Diatom Blooms in Biscayne Bay

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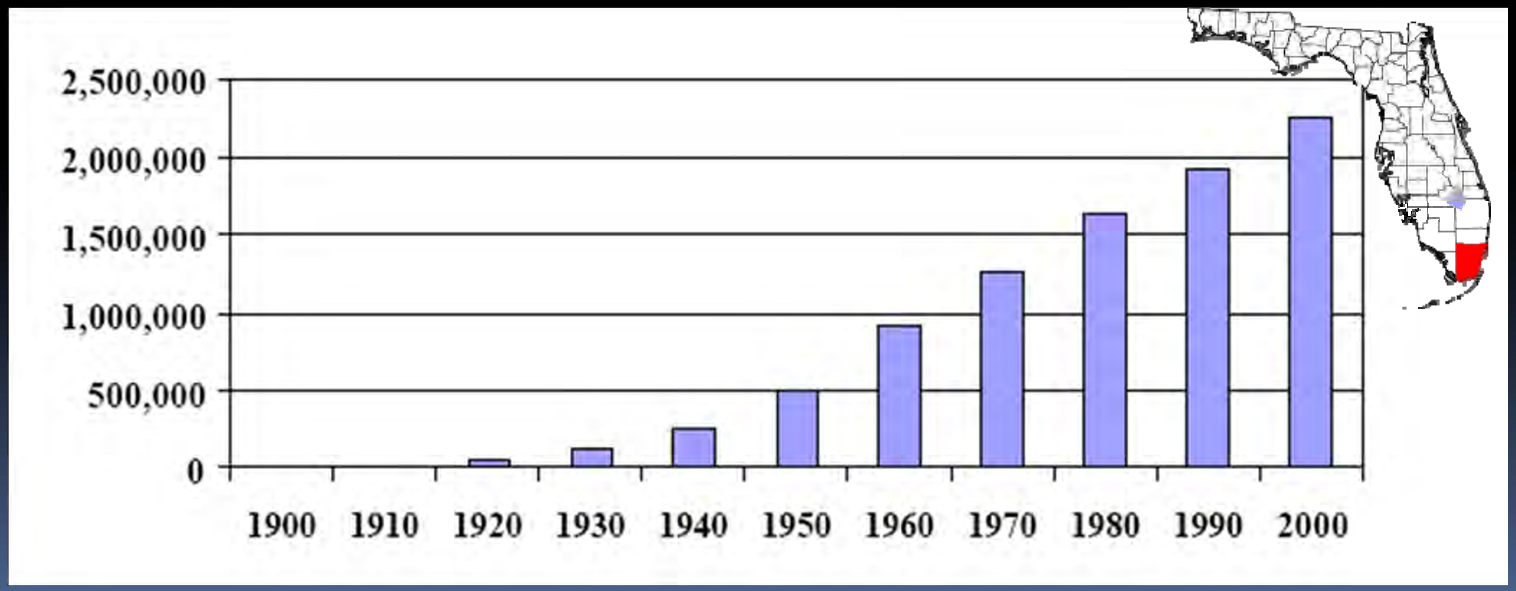
Miami ~ A.D. 1900

Miami Today



Human Population Growth in Miami Dade County (1900-2000)

Effects of Coastal Population Growth on Biscayne Bay Ecosystem

- Habitat loss (e.g.,SAV in northern Biscayne Bay)
- Shift in species composition, abundance, and diversity
- Micro- & Macroalgal blooms (nearshore areas)
- Highly pulsed point source freshwater discharges from canals
- Altered water quality
- Saltwater encroachment
- Altered water circulation & residence time

SIO, NOAA, U.S. Navy, NGA, GEBCO

Drivers of Change

Impacts

Microalgal Blooms

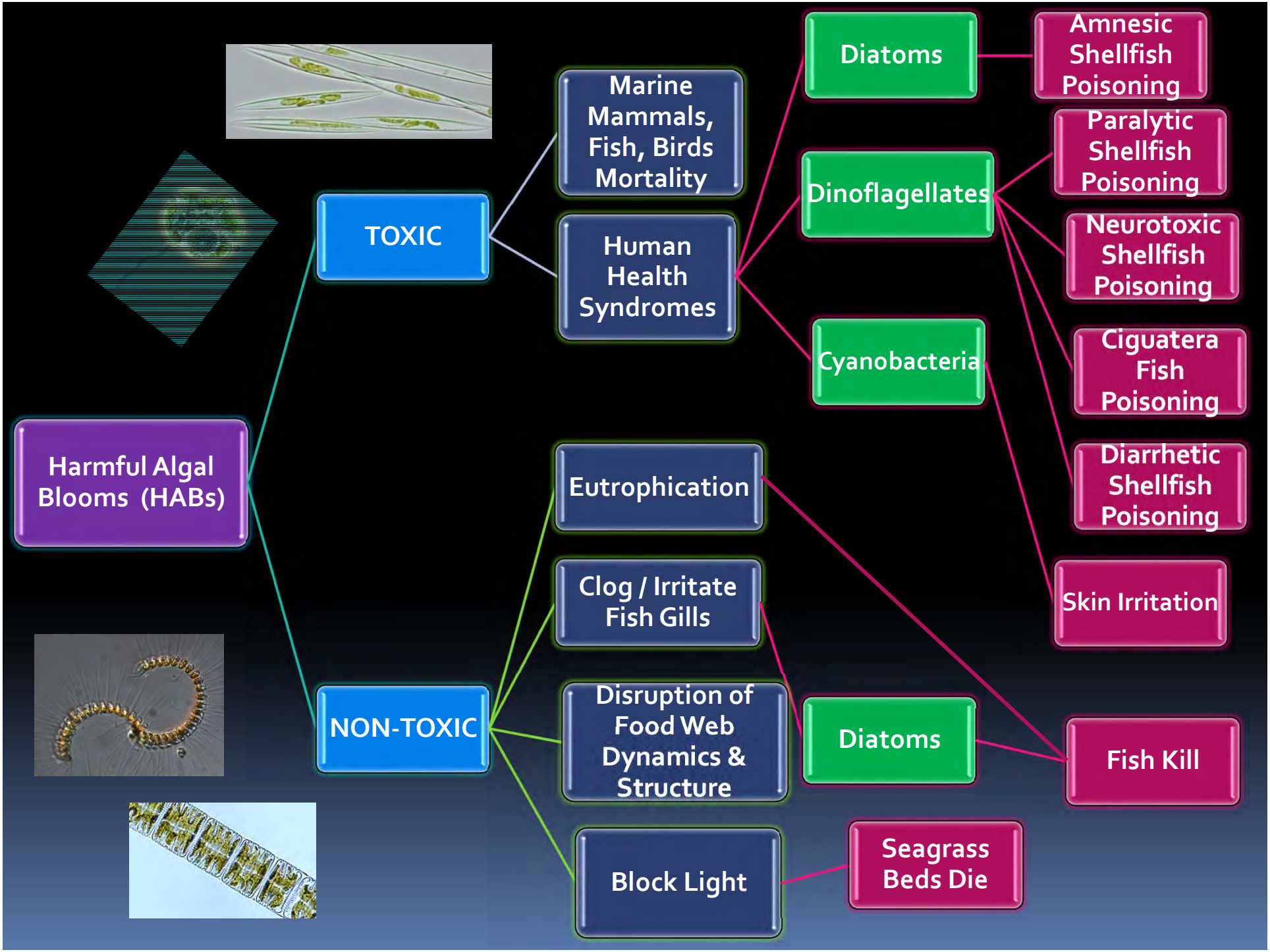
Chaetoceros debilis (Wim van Egmond)

Causes of Harmful Algal Blooms (HABs)

THERE IS NO SINGLE FACTOR WHICH CAUSE AN ALGAL BLOOM !!!

Blooms of these organisms are attributed to two primary factors:

- **Natural processes such as circulation, upwelling relaxation, river flow, high temperatures, high salinity**
- **Anthropogenic nutrient loadings leading to eutrophication**


Harmful Algal Blooms (HABs)
TOXIC
NON-TOXIC
Marine Mammals, Fish, Birds Mortality
Human Health Syndromes
Eutrophication
Clog / Irritate Fish Gills
Disruption of Food Web Dynamics & Structure
Block Light
Diatoms
Dinoflagellates
Cyanobacteria
Diatoms
Amnesic Shellfish Poisoning
Paralytic Shellfish Poisoning
Neurotoxic Shellfish Poisoning
Ciguatera Fish Poisoning
Diarrhetic Shellfish Poisoning
Skin Irritation
Fish Kill
Seagrass Beds Die

The most severe effects of HABs include:

- fish, bird, and mammal (including human) mortalities
- respiratory or digestive tract problems
- memory loss,
- seizures,
- lesions
- skin irritation,
- losses of coastal resources such as submerged aquatic vegetation and benthic epi- and in-fauna

Non-Toxic Algal Blooms

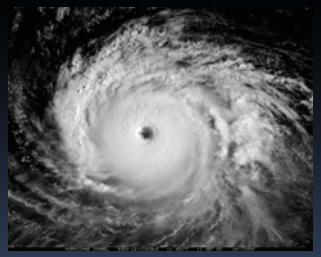
Effects of Water Quality Changes on Estuarine Ecosystem

Changes in water quality and salinity

Fish, shrimp, marine mammals decline /biodiversity decline

Loss of submerged vegetation (SAV)

Destabilization of sediments and release of nutrients



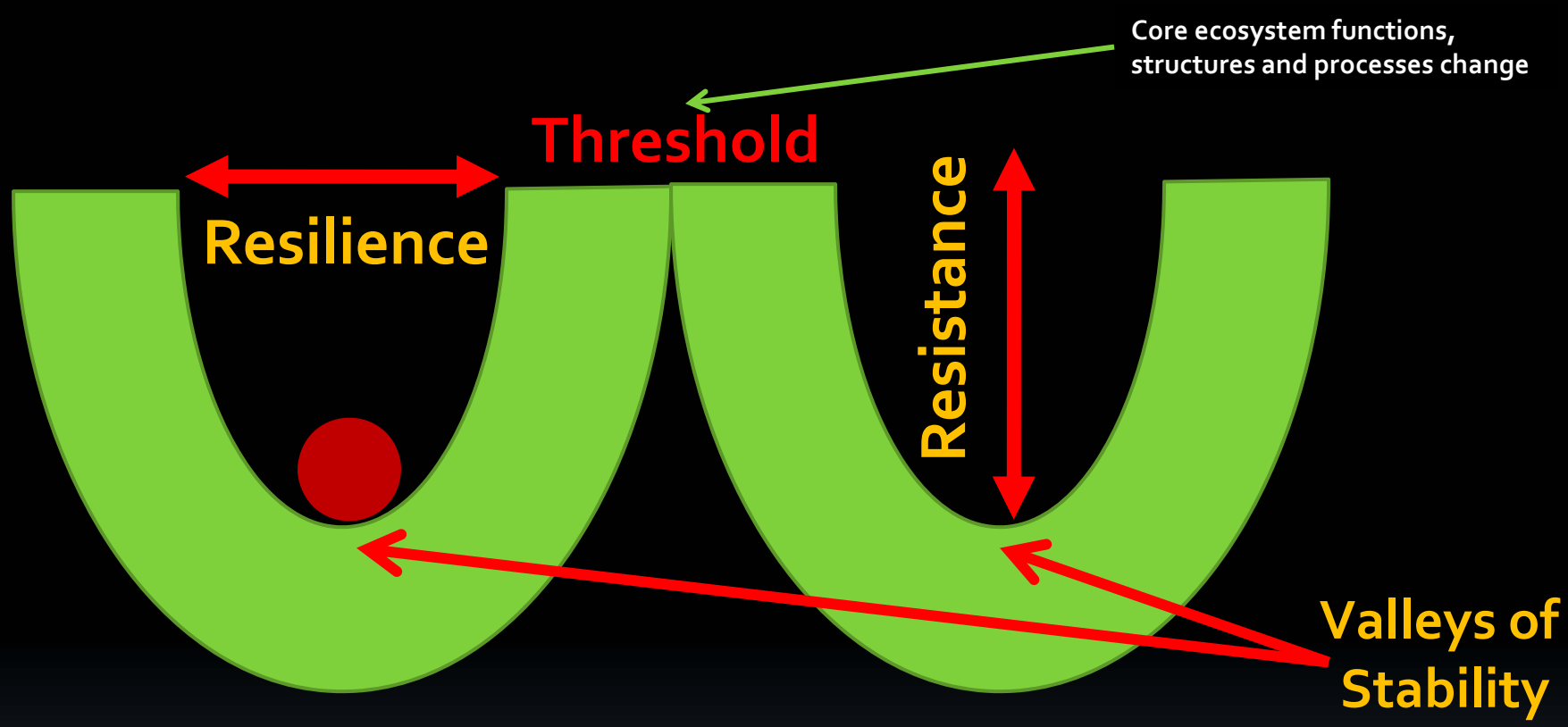
Phytoplankton blooms / Macro algae blooms

Further Loss of SAV due to shading

Decomposition of algae and SAV by bacteria/O2 Depletion

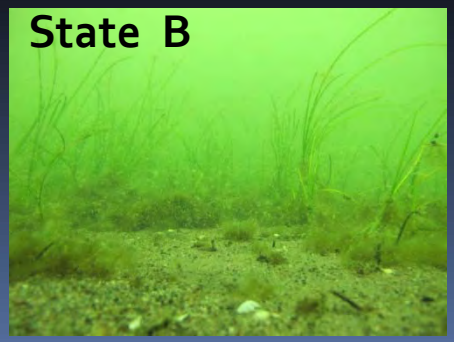
Ecological Regime Shift

Ecosystem State Changes



Ecological Regime Shift

- Very EXPENSIVE and difficult (impossible) to reverse



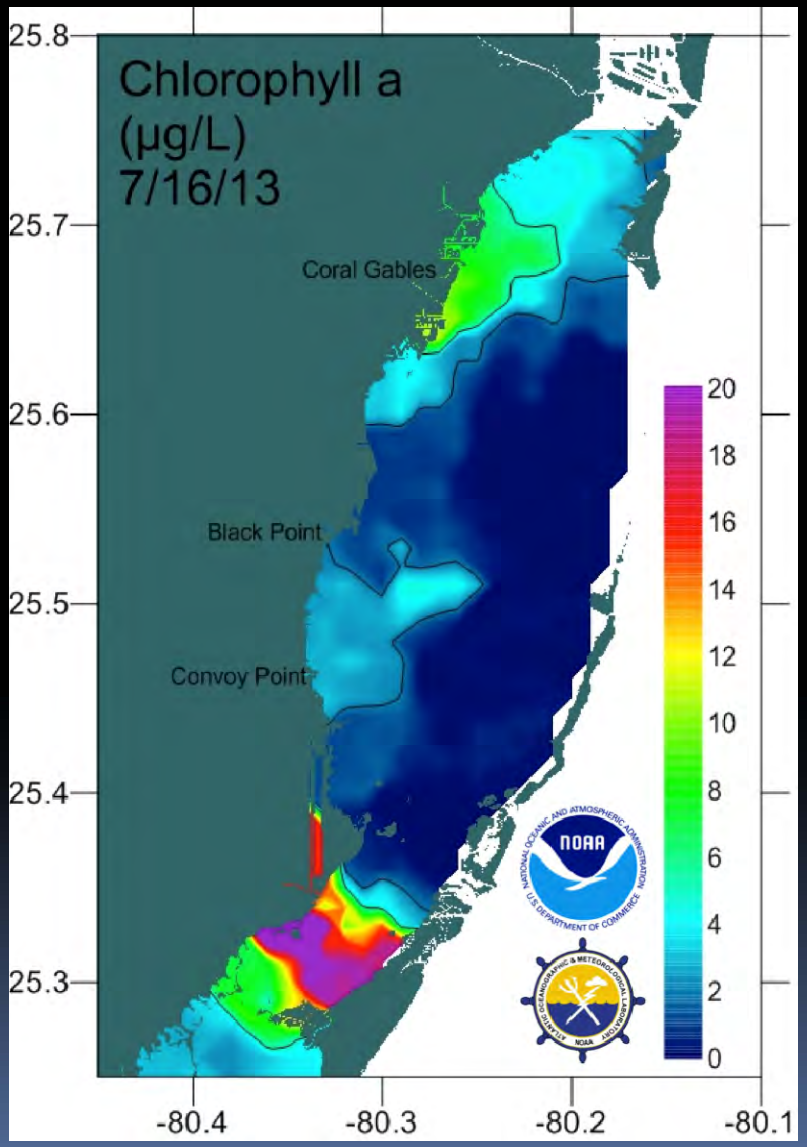
Hollings 1973; Hagerthey et al. 2008

Algal Bloom in Biscayne Bay – Summer 2013

Lindsey Visser (NOAA) shows a sampling net slimed by algae during a survey of Biscayne Bay (July 2013)

Algal bloom North of Convoy Point (South of Mowry Canal), June 28th, 2013)

Algal Bloom in Biscayne Bay – Summer 2013



Source: NOAA

Three bloom patches:

- Card Sound is the strongest (~20 ug/l)
- The NW patch (~10 ug/l)
- Patch between Black Point and Convoy Point (~5 ug/l).

Which Organisms Dominated the 2013 Bloom?

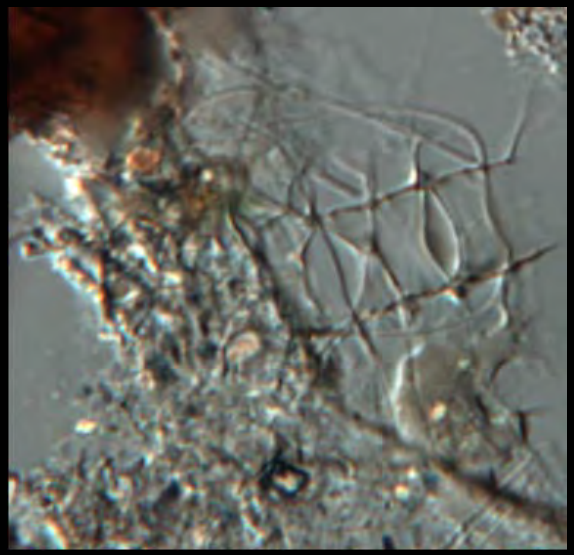
- Bloom composed mostly of at least 5-6 different species of *Chaetoceros* diatoms

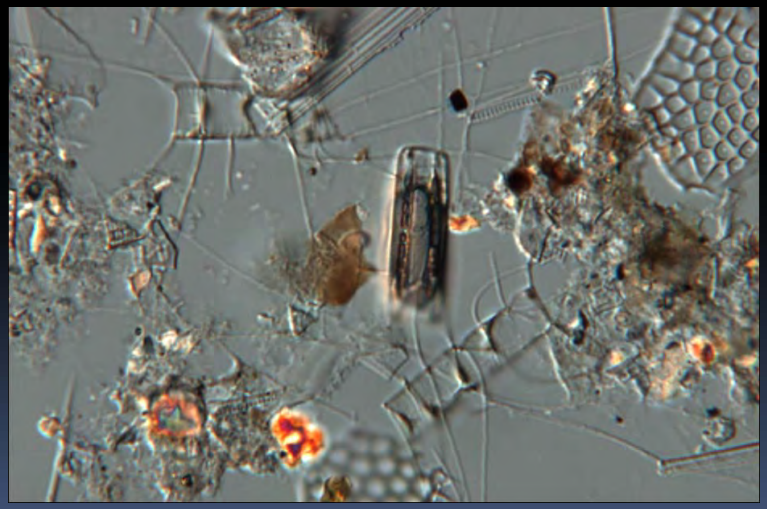
- All the species form long chains (colonies) and have long spines

- These taxa can easily kill fish even at low densities and abundance!!!!

- The abundance of *Chaetoceros* spp. was absolutely staggering in Card Sound!!!

- NO FISH KILLS WERE REPORTED IN 2013…. <u>but If the blooms worsen (and they probably will), fish kills due to low dissolved oxygen concentrations & suffocation might occur….</u>



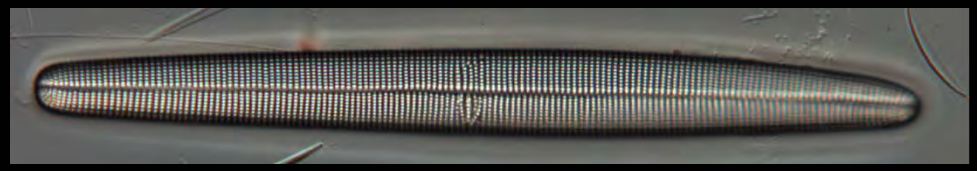


B10 station (Card Sound), 07/16/2013

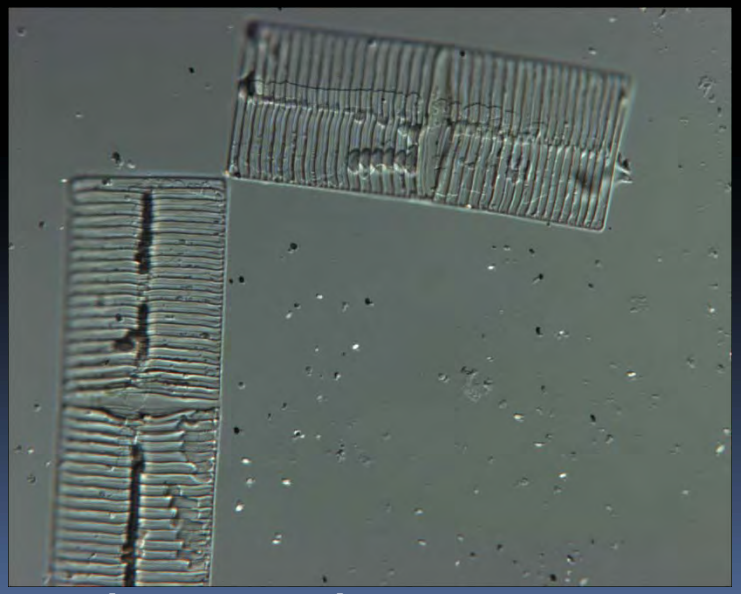
Other Diatom Taxa Forming the 2013 Bloom

- Present in high abundance in NW part of Biscayne Bay & Near Convoy Point

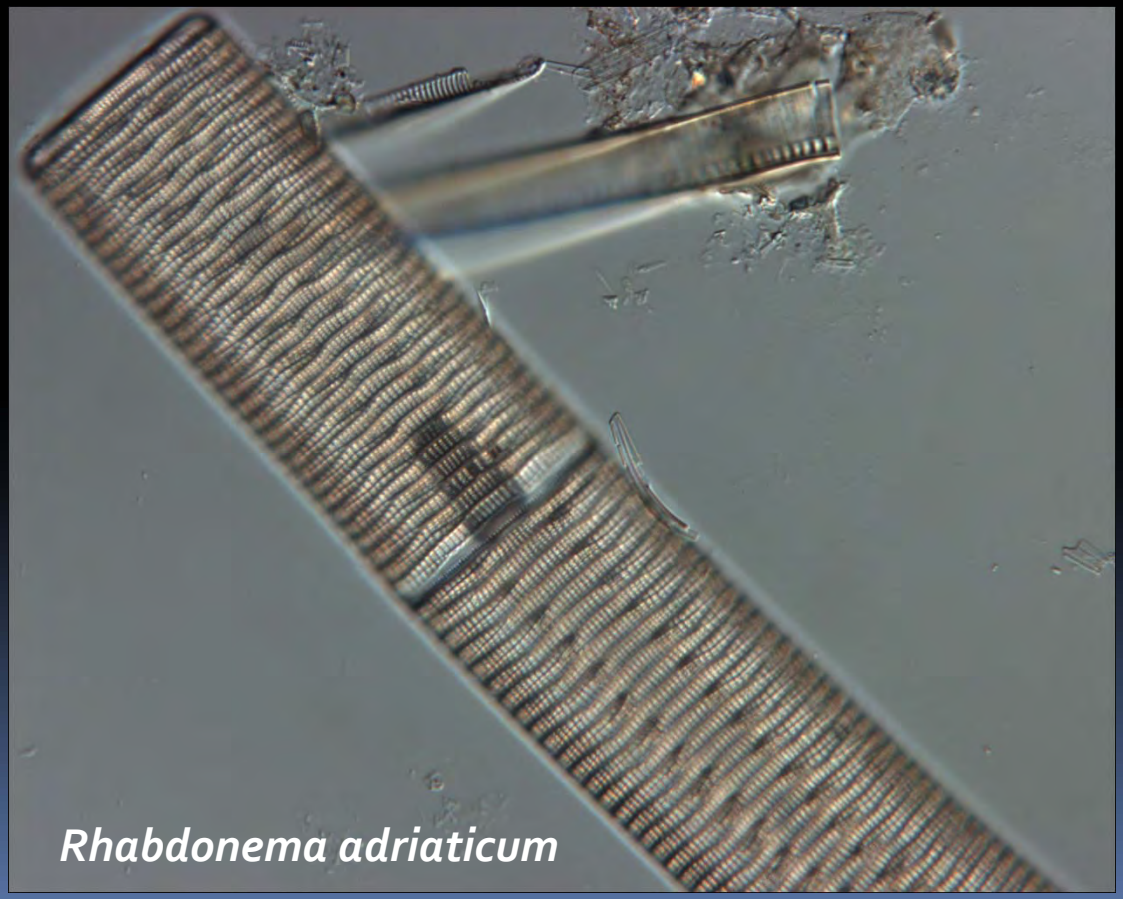
- Non-toxic; cause water discoloration (decrease light penetration to the bottom)



Synedra bacillaris

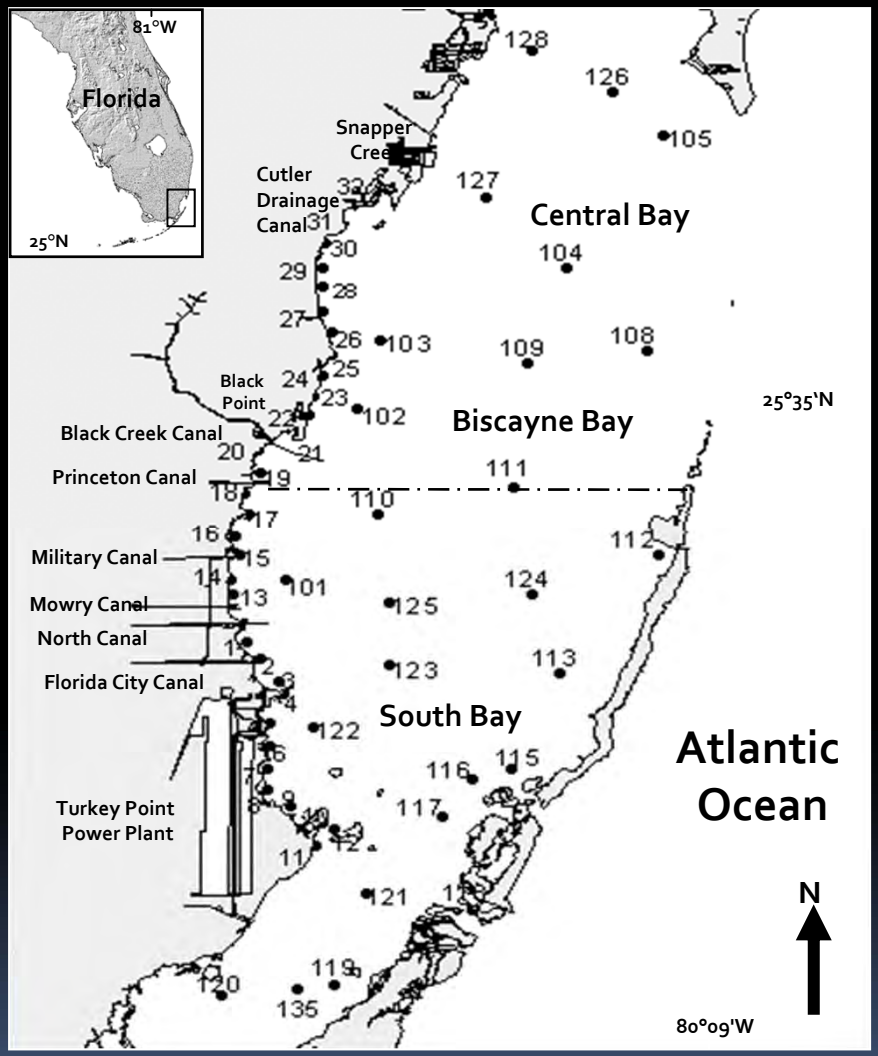


Microtabella interrupta



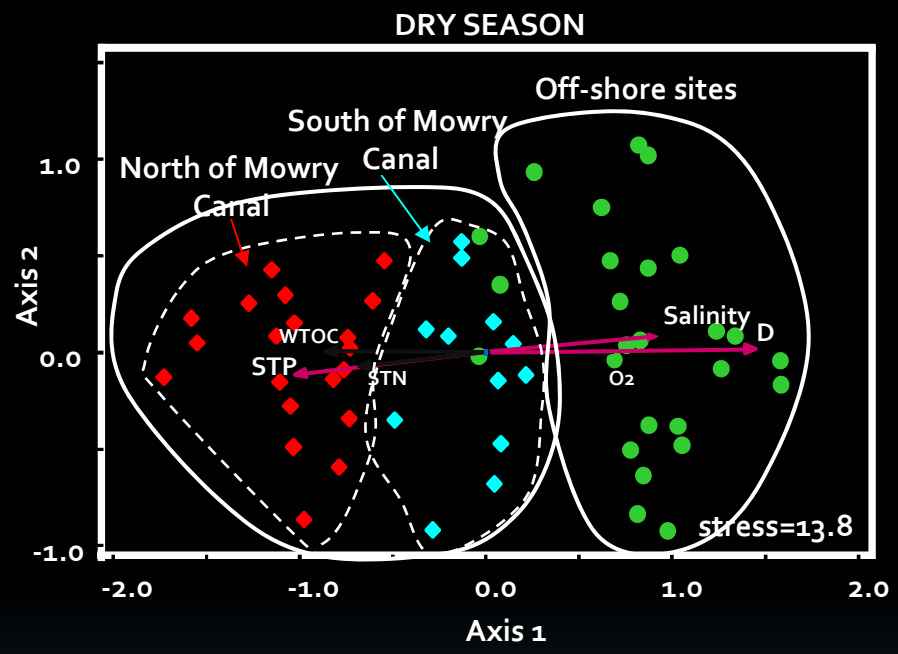
Rhabdonema adriaticum

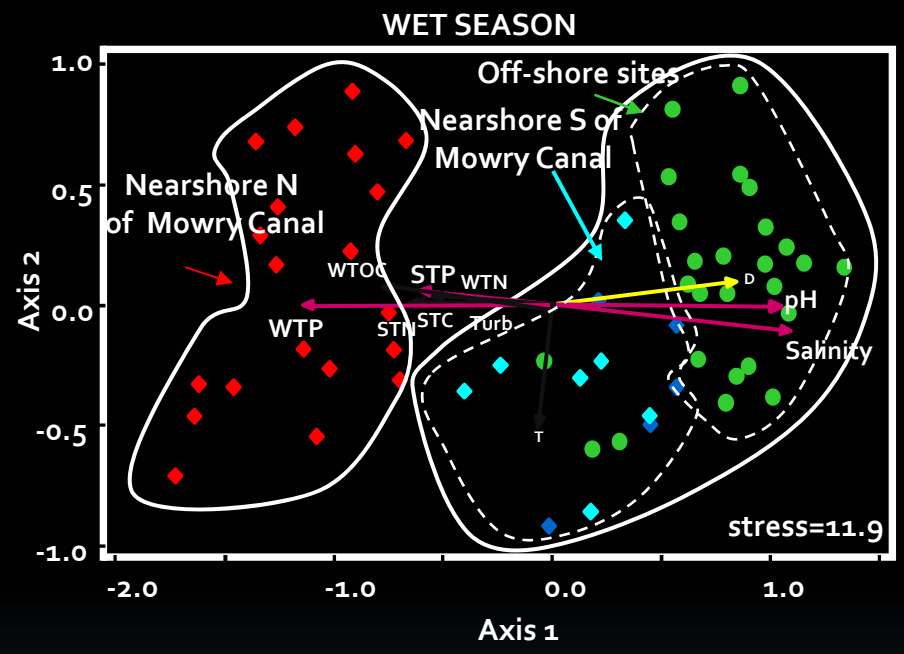
2005 Survey

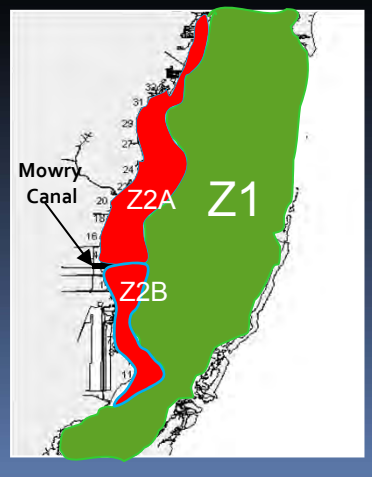


⊙ modern samples collected from 58 sites in wet and dry season

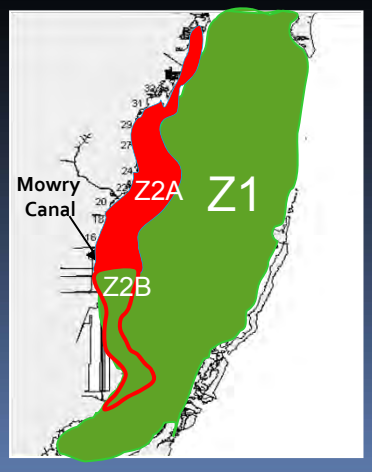
Seasonal Differences in Diatom Assemblage Structure Among Sites Across Biscayne Bay in 2005



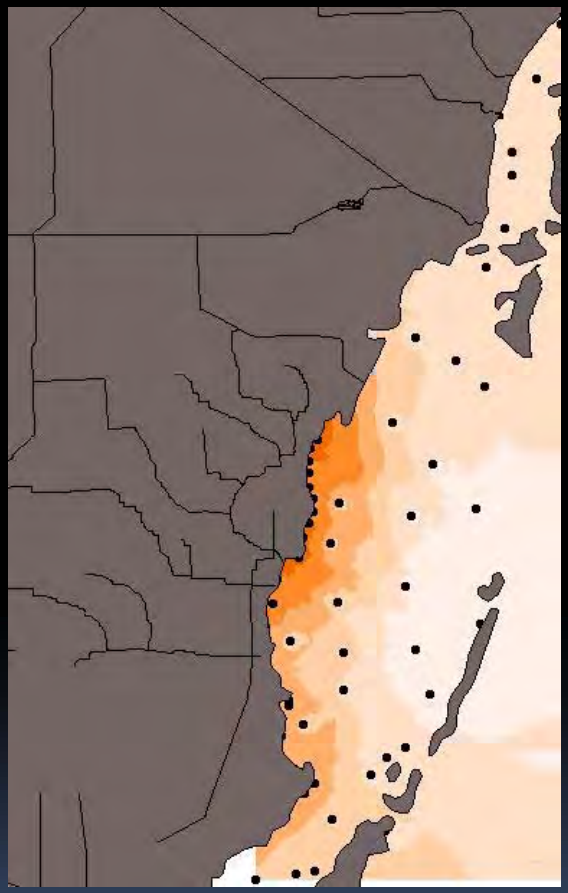




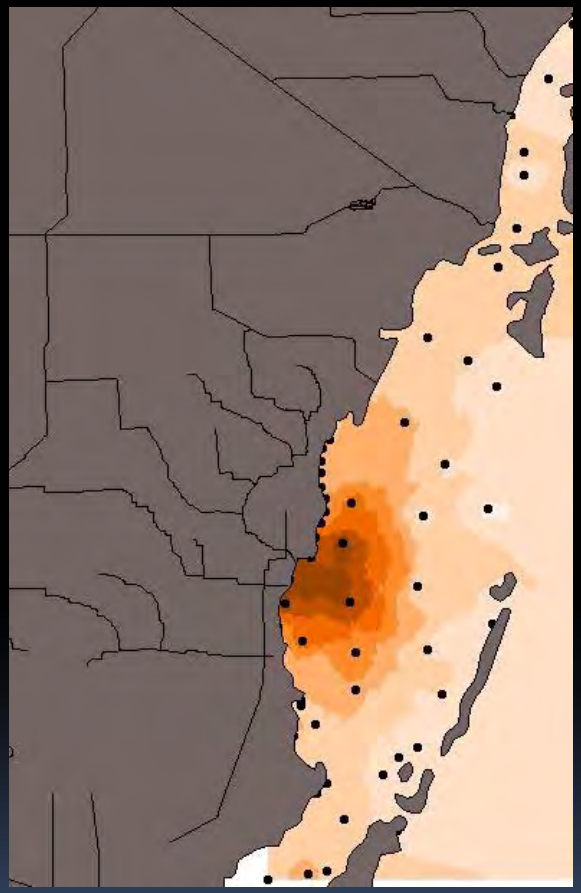
- off-shore sites (ZONE 1 –Salinity >30psu))
- nearshore sites North of Mowry Canal (Zone 2A – Salinity 5-15psu (wet) & 15-30psu (dry))
- nearshore sites South of Mowry Canal (Zone 2B – Salinity 10-20psu (wet) & 15-30psu (dry))



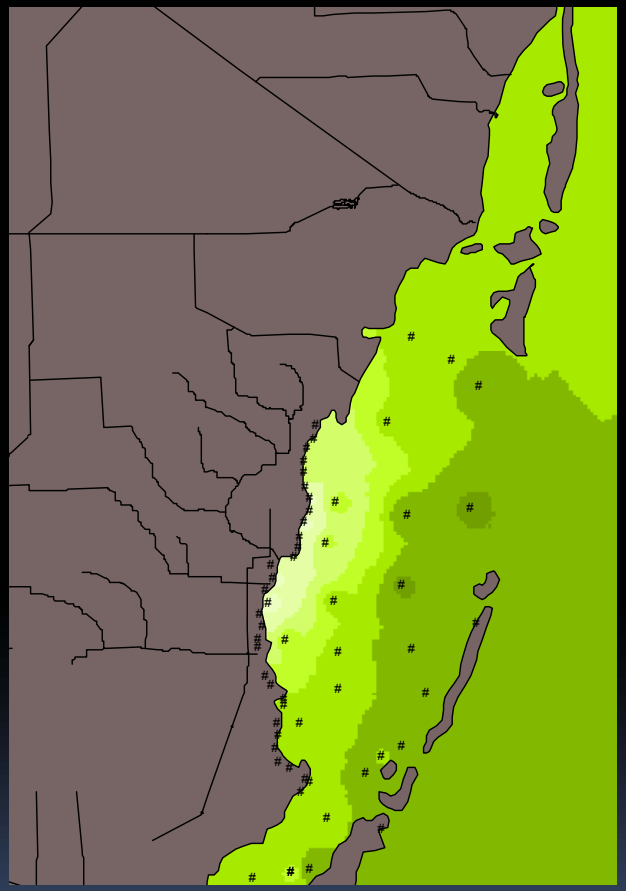
Water Quality Conditions in the Wet Season 2005



Total Phosphorus

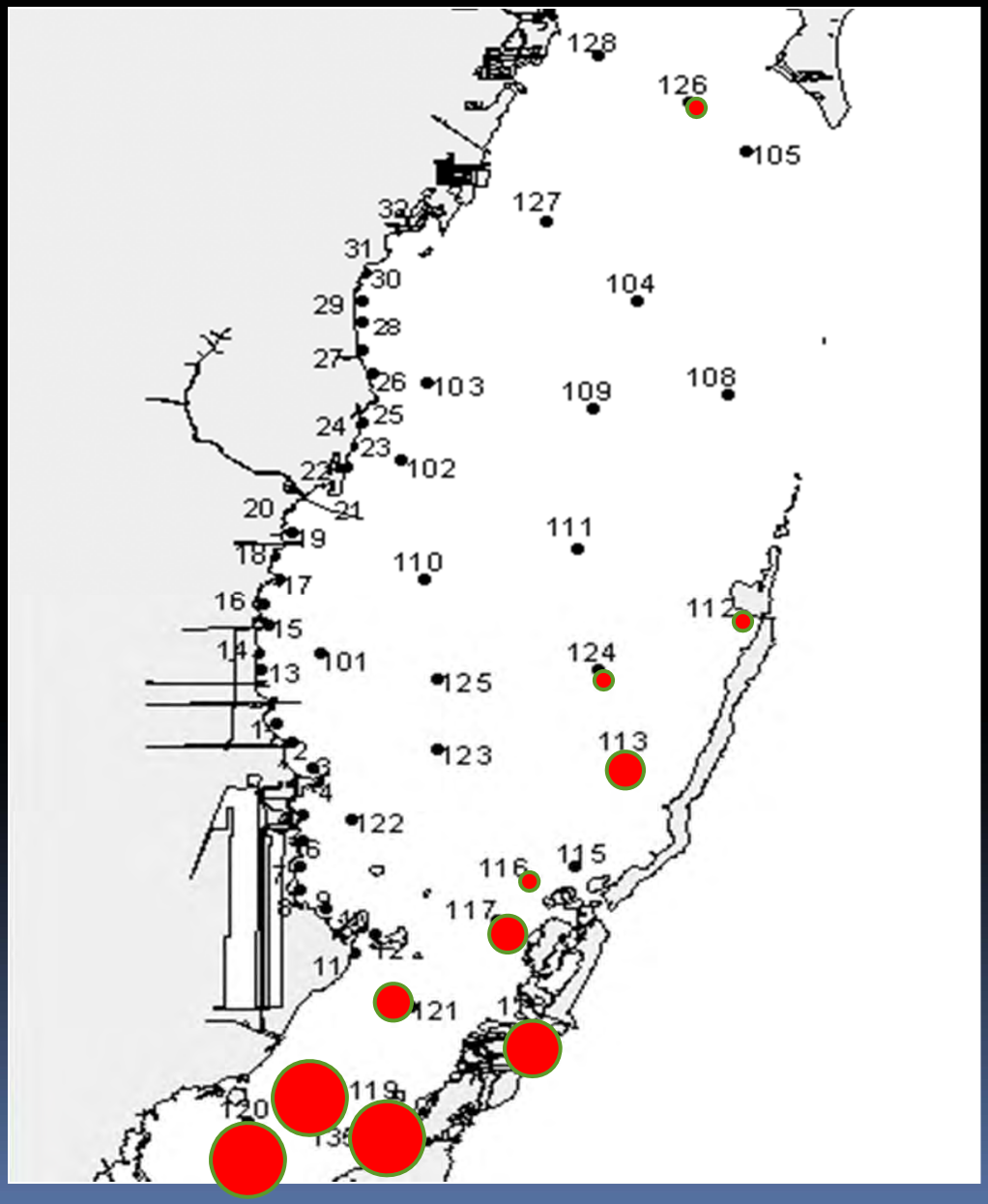


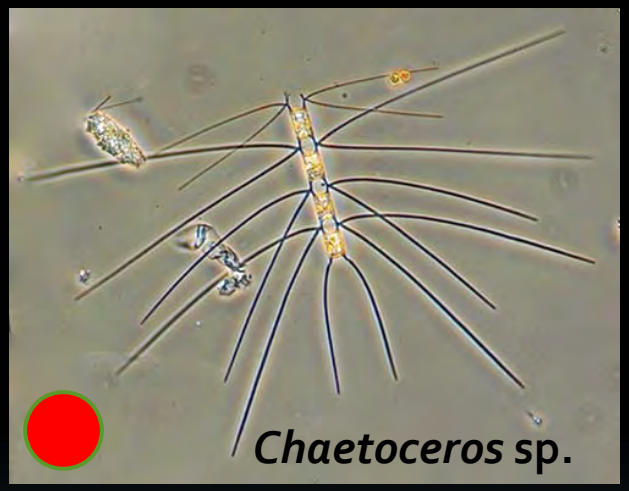
Total Nitrogen



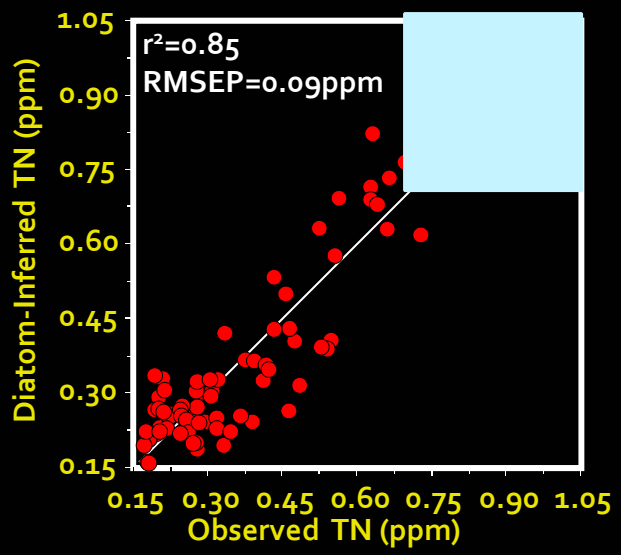
Salinity

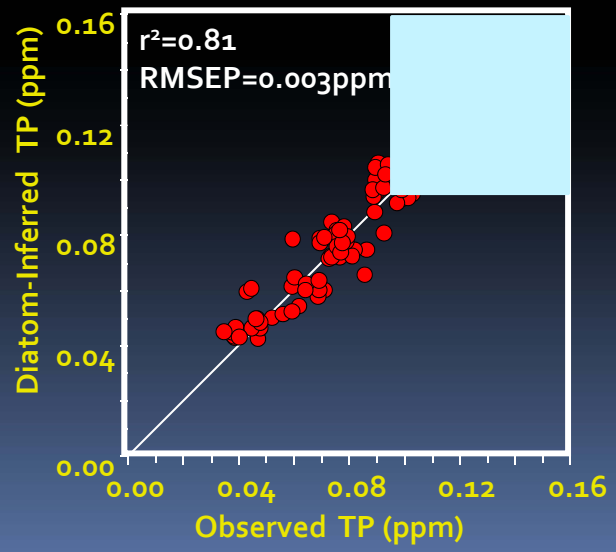
2005 Diatom Survey in Biscayne Bay



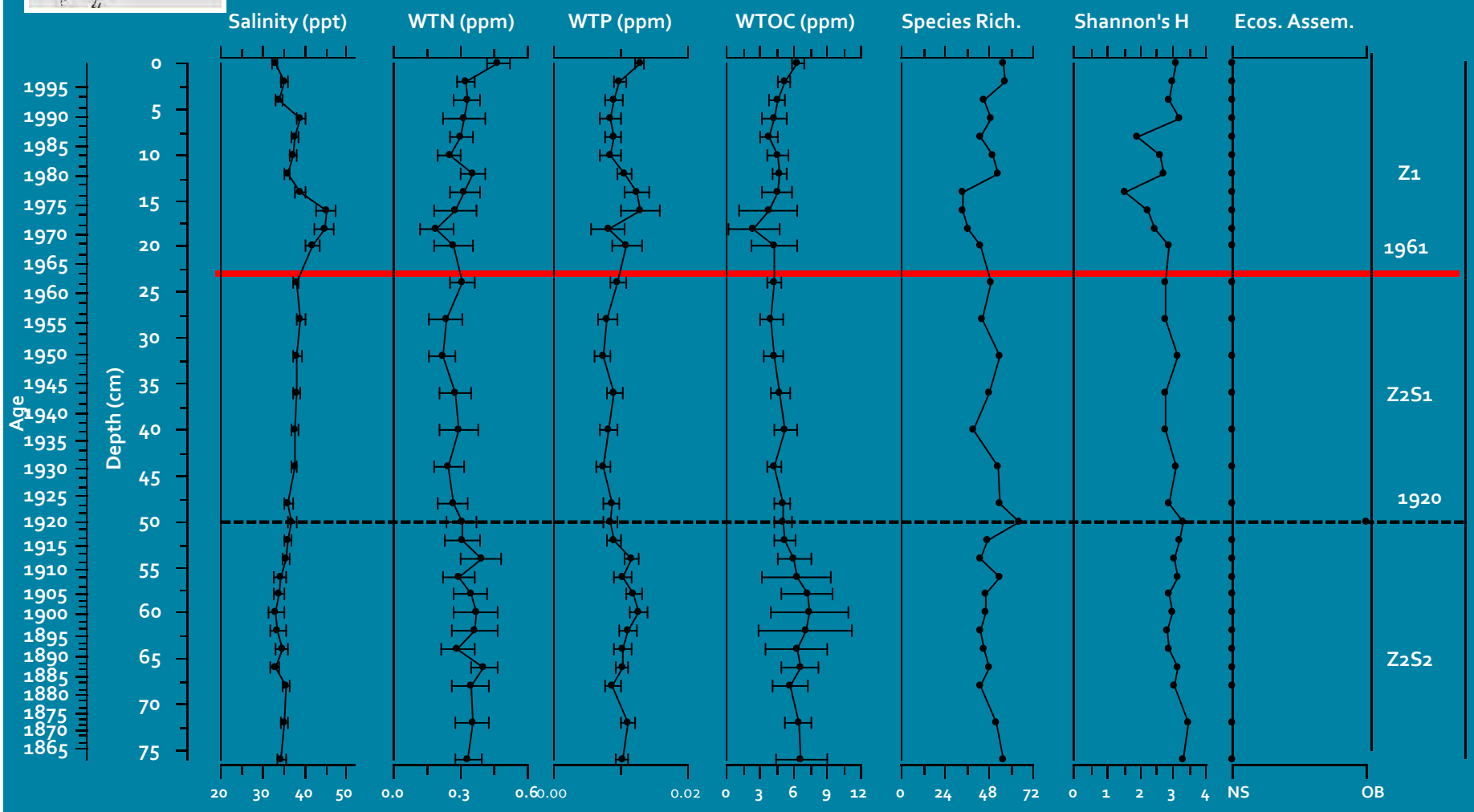


Indicators of Nutrient Enrichment



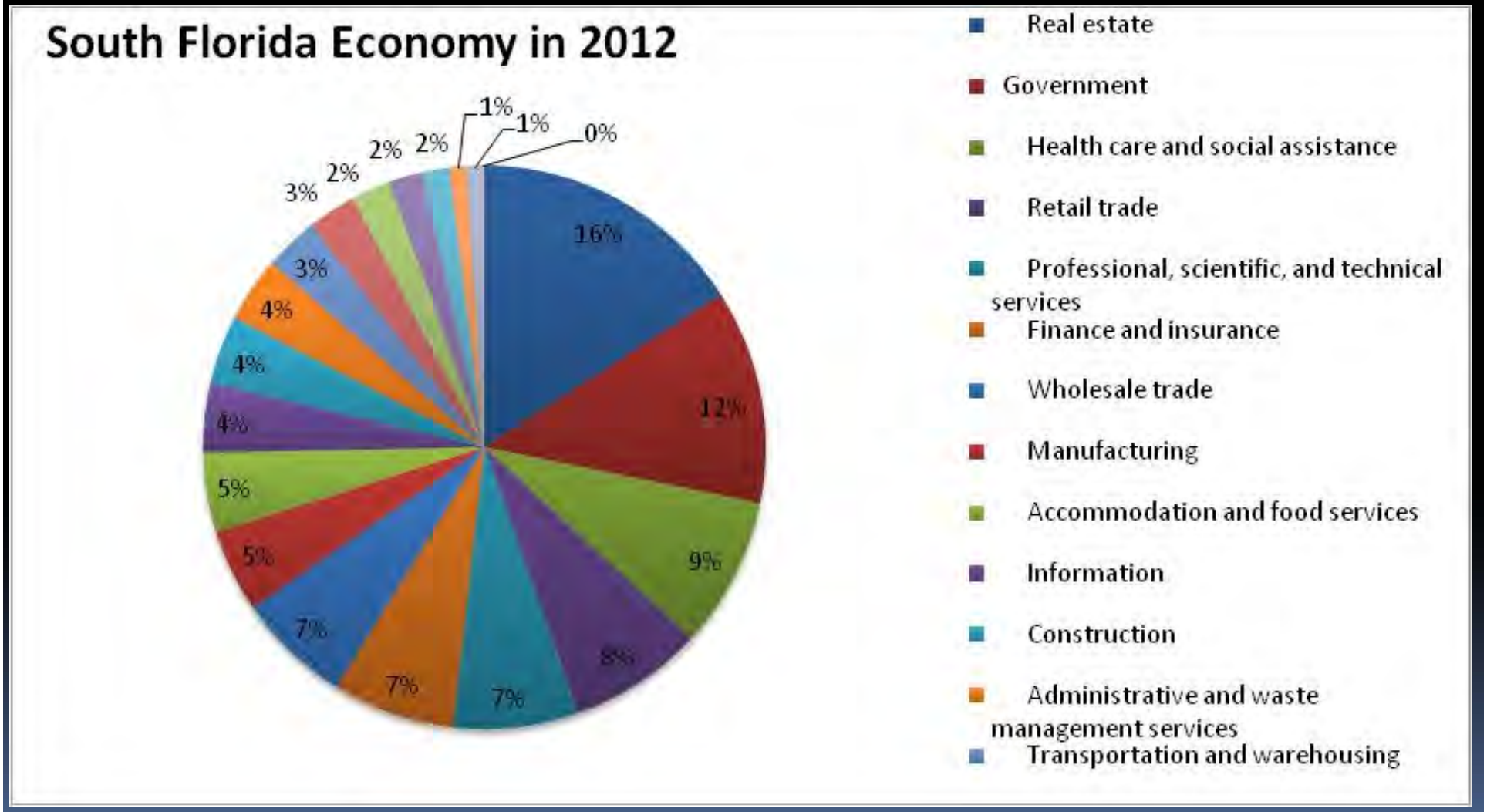


Environmental Changes at No Name Bank Since The Late 1800s



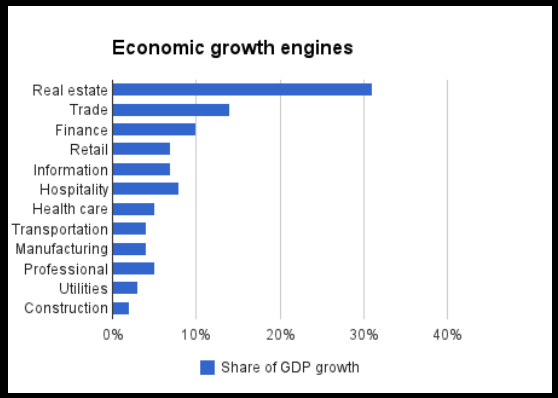
Impact of Non-Toxic Algal Blooms on Florida Economy

Florida Gross Domestic Product (GDP)



Source: Bureau of Economic Analysis

What About South Florida?



- In 2013, an estimated 14 million TOURISTS spent over $ 22.8 billion in Miami Dade (www.florida.gov)

- In 2013, the REAL ESTATE sector contributed over $52 billion to the combined economies of Broward, Miami-Dade and Palm Beach (www.bea.gov)

*Economic effects of HABs in the U.S. are at least $82 million/year**

- Commercial Fisheries Impacts: $38 million/year
- Public Health Costs of Illness: $37 million/year
- Recreation and Tourism Impacts: $4 million/year
- Coastal Monitoring and Management: $3 million/year

* 2005 dollars, Hoagland and Scatasta (2006). Based on subset of outbreaks in 1987-2000.

Economic effects of HABs in FLORIDA

- Recurrent red tides cause between $19-32 mln in tourism-related losses every year (Steidinger et al. (1999))
- The annual impact of HABs to commercial fisheries was estimated to vary from $13-$25 mln

Why should we be Concerned about Harmful Algal Blooms in Biscayne Bay?

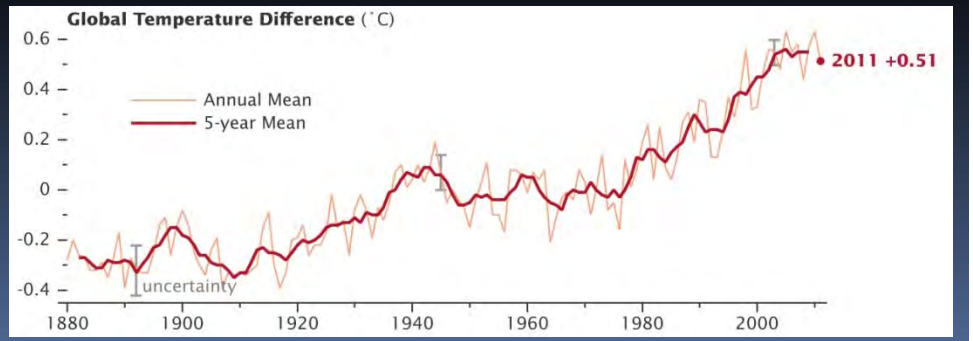
- HABs reduce tourism / reduced restaurant revenues
- Close beaches and shellfish beds
- Decrease the catch from both recreational and commercial fisheries
- Decrease the attractiveness of waterfront properties
- Cost of maintaining monitoring and testing programs designed to detect algal toxins

Climate Change & Algal Blooms

- The frequency, severity and geographic distribution of HABs increased worldwide over the last few decades!!!!

- Climate change may promote the growth and dominance of harmful algal blooms through a variety of mechanisms including:

  - Warmer water temperatures
  - Changes in salinity
  - Intensifying of coastal upwelling
  - Increases in CO_2 concentrations
  - Changes in rainfall patterns
  - Sea level rise



Source: NASA.gov

Questions that Need to be Answered

- Did the magnitude of HABs increased over time due to natural and anthropogenic factors?

- What are the major drivers of toxic and non-toxic algal blooms?

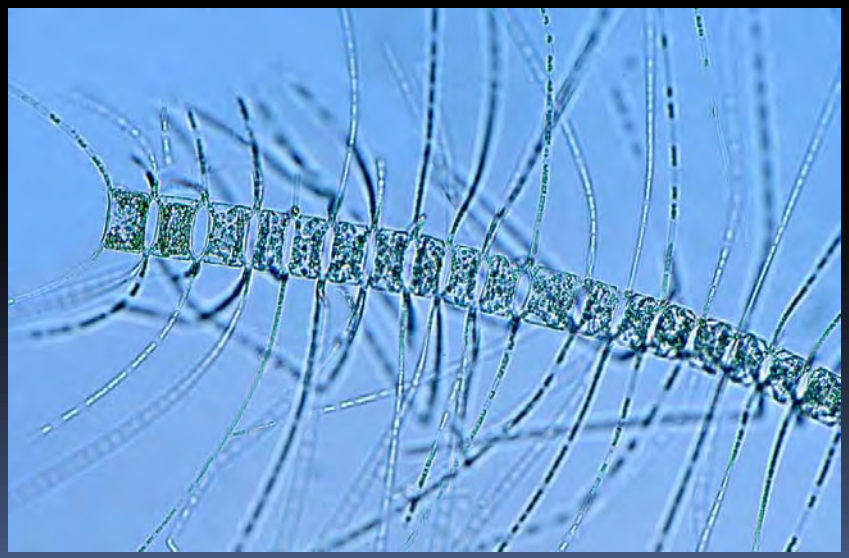
- How are non-toxic algal blooms affecting valuable ecological components (e.g., seagrass beds)?

- Are algal blooms an important internal source of nutrients for the Bay?

- Can we expect toxic algal blooms in Biscayne Bay in the future & under what condition they will develop?

- How are HABs affecting the Miami-Dade economy?

What Should be Focus on?

- Learn more about physiology and behavior of individual HAB species and toxins
- Causes of different types of HABs
- Predicting, detecting and forecasting of the occurrence of HABs (development of predictive models; remote sensing techniques, etc.)

Questions?