Nutrients & *Karenia* Red Tides

**ANEPP Meeting**

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Florida Red Tide – Pollution?

Karenia brevis

Microscopic marine alga
Dinoflagellate
Kingdom: Protista

Occurs Naturally in the Gulf
Produces Neurotoxins (brevetoxins)
Interferes with nerve cell transmission.

2018 Bloom on Steroids
Public & Environmental Health Impacts

Red Tide Fish Kill

Contaminated Shellfish (NSP): Public Health, ingestion

Aerosol Respiratory Effects; Public Health and Marine Mammals
THE VALUE OF SARASOTA BAY RESOURCES
$11.8 BILLION
Manatee & Sarasota Counties

REGIONAL VALUE
$57.9 BILLION
This includes: Pinellas, Hillsborough, Polk, Hardee, Charlotte, DeSoto, Sarasota and Manatee Counties

TOURISM
Both Counties have an annual VISITOR COUNT of 7,477,300.
With the annual Bay-related visitor spending $1.15 BILLION

JOBS:
21,000 JOBS
$731 MILLION in earnings
(1 in every 17 jobs)

$184 MILLION
in additional TAX REVENUE ANNually

RECREATIONAL DAY TRIPS - willingness to pay PER PERSON PER DAY
$104

RECREATION
12,174,175 TRIPS
including visitors are valued at $487 MILLION
May 2018

- Bloom developed at mouth of Caloosahatchee River, near Ft. Myers, Florida; 2005 bloom offshore of Tampa Bay.
- Expanded north with summer southerly winds and currents
- Bloom appeared to develop concurrent with release of water from Lake Okeechobee in Florida – no definitive data for this specific outbreak.
Cyanobacteria

The “green slime” harmful algae in fresh waterbodies are often cyanobacteria, including some that produce toxins.

Microcystis aeruginosa can produce neurotoxins and hepatotoxins, such as microcystin and cyanopeptolin.

Microcystis is capable of strong uptake of phosphate and nitrogen; they are believed to strongly influence nitrogen to phosphorus ratios ("N:P ratio").

Above: toxic cyanobacteria outbreak that blanketed the entire 75-miles of the Caloosahatchee River in SW FL this summer.

Protecting and restoring water resources from Venice to Bonita Springs to Winter Haven
Pollution creates Cyanobacterium slime? Yes

• Connection between Red Tide and Microcystis? No direct proof

• Connection with nutrient regeneration? Likely
Bloom Initiated May 2018

Statewide *Karenia brevis* concentrations
09/04/2018 - 09/11/2018

*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)

Image credits: Google Earth, NOAA, US Navy, NGA, GEBCO
Statewide *Karenia brevis* concentrations
09/20/2018 - 09/27/2018

**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)
What nutrients do red tides use?

I. Dissolved Organic Nutrients (DOP, DON, DOC)
   Can take up LMW DOC & HMW DOC (tannins)
   Can utilize amino acids, urea, ‘natural’ DON
   DOP uptake not repressed by ↑PO4

II. Inorganic Nutrients (PO4, NH4, NO3, NO2)

III. Particulate Nutrients?
   Little known but we suspect . . .

Direct uptake

Enzyme mediated uptake/assimilation

What nutrients do red tides use?

Direct uptake

Enzyme mediated uptake/assimilation

- PO4
- NH4+
- NO3
- Urea
- Amino acids/proteins

Particle Ingestion?
N forms used by *K. brevis* blooms:
both inorganic & organic N

2001 Large Red Tide
9.5 x 10^6 cells/L *K. brevis*

2002 Medium Red Tide
2.5 x 10^5 cells/L *K. brevis*

(data from Bonk et al., in prep.)
What nutrients are available?

- bloom stage:
  - Initiation: Offshore
  - Maint: Nearshore
- bloom area
- bloom duration

**Atmospheric Inputs**
- Nutrients from deep water
- Dead fish
- Trichodesmium: N₂ fixation
- Fe

**Zooplankton Grazing**

**Nutrients from dead fish**

**Estuarine Discharge of N & P**
- (wet season)

**Benthic Flux**

**Hawthorn P Deposits**

**Agricultural Inputs**

**Eutrophication**
Unanswered Questions:

- Are there pollution links? Direct or Indirect influence?
- Effects of Everglades restoration on HABs in general and release of nutrient rich water from Lake O.?
- Multi-year, multi-decadal bloom patterns in relation to watershed usage changes

Answer: Likely – no data to prove.
The 2005 Benthic Mortality Event

- Reports of mass benthic mortalities (Corals, sponges, urchins, fish etc)
- Fish kills, Sulfur smell, tarnished diver jewelry

What’s going on?

Hypoxia (low DO)/Anoxia (no DO) area within the bloom

- Red tide toxins kill fish or other biota
- Summer heats surface water & traps red tide and or decaying fish near bottom
- Decay occurs, bacteria use up oxygen
- Stress & low DO kills benthic biota in that area

Has it happened before?

Yes. A 1971 Red Tide caused mass mortalities of >1,536km² of reef inhabitants in same general area

Yes. Fish will return with 12-18 months, other organisms will take 2-3 years
(Source: USF PhD on 1971 Event, Smith, 1978)

Will these reefs recover?
Questions?