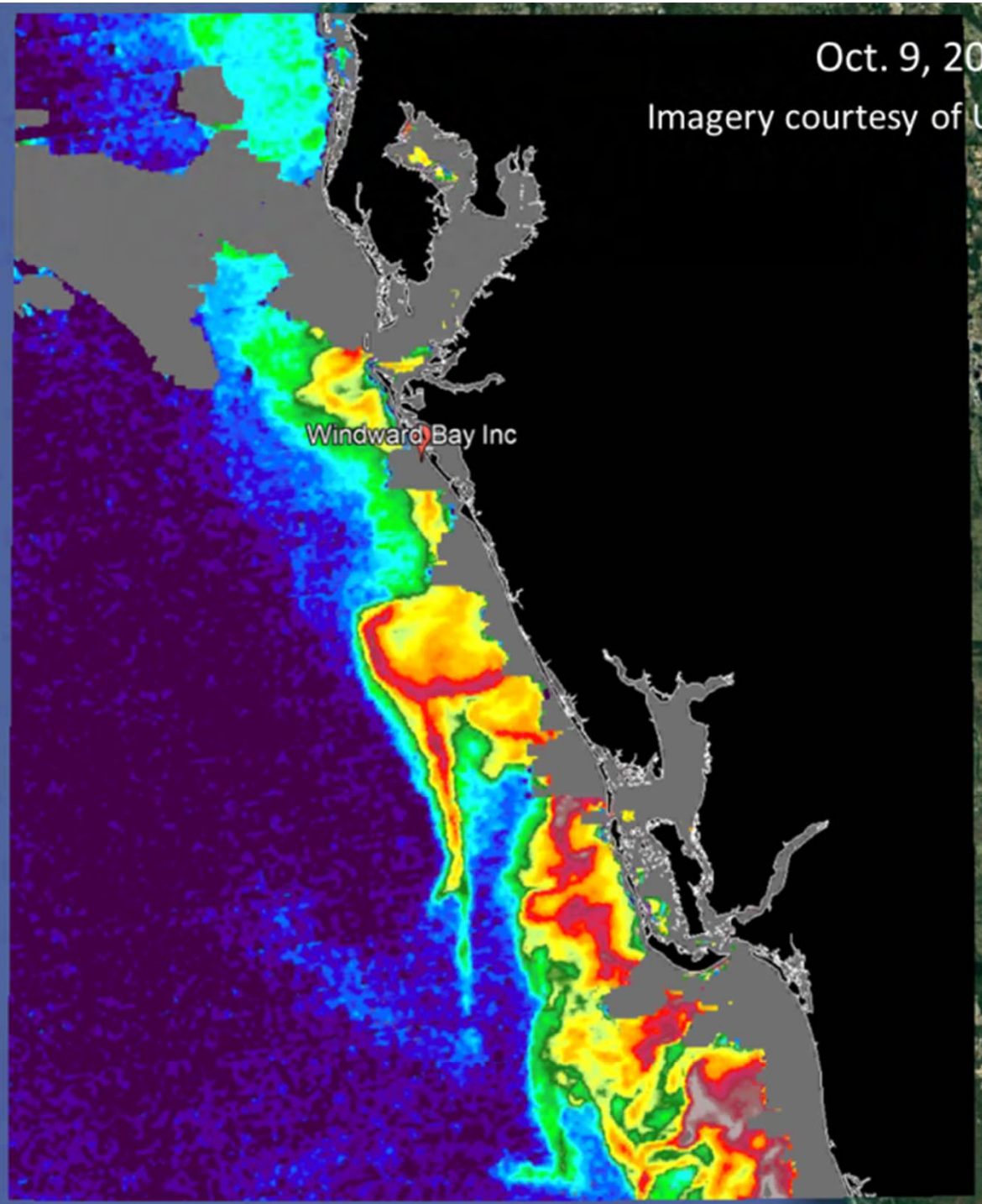

2015-16
Sept. 20, 2015
Imagery courtesy of USF
Elevated counts of K. brevis along central W. Florida and on panhandle
First observed in September 2015, persisted into February 2016
Massive respiratory effects, fish mortalities
Image Landsat
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
90 mi
Google
Imagery Date: 4/9/2013 28°13'31.26" N 84°20'10.31" W elev -169 ft eye alt

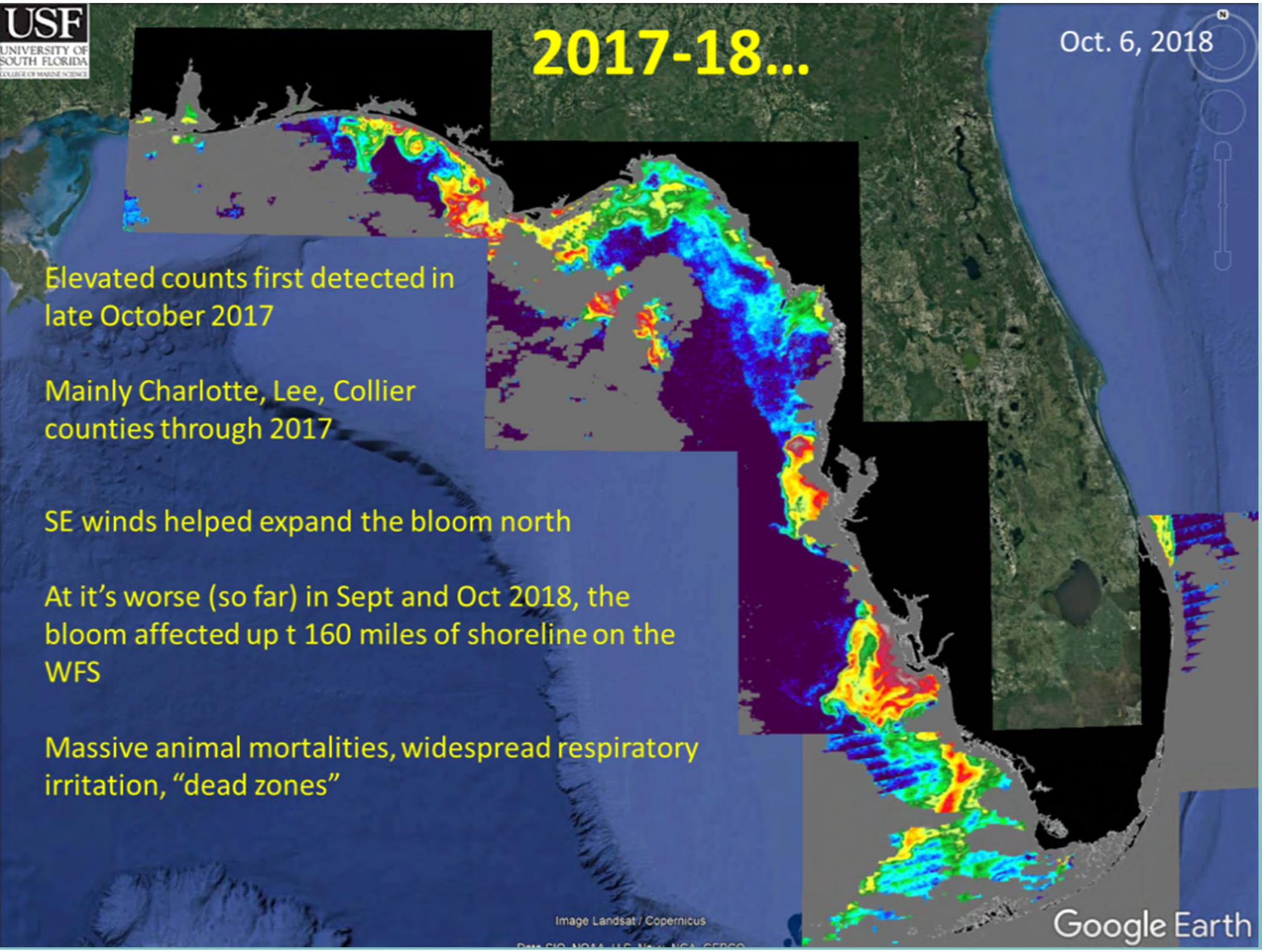
2016-17

First indicated in September 2016

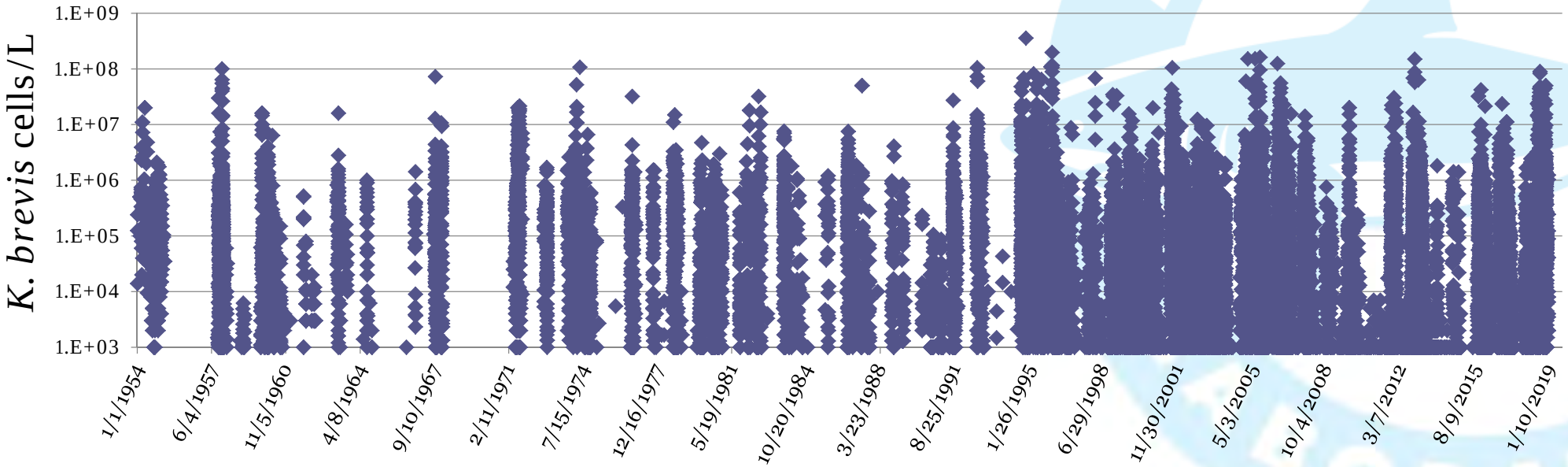
Persisted along coast into February 2017, though very patchy

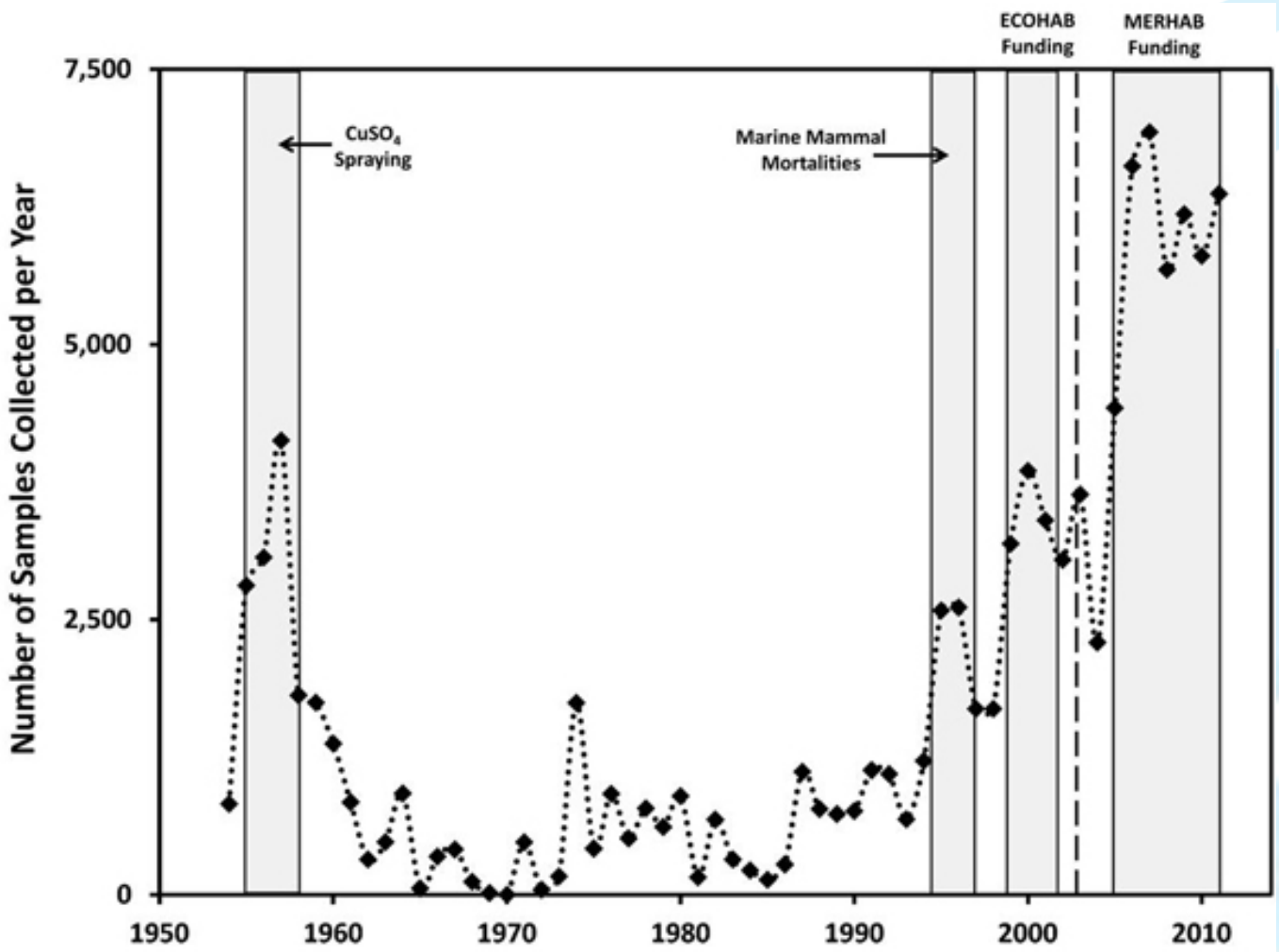
Remained entrained in Sarasota Bay into May

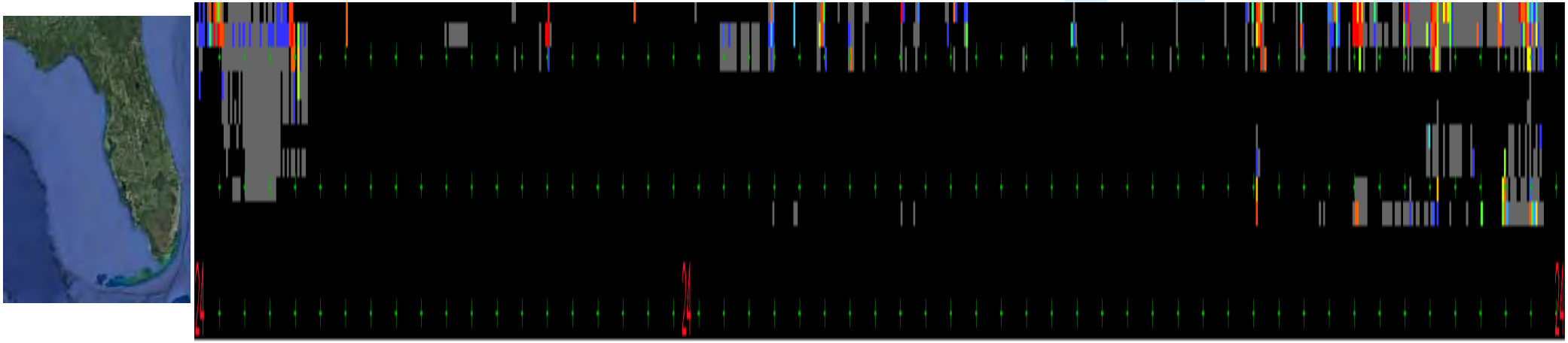



USF
UNIVERSITY OF SOUTH FLORIDA
2017-18…
Oct. 6, 2018
Elevated counts first detected in late October 2017
Mainly Charlotte, Lee, Collier counties through 2017
SE winds helped expand the bloom north
At it's worse (so far) in Sept and Oct 2018, the bloom affected up t 160 miles of shoreline on the WFS
Massive animal mortalities, widespread respiratory irritation, "dead zones"
Image Landsat / Copernicus
Google Earth

Karenia brevis abundance 1954 - 2019




ECOHAB Funding
MERHAB Funding
7,500
5,000
2,500
0
$CuSO_4$ Spraying
Marine Mammal Mortalities
Number of Samples Collected per Year
1950
1960
1970
1980
1990
2000
2010



x-axis is time with one pixel per month, starting Jan 1954 ending in 2007. Ticks are start of year. y-axis is latitude 24 – 31 (ticks every 1 degree bottom is 24 degrees).
Gray means sampled but absent, colors are present; blue = up to 1K cells/L, cyan up to 5K
green up to 10K (FWRI very low), yellow up to 50K, orange up to 100K, red up to 1000K, dark red > 1000K, darkest red > 32000K

FWC/FWRI-Mote Cooperative Red Tide Program
Monitoring, Research, and Mitigation

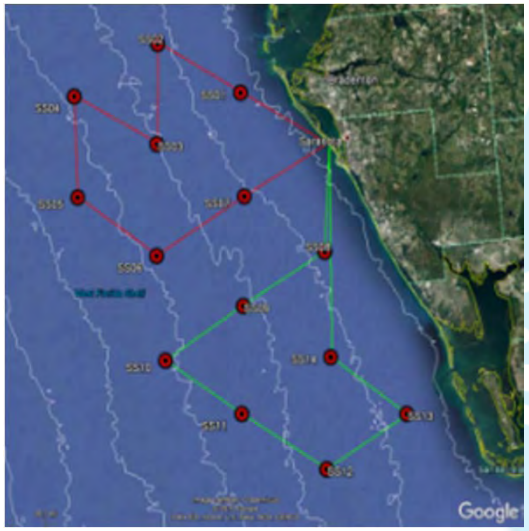
"Comprehensive" monitoring of coastal waters in areas of bloom initiation and propagation

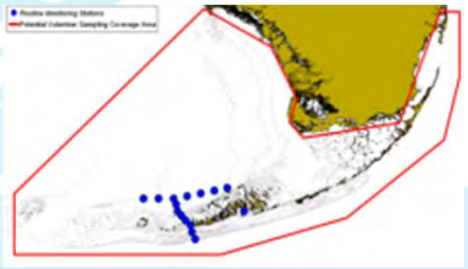
- Bloom detection, tracking, mapping
- Improve knowledge of environmental correlates
- Provide a time series of chemical and physical conditions in SW FL coastal waters
- Estimate nutrients and nutrient ratios
- Provide data for modeling efforts for prediction and forecasting

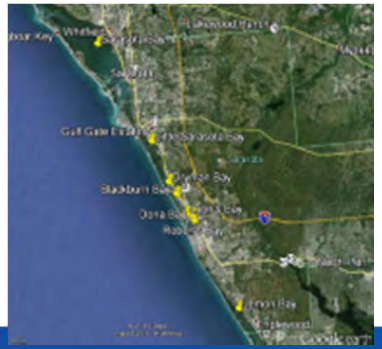
FWC/FWRI-Mote Cooperative Red Tide Program
Monitoring, Research, and Mitigation

4 Components

- Routine Surveys
- Florida Keys Monitoring
- Adaptive Response
- Collaborative Support





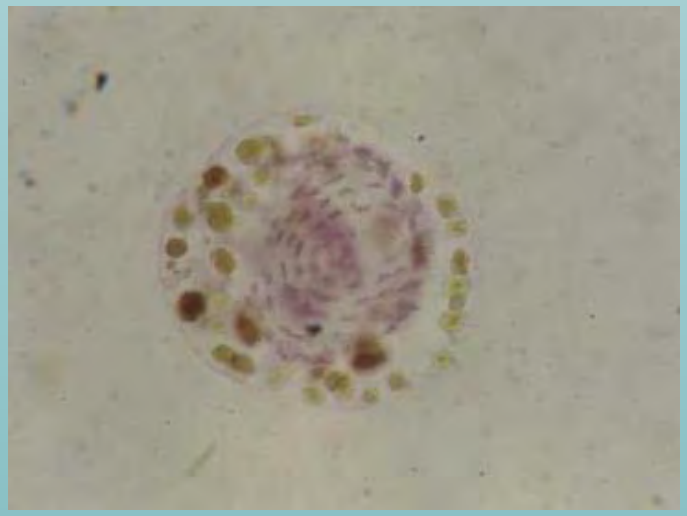


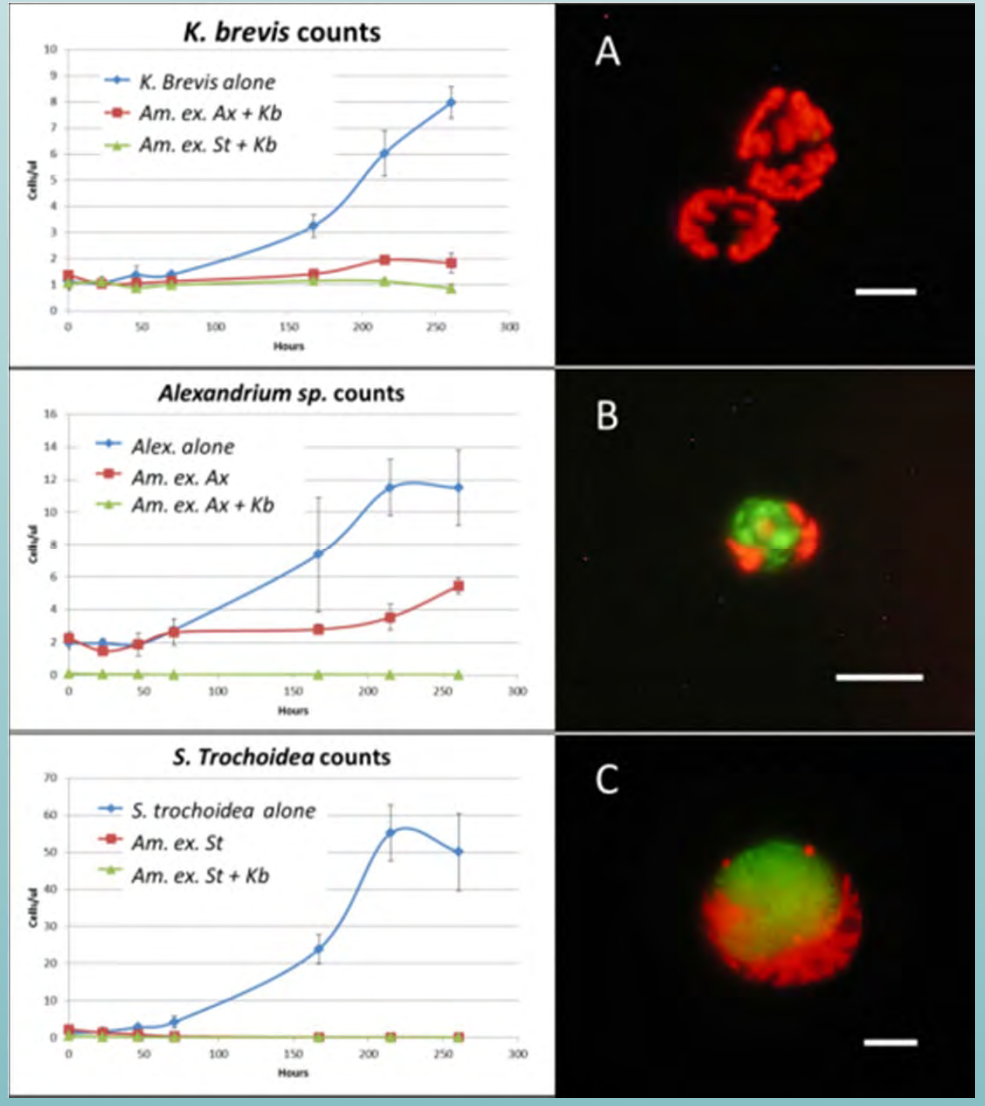

MARINE RESEARCH
www.mote.org

Mote Phytoplankton Ecology Program: Pilot Projects/Future Work -

Amoebophrya – A parasitic dinoflagellate that parasitizes other dinoflagellates

- Little work re: *Am*. And *K. brevis*
- Possible control mechanism





Mote Environmental Health Research Program

Goals:

- Investigate How Human Interactions with the Environment Impact Ecosystem Health
- Investigate How Marine And Freshwater Chemicals Impact Public Health
- Communicate Human Impacts And Health Risks To The Public
- Design Strategies And Methodologies To Alleviate Impacts

FATE OF BREVETOXINS IN THE MARINE ENVIRONMENT