Harmful Algal Blooms

Funding for Better Monitoring, Prediction and Public Notification

CALUSA WATERKEEPER®

WATERKEEPER® ALLIANCE MEMBER
Presentation Outline

➢ What are HAB blooms and common species with an emphasis on cyanobacteria

➢ Characteristics that make the cyanobacteria successful

➢ Problems related to toxin production related to both public health and the economy

➢ The Florida HAB Task Force
Harmful Algal Blooms

Defined generally as overgrowths of algae in water, some producing dangerous toxins

- Red Tides – marine dinoflagellates, can produce toxins
- Blue-green algae or cyanobacteria, freshwater and estuarine systems
Cyanobacteria

Microcystis

Anabaena
➢ One of the earliest life forms on the planet, oldest known photosynthetic microorganisms

➢ The ability to process atmospheric nitrogen and render it into an organic form

➢ Can regulate their position in the water column near the surface for optimal light

➢ Prefer warm, nutrient-rich fresh or brackish water with minimal flow or turbulence

➢ Produce toxins dangerous to humans and animals – at least 46 species cause toxic effects in vertebrates, at least 15 spp in FL

➢ Harmful algal blooms have severe impacts on human health, aquatic ecosystems and the economy.
Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems?

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Degraded water quality from increased nutrient pollution promotes the development and persistence of many HABs and is one of the reasons for their expansion in the U.S. and other nations.
Minireview

Climate change: a catalyst for global expansion of harmful cyanobacterial blooms

“climatic change may benefit various species of harmful cyanobacteria by increasing their growth rates, dominance, persistence, geographic distributions and activity.”
Fig. 4. Conceptual figure, illustrating the environmental controls of cyanobacterial bloom dynamics, and the direct and indirect effects of climate change on these dynamics.
WATERKEEPER ALLIANCE PROTECTS THE NATION’S WATERS FROM HARMFUL ALGAL BLOOMS

Waterkeeper organizations protect waters across the US from harmful algal blooms by fighting their root causes: nutrient pollution from industrial agriculture, wastewater treatment plants and other sources.
HABs and Public Health Issues
Cyanotoxins

**Microcystins** (hepatotoxins)
- most widespread cyanobacterial toxins
- can bioaccumulate
- potentially carcinogenic

**Cylindrospermopsin** (hepatotoxin)
- toxic to liver and kidney

**Anatoxins** (neurotoxin)

**Saxitoxins** (Paralytic Shellfish Poisoning toxin)
- Also reported in freshwater

**BMAA** (neurotoxin)
Modes of Exposure to Cyanotoxins

➢ Dermal

➢ Inhalation or aspiration from aerosolized surface water

➢ Ingestion
EPA 10-day risk based drinking water guidelines.

<table>
<thead>
<tr>
<th>Cyanotoxin</th>
<th>Drinking Water Health Advisory (10-day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bottle-fed infants and pre-school children</td>
</tr>
<tr>
<td>Microcystins</td>
<td>0.3 µg/L</td>
</tr>
<tr>
<td>Cylindrospermopsin</td>
<td>0.7 µg/L</td>
</tr>
</tbody>
</table>
Lee County Public Water Supply – Olga Water Treatment Plant
Supply Source is the Caloosahatchee River
Frequently shut down due to presence of cyanobacteria
Blue green algal (cyanobacterial) toxins, surface drinking water, and liver cancer in Florida

Lora EFleming, CarlosRivero, JohnBurns, ChrisWilliams, Judy ABean, Kathleen AShea, John Stinn

“A significantly increased risk for HCC with residence within the service area of a surface water treatment plant was found compared to persons living in areas contiguous to the surface water treatment plants.”
Ohio State University study links toxic algae blooms, fatal liver disease | Video

TYLER TREADWAY, TC PALM
MAY 22, 2017

Francisco Hernandez skims dying blue-
Risk From Recreational Exposure – Primary Contact
As an example:

- To protect swimmers, the concentration of total microcystins shall not exceed 4 micrograms per liter in a day.

- To protect the recreational use, the concentration of total microcystins shall not exceed 4 micrograms per liter more than 10 percent of days in a recreational season.

- Caloosahatchee River has had documented concentrations of Microcystin of > 5000 ug/l

- Lake Okeechobee had a reported concentration of Microcystin of > 800 ug/l
Figure 2-3. State Guidelines for Cyanotoxins and Cyanobacteria in Recreational Water by Type and Scope of Guidelines

- Cyanotoxin and cyanobacteria guidelines
- Cyanobacteria guidelines only
- Cyanotoxin guidelines only
- No cyanobacteria or cyanotoxin guidelines
<table>
<thead>
<tr>
<th>State</th>
<th>Lowest Recreational Water Guideline or Action Level&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Delaware</td>
<td>thick green, white, or red scum on surface of pond</td>
<td>Delaware Department of Natural Resources and Environmental Control: Division of Water (2016)</td>
</tr>
<tr>
<td>Florida</td>
<td>cyanobacteria bloom</td>
<td>Florida Department of Environmental Protection (2016); Florida Department of Health (2016)</td>
</tr>
<tr>
<td>Idaho</td>
<td><em>Microcystis</em> or <em>Planktothrix</em>: &gt; 40,000 cells/mL; sum of all potentially toxigenic taxa: ≥ 100,000 cells/mL</td>
<td>IDEQ (2015)</td>
</tr>
<tr>
<td>Illinois</td>
<td>microcystin-LR: &gt; 10 µg/L</td>
<td>Illinois Environmental Protection Agency (2015)</td>
</tr>
<tr>
<td>Indiana</td>
<td>blue-green algae: 100,000 cells/mL; microcystin-LR: 6 µg/L</td>
<td>Indiana Department of Environmental Management (2015)</td>
</tr>
</tbody>
</table>

<sup>a</sup> Includes samples from both aquatic and terrestrial settings.
Toxins in algae linked to neurological diseases

By Chuck Wickenhofer Free Press Staff
November 29, 2017
Algae bloom toxin linked to Alzheimer's, other diseases
Institute for EthnoMedicine

PUBLIC RELEASE: 22-JAN-2016
Environmental toxin may increase risk of Alzheimer's disease and other neurodegenerative illnesses
First time scientists have observed brain tangles in an animal model through exposure to environmental toxin
Cyanobacterial Blooms and the Occurrence of the neurotoxin beta-N-methylamino-L-alanine (BMAA) in South Florida Aquatic Food Webs

Larry E. Brand,¹,* John Pablo,² Angela Compton,¹ Neil Hammerschlag,¹ and Deborah C. Mash²

Harmful Algae. Author manuscript; available in PMC 2011 Sep 1.
Published in final edited form as:
Harmful Algae. 2010 Sep 1; 9(6): 620–635.
doi: 10.1016/j.hal.2010.05.002

“It is predicted that human exposure to cyanobacteria and BMAA will increase, leading to a possible increased incidence of neurodegenerative diseases such as Alzheimer’s disease, Parkinson’s disease, and Amyotrophic Lateral Sclerosis (ALS).”
Health Risks to Animals

➢ Domestic animals and wildlife are also subject to poisoning by cyanotoxins
➢ Dogs are particularly vulnerable due to habit of swimming in or drinking contaminated water
➢ 58% of occurrences were fatal (Backer et al. 2013)
➢ Impacts of cyanotoxins on domestic and wild animals is significantly under-recognized.
Status and Trends of HABs Nationally and in Florida

- Many HABs are increasing in severity and frequency, and biogeographical range.

- The number of hypoxic water bodies in the U.S. has increased 30 fold since the 1960s with over 300 coastal systems now impacted.

- Frequency of cyanoblooms in Caloosahatchee basin has gone from 2-3 blooms during the 1990s to every other year over the past decade.

- Monitoring and public health advisories have been inadequate often blamed on lack of adequate resources.
Algal blooms in Lake Erie have been increasing.

2011 harmful algal bloom
Primarily *Microcystis aeruginosa*

6 largest algal blooms since mid-1990s have occurred over the past 7 years

Toxins from the 2014 bloom shut down Toledo’s (pop 400,000) drinking water

May 2013 issue of National Geographic
2016 Algae Bloom
Governor Declares State of Emergency in Three Counties
HOW ENVIRONMENTAL POLICIES AFFECT TOURISM MARKETING...

Greetings from FLORIDA: The Sun SLIME State.
➢ Delayed warnings from state agencies

➢ State toxicity measurements questioned. Readings much higher than state scientists report

➢ Lack of transparency in public information

➢ HAB Task Force Goes Unfunded
LEMMIE GUESS: THIS IS OBAMA'S FAULT.
Progress on Monitoring and Prediction of Cyanoblooms
The combined use of satellite technology with crowd sourcing provided a sophisticated stakeholder tool that may allow for more holistic management to reduce exposure risk to the public.
How to Monitor Cyanobacteria/Toxins in Recreational Waters*

Step 1: Assess vulnerability of the water body to cyanobacterial blooms and prioritize recreational waters for monitoring
Peri­odically e­valuate the vulnerability of recreational waters to cyanotoxins or harmful algal blooms based on historical information, remote sensing data, or environmental conditions during the recreational season.

Is your water body vulnerable to a bloom?

No

Deprioritize

Yes

Continue to Step 2

Step 2: Observe the recreational water body for blooms
Look for evidence of a bloom throughout the recreational season, based on visual observations, satellite data, or phytoplankton (i.e., algal and cyanobacterial) cell counts.

Are there signs of a bloom?

No

Continue Observations

Yes

Consider notifying** & continue to Step 3

Step 3: Monitor for cyanotoxins and/or cell densities
Choose amongst several methods based on testing logistics and suspected bloom characteristics. (i.e., algal and cyanobacterial) cell counts.

Are cyanotoxins or cyanobacterial cell counts detected above state or local advisory levels****?

No

Consider modifying notification*** & continue to Step 4

Yes

Continue to observe during recreational season (Step 2)

Step 4: Follow up cyanotoxin monitoring
Continue monitoring and notifying public until two consecutive tests show the toxin values or cell counts fall below the levels**** used to post the notification and visual signs of the bloom are gone.

Are toxin values and cells consistently below levels used to post the notification?

No

Continue monitoring & notification

Yes

Lift Notice, return to Step 2
Recreational Water Communication Toolbox for Cyanobacterial Blooms
Florida HAB Task Force

➢ Established in 1999 through legislation
➢ Funded at about $1 million per year for 3 years
➢ Defunded in 2001
➢ Enabling statute still in effect FS 379.2271
Economic Impacts of Harmful Algal Blooms

A 2006 study shows that the economic impacts from a subset of HAB events in U.S. marine waters averaged to be $82 million/year (2005 dollars).

However, just one major HAB event can cost local coastal economies tens of millions of dollars, indicating that the nationwide economic impact of HABs is likely much larger.

Almost every state in the U.S. now experiences some kind of HAB event and the number of hypoxic water bodies in the U.S. has increased 30 fold since the 1960s with over 300 coastal systems now impacted.
Economic Impacts From HABs in Florida

Public Health
  > $22 million lost annually

Tourism and Mitigation Costs
  > $6.5 million in Okaloosa County 1995-2000

Commercial Fisheries Costs
  > $18 million average annual impact (2000 dollars)

Florida Assoc. of Realtors 2015 report estimates > $500 million increase in property values when water clarity increase by one foot in Lee County alone.
Florida Boat Companies Lose Millions as Polluted Waters, Fish Shortages Hammer Business

Stationed beneath a navy-blue pennant, Capt. Chris Peterson strokes the plush lining of his company's prized 18-foot skiff. As a
HAB Funding Inadequacy

Algal blooms persist in Florida despite $35 million in federal funds

Lucas Daprile, lucas.daprile@tcpalm.com Published 10:02 a.m. ET Nov. 17, 2017 | Updated 10:08 a.m. ET Nov. 17, 2017

Algal blooms increase despite $1.8B USDA program

Lucas Daprile
Treasure Coast Newspaper s USA TODAY NETWORK - FLORIDA

The federal government's $1.8 billion

the state takes polluters at their word and does not factor in the use of treated human waste when calculating the effect of farm pollution on water quality.

Collier: $1.7 million

Gilchrist: $1.4 million

Okeechobee: $1.05 million
SUMMARY

➢ Many HABs are increasing in severity, frequency, and biogeographical range.

➢ Federal deregulation combined with diminished funding will increase public health risks and economic impacts.

➢ Accelerated nutrient impairment of Florida waters has promoted HAB problems concurrent with rapid growth and static or decreased funding support.
Summary continued

➢ Advances in prediction and monitoring tools should be integrated into actionable policy.

➢ Reinstating and adequately funding the Florida HAB Task Force would be a significant step toward development of quantitative criteria for better monitoring and public notification.
Table 8. Reductions towards the TMDL

* Reductions to date only include TN reductions associated with projects completed as of the end of the reporting period (November 30, 2016).

<table>
<thead>
<tr>
<th>Lead Entity</th>
<th>TN Allocation (lbs/yr)</th>
<th>TN Reduction to Date* (lbs/yr)</th>
<th>% of Allocation Achieved</th>
</tr>
</thead>
<tbody>
<tr>
<td>Charlotte County</td>
<td>943</td>
<td>52</td>
<td>6</td>
</tr>
<tr>
<td>City of Cape Coral</td>
<td>103,414</td>
<td>48,567</td>
<td>47</td>
</tr>
<tr>
<td>City of Fort Myers</td>
<td>40,924</td>
<td>21,533</td>
<td>53</td>
</tr>
<tr>
<td>FDACS</td>
<td>55,597</td>
<td>31,169</td>
<td>56</td>
</tr>
<tr>
<td>FDOT</td>
<td>9,119</td>
<td>11,490</td>
<td>126</td>
</tr>
<tr>
<td>LA-MSID</td>
<td>37,736</td>
<td>23,168</td>
<td>61</td>
</tr>
<tr>
<td>Lee County</td>
<td>140,853</td>
<td>45,792</td>
<td>33</td>
</tr>
<tr>
<td>Lucaya CCD</td>
<td>132</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>388,718</strong></td>
<td><strong>181,680</strong></td>
<td><strong>47</strong></td>
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</tbody>
</table>