Harmful Algal Blooms

Funding for Better Monitoring, Prediction and Public Notification

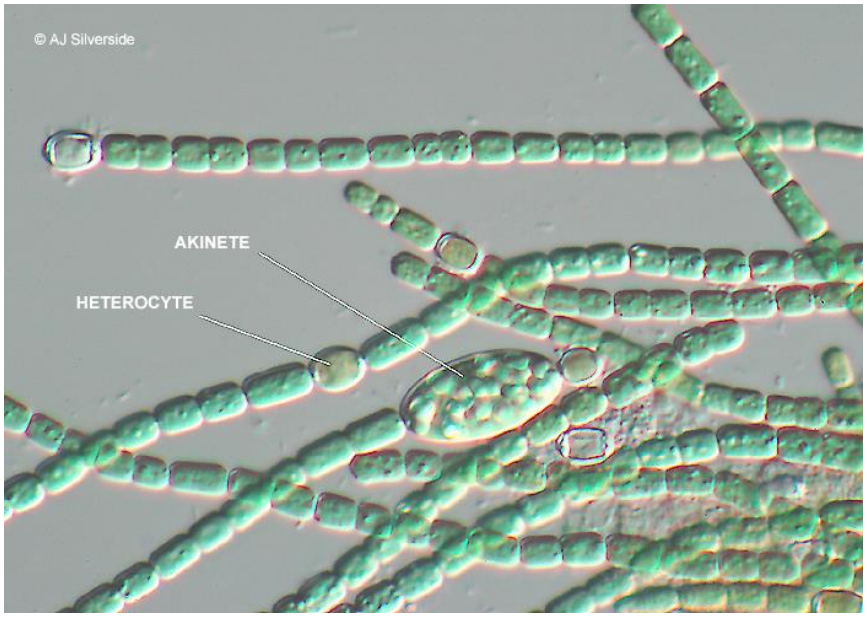
Harmful Algal Blooms

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**

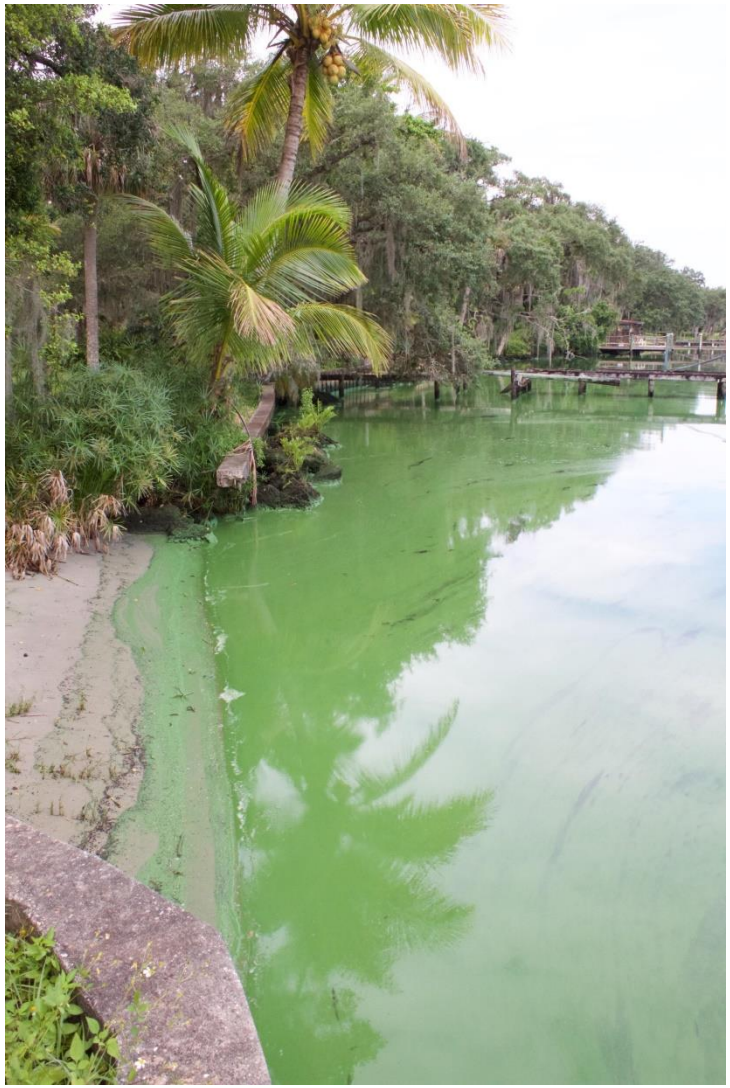
Cyanobacteria

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.



- HABs are a worldwide phenomenon

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

- **Causes** are complex, but in some cases can be attributed to **climate change** and **human impacts**, including eutrophication, habitat modification, and human-mediated introduction of exogenous species.

- Decades of research have improved our understanding of HABs leading to **better monitoring and prediction strategies**

In This Issue:

ET&C FOCUS

Focus articles are part of a regular series intended to sharpen understanding of current and emerging topics of interest to the scientific community.

Are Harmful Algal Blooms Becoming the Greatest Inland Water Quality Threat to Public Health and Aquatic Ecosystems?

Bryan W. Brooks,*† James M. Lazorchak,‡ Meredith D.A. Howard,§ Mari-Vaughn V. Johnson,‖ Steve L. Morton,# Dawn A.K. Perkins,†† Euan D. Reavie,‡‡ Geoffrey I. Scott,§§ Stephanie A. Smith,‖‖ and Jeffery A. Steevens##

†Department of Environmental Sciences, Center for Reservoir and Aquatic Systems Research, Institute of Biomedical Studies

Harmful Algae
Volume 8, Issue 1, December 2008, Pages 3-13

Eutrophication and harmful algal blooms: A scientific consensus

Author links open overlay
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https://doi.org/10.1016/j.hal.2008.08.006

- **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.**

DWR-733

Environmental Microbiology Reports (2009) **1**(1), 27–37 doi:10.1111/j.1758-2229.2008.00004.x

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.”

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.

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Waterkeeper Alliance
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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.

Cyanotoxin	Drinking Water Health Advisory (10-day)	
	Bottle-fed infants and pre-school children	School-age children and adults
Microcystins	0.3 µg/L	1.6 µg/L
Cylindrospermopsin	0.7 µg/L	3 µg/L

Lee County Public Water Supply – Olga Water Treatment Plant
Supply Source is the Caloosahatchee River
Frequently shut down due to presence of cyanobacteria

Harmful Algae
Volume 1, Issue 2, June 2002, Pages 157-168

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. “

BREAKING NEWS

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

Table 6-1. Recreational Criteria or Swimming Advisory Recommendations for Microcystins and Cylindrospermopsin

Application of Recommended Values	Microcystins			Cylindrospermopsin		
	Magnitude (µg/L)	Frequency	Duration	Magnitude (µg/L)	Frequency	Duration
Swimming Advisory	4	Not to be exceeded	One day	8	Not to be exceeded	One day
Recreational Water Quality Criteria		No more than 10 percent of days	Recreational season (up to one calendar year)		No more than 10 percent of days	Recreational season (up to one calendar year)

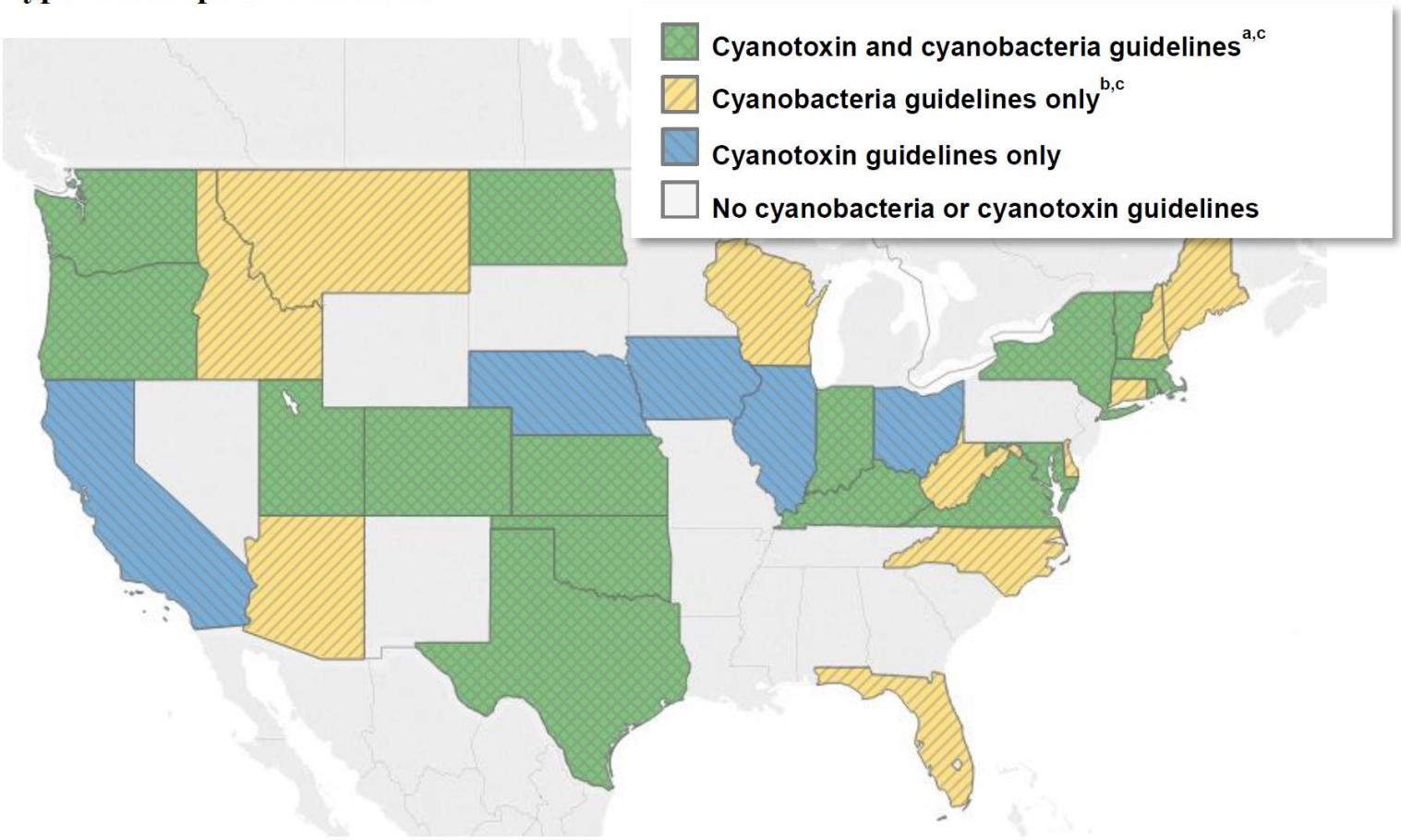
As an example:

- 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



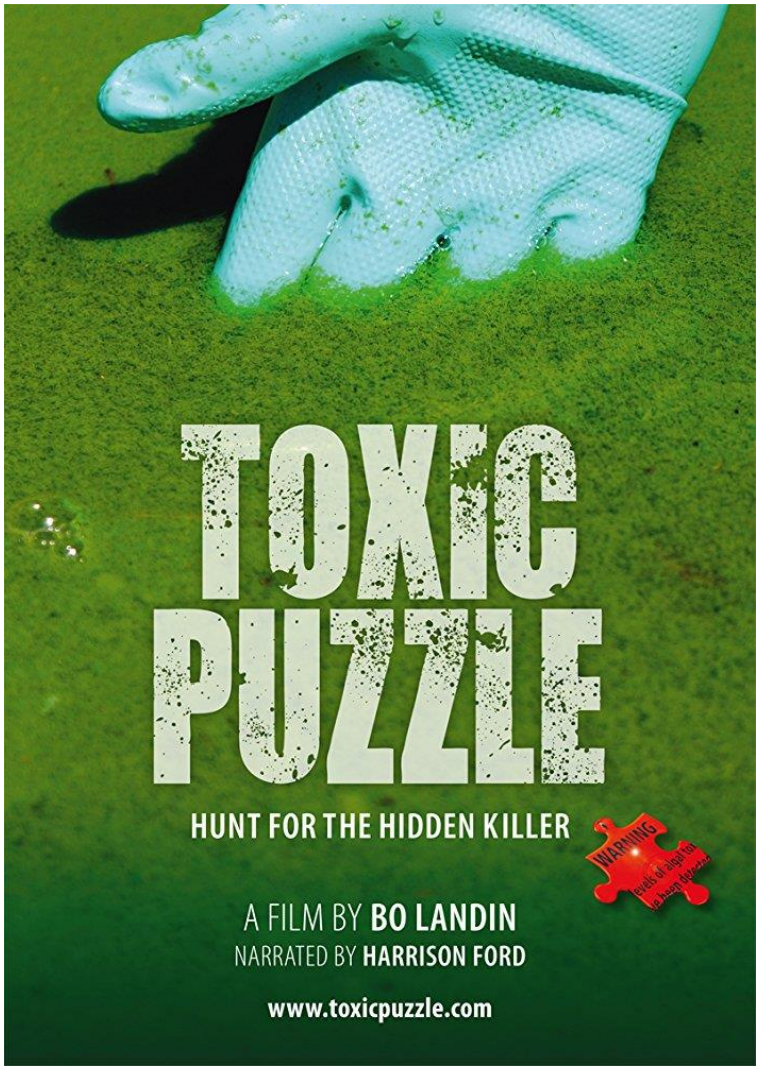
State	Lowest Recreational Water Guideline or Action Level[a]	Reference
	water is generally clear; OR blue-green algae cells > 20,000 cells/mL and < 100,000 cells/mL	Environment (2013)
Delaware	thick green, white, or red scum on surface of pond	Delaware Department of Natural Resources and Environmental Control: Division of Water (2016)
Florida	cyanobacteria bloom	Florida Department of Environmental Protection (2016); Florida Department of Health (2016)
Idaho	*Microcystis* or *Planktothrix*: > 40,000 cells/mL	IDEQ (2015)
	sum of all potentially toxigenic taxa: ≥ 100,000 cells/mL	
Illinois	microcystin-LR: > 10 µg/L	Illinois Environmental Protection Agency (2015)
Indiana	blue-green algae: 100,000 cells/mL	Indiana Department of Environmental Management (2015)
	microcystin-LR: 6 µg/L	

keysnews.com FLORIDA KEYS

Toxins in algae linked to neurological diseases

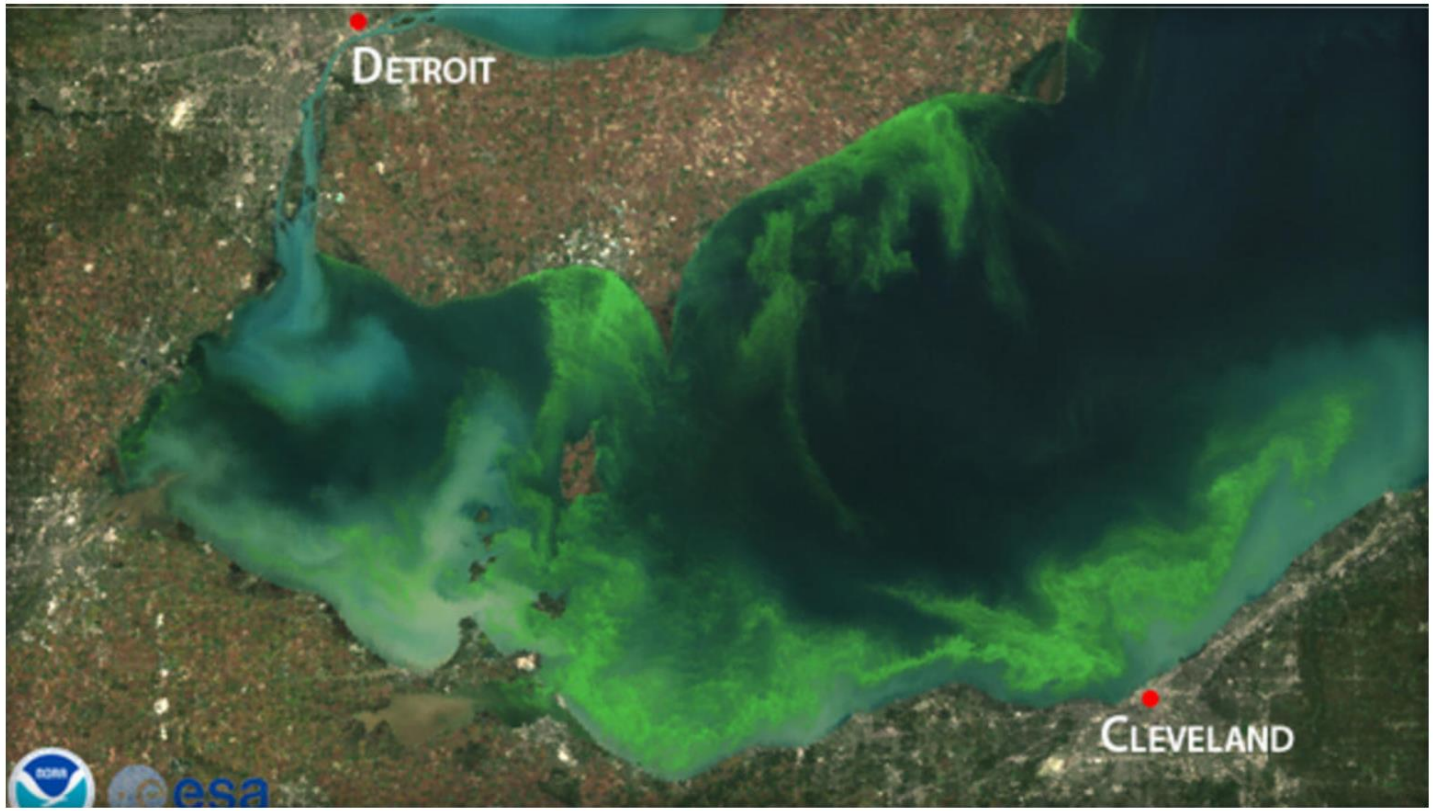
By Chuck Wickenhofer Free Press Staff

November 29, 2017



By AMY KRAFT / CBS NEWS / January 21, 2016, 3:32 PM

Algae bloom toxin linked to Alzheimer's, other diseases



Satellite image of a toxic algae bloom in Lake Erie in 2011, one of the worst blooms in recent years. / **MERIS/ESA, PROCESSED BY NOAA/NOS/NCCOS**

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. Mash[2]

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

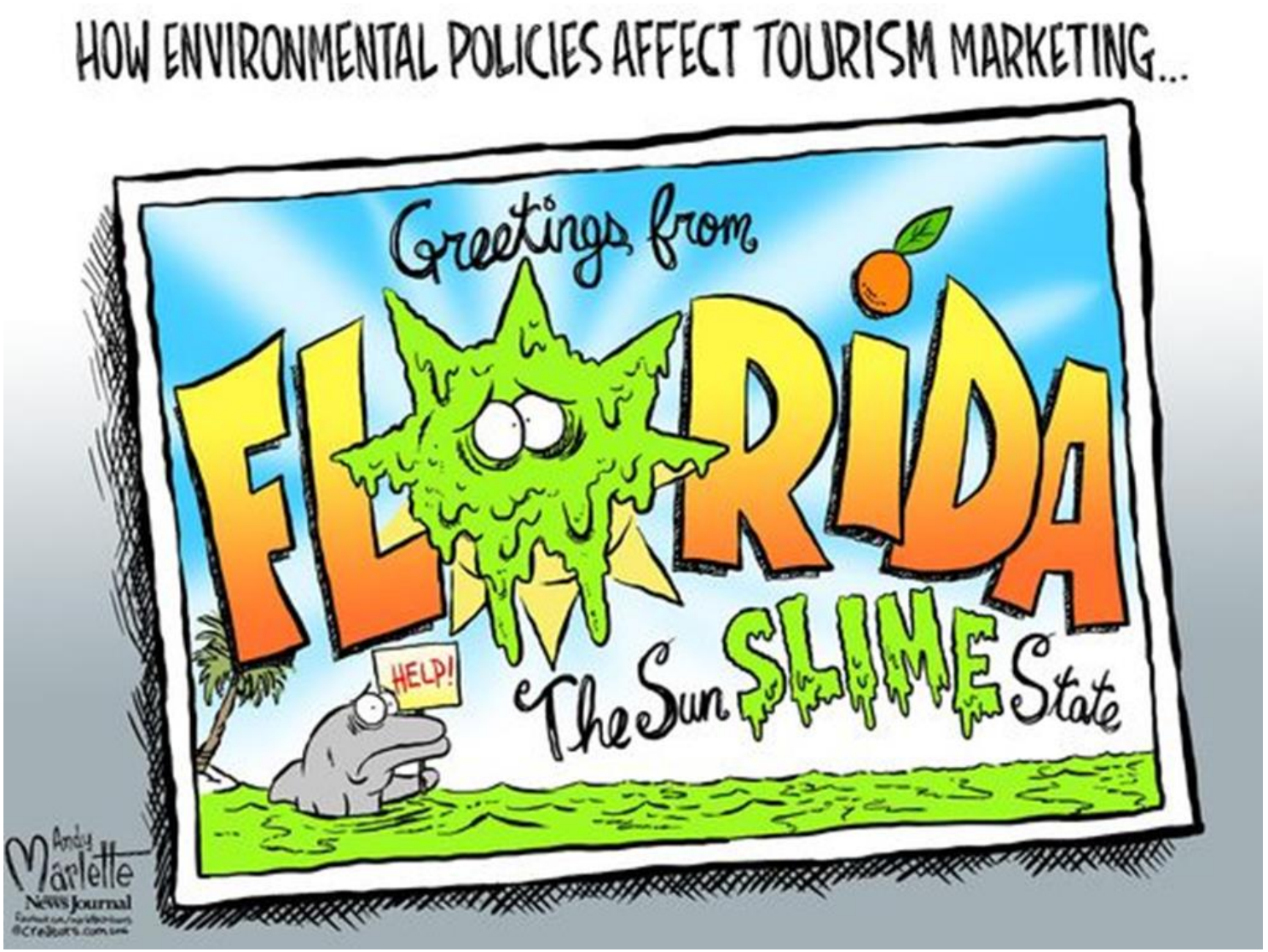
Primarily *Microcystis aeruginosa*

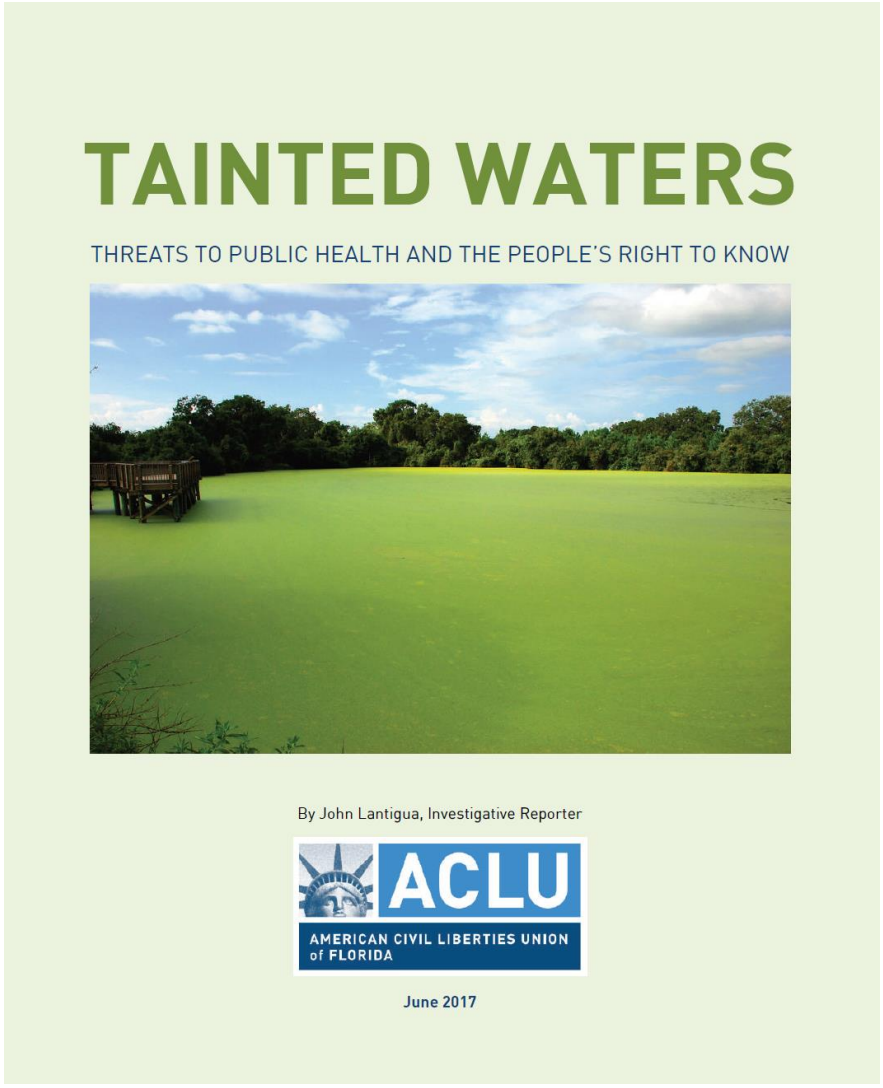
6 largest algal blooms since mid-1990s have occurred over the past 7 years

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
HELP!
Andy Marlette
News Journal



- **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**


Andy Marlette
News Journal
facebook.com/marlettecartoons
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LEMME GUESS: THIS IS OBAMA'S FAULT.
Scott

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.

Miami New Times

Photo by L'eau Bleue / Flickr

Florida Boat Companies Lose Millions as Polluted Waters, Fish Shortages Hammer Business

ISABELLA GOMES | AUGUST 4, 2017 | 8:30AM

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

Challenges for Mitigating HAB Impacts

- Deregulation furor nationally (massive budget cuts to EPA proposed)

- Reduced funding for or elimination of environmental programs that support public health and economic stability.
    - * Federal funds for Healthy Beaches Program
    - * Funding for National Estuary Program
    - * Climate related monitoring for prediction and response
- Shifting funding responsibility from traditional federal support to the states. If states are unwilling then programs may be eliminated

- Reduced enforcement actions over the last 8 years

HAB Funding Inadequacy

TCPALM

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

USDA

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.

Data the news organization released to

- *Collier: $1.7 million*
- *Gilchrist: $1.4 million*
- *Okeechobee: $1.05 million*

Federal Legislation on HABs

Two Congressional Bills Introduced in 2017 for use of Federal Emergency Funds on HABs.

"Federal Do No Harm Act of 2017“ by US **Representative Brian Mast**

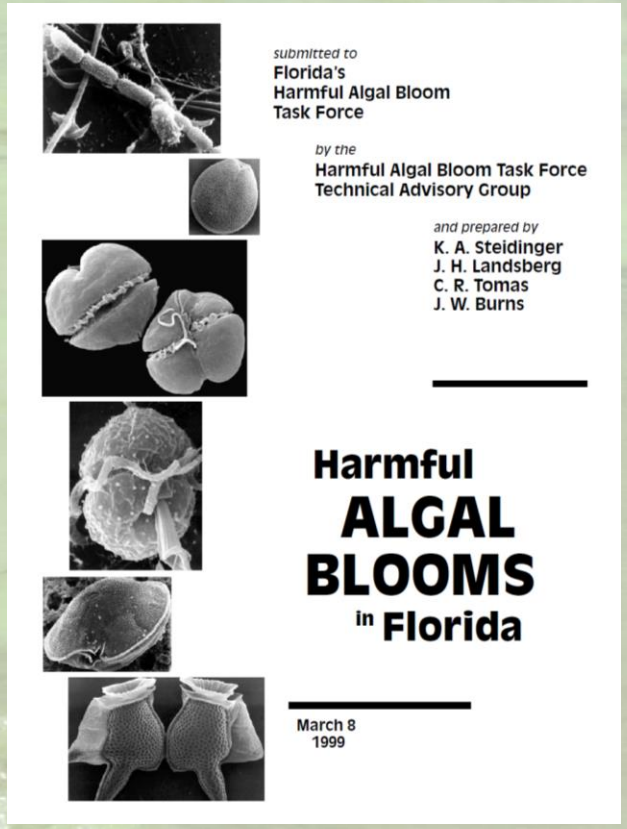
Introduce 4-25-17, Referred to the Subcommittee on Water Resources and Environment by House Committee on Transportation and Infrastructure on 4-26-17

> “To direct the President to treat a harmful algal bloom caused by certain activities of the Federal Government as an emergency for purposes of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, and for other purposes.”

Senator Bill Nelson
9-27-17, Senate passes bill allowing federal assistance for toxic algae 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




SUNCOAST WATERKEEPER
CALUSA WATERKEEPER
EMERALD COASTKEEPER
LAKE WORTH WATERKEEPER
COLLIER COUNTY WATERKEEPER
CC WK
CUSTOS QUIA AQUA MUNDO
TAMPA BAY WATERKEEPER
MATANZAS RIVERKEEPER
MIAMI WATERKEEPER
Suwannee RIVERKEEPER
ST. JOHNS RIVERKEEPER
Indian RIVERKEEPER
APALACHICOLA RIVERKEEPER
SAVING AN AMERICAN TREASURE

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.
- 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 policies.