Harmful Algal Blooms (HABs) – A Primer on Cyanobacteria Blooms and Red Tide

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Outline....

Cyanobacteria Blooms vs. Red Tide Outbreaks

Environmental Health Concerns of Blooms

Potential Causative Factors of Blooms

Scientific Studies Underway and Planned
**Harmful Algal Blooms (HABs) Definitions**

*Algae* – an umbrella term that includes all photosynthetic microbes including cyanobacteria

*Algal Bloom* – an overabundance of algae that can be concentrated by hydrology and/or weather to form an accumulation or scum.

*Harmful Algal Bloom (HAB)* – an algal bloom that imparts harm (toxicity, hypoxia, aesthetics) related to health and/or economy.
Potential Concerns Associated with HABs and Associated Toxins....

Environmental Health
  - Wildlife
  - Livestock
  - Companion Animals
  - Humans

Full and Sustainable Resource Utilization
  - Drinking Water Treatment
  - Consumption (e.g. fish)

Tourism

Economics
Cyanobacteria = Blue-Green Algae

- Bacteria
- Chlorophyll; phycocyanin

Dinoflagelletes members responsible for Red Tides

- Algae
- Chlorophyll; carotenoids

Red Algae members responsible for red drift algae

- Algae
- Chlorophyll; phycoerythrin

Microcystis aeruginosa

Karenia brevis 1/1000 inch wide

USGS
Cyanobacteria....  Red Tides (Karenia)....

commonalities

• Near shore accumulation
• Vertical migration
• Turbulence is disruptive
• Nutrients
Where Does Red Tide Occur in Florida....

- Initiates offshore in the Gulf of Mexico, subsurface
- Transported inshore via currents and winds
- Most common in SW FL
- Atlantic can be impacted if blooms are transported to the E. coast
- Other Gulf states and Mexico also affected

FWC’s observations of *K. brevis* since 1953
Algal Blooms Do Not Always Produce Toxins....

Cyanobacteria

Microcystins

Cylindrospermopsins

Saxitoxins

https://doi.org/10.1016/j.hal.2016.04.001
Are Inland Cyanobacteria and Toxins Transported Into Estuaries?

Evidence for a Novel Marine Harmful Algal Bloom: Cyanotoxin (Microcystin) Transfer from Land to Sea Otters

https://journals.plos.org/plosone/article/file?id=10.1371/journal.pone.0012576&type=printable
Ongoing: Investigating Toxin Exposure....

Toxicity and Pathology Studies
  Fish
  Birds

Biomarkers of Toxin Exposure

Toxin Bioaccessibility from Consumption
Ongoing: Identifying Drivers of Toxin Production and Control….

Laboratory and Field Evaluation of:
- Temperature
- Nutrients
- Metals
- Microbial succession
- Organic chemicals

Impact of Natural Process (volcanic ash, forest fire ash, and atmospheric dust) on algal bloom formation and toxin production
- Cyanobacteria (*Microcystis*)
- Red Tide (*Karenia*)
Agencies Collaborate on Development of Cyanobacteria Assessment Network

https://eos.org/project-updates/agencies-collaborate-develop-a-cyanobacteria-assessment-network
https://www.epa.gov/water-research/cyanobacteria-assessment-network-cyan
**Lake Okeechobee Early Warning System Research**

Fixed Monitoring Locations
- S-79
- S-80

**Moving Boat Surveys**
- Latitude and Longitude
- Satlantic SUNA Nitrate
- YSI EXO
  - Temp, Sp. Cond, pH, turbidity, DO, Chl and Phycocyanin Fluorescence, fDOM
Multi-Agency Lake Okeechobee Research on Cyanobacteria Bloom Dynamics

Q: Where in the Lake Okeechobee do we see the blooms develop (monthly) and what are the suite of organisms that allow bloom formation? Do the current physical and chemical parameters explain the dynamics of these blooms?

Testing: chemical and physical parameters, metagenomics, cyanotoxins-genes and toxins, and species ID and quantification
**Multi-Agency Lake Okeechobee Research on Cyanobacteria Bloom Dynamics**

1) pre-bloom “jumpstart” (using nitrate, ammonia or phosphorus)
2) mid-bloom stimulation (same treatments)
3) post-bloom “re-initiation” (same treatments)

**Partners:** USGS (Ft. Myers, Orlando and KS), COE, SFWMD, FDEP, universities

**Testing:** chemical and physical parameters, metagenomics, metatranscriptomics, proteomics, cyanotoxins, species, nutrient uptake, etc.
Communicating Capabilities and Outcomes

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http://water.usgs.gov/owq/FieldManual/Chapter7/7.5
http://pubs.usgs.gov/sir/2008/5038
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