CyanoHABs: a global problem with regional impacts

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Outline

1. What are cyanoHABs and how do they form?

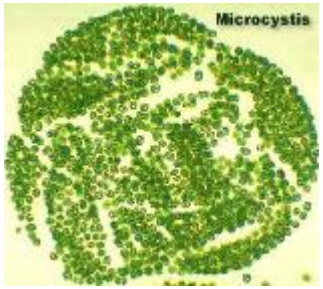
2. What do we know?

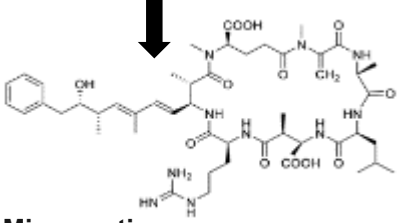
3. Socioeconomic impacts

What are cyanoHABs and how do they form?

Common cyanoHABs ('blue-green algae') and their toxins

Liver toxins





Microcystins

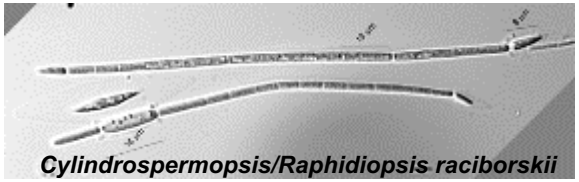
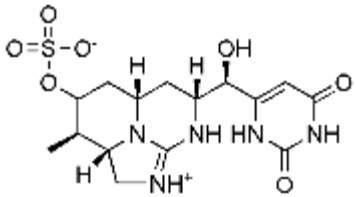


Photo: Rex Lowe



Cylindrospermopsins

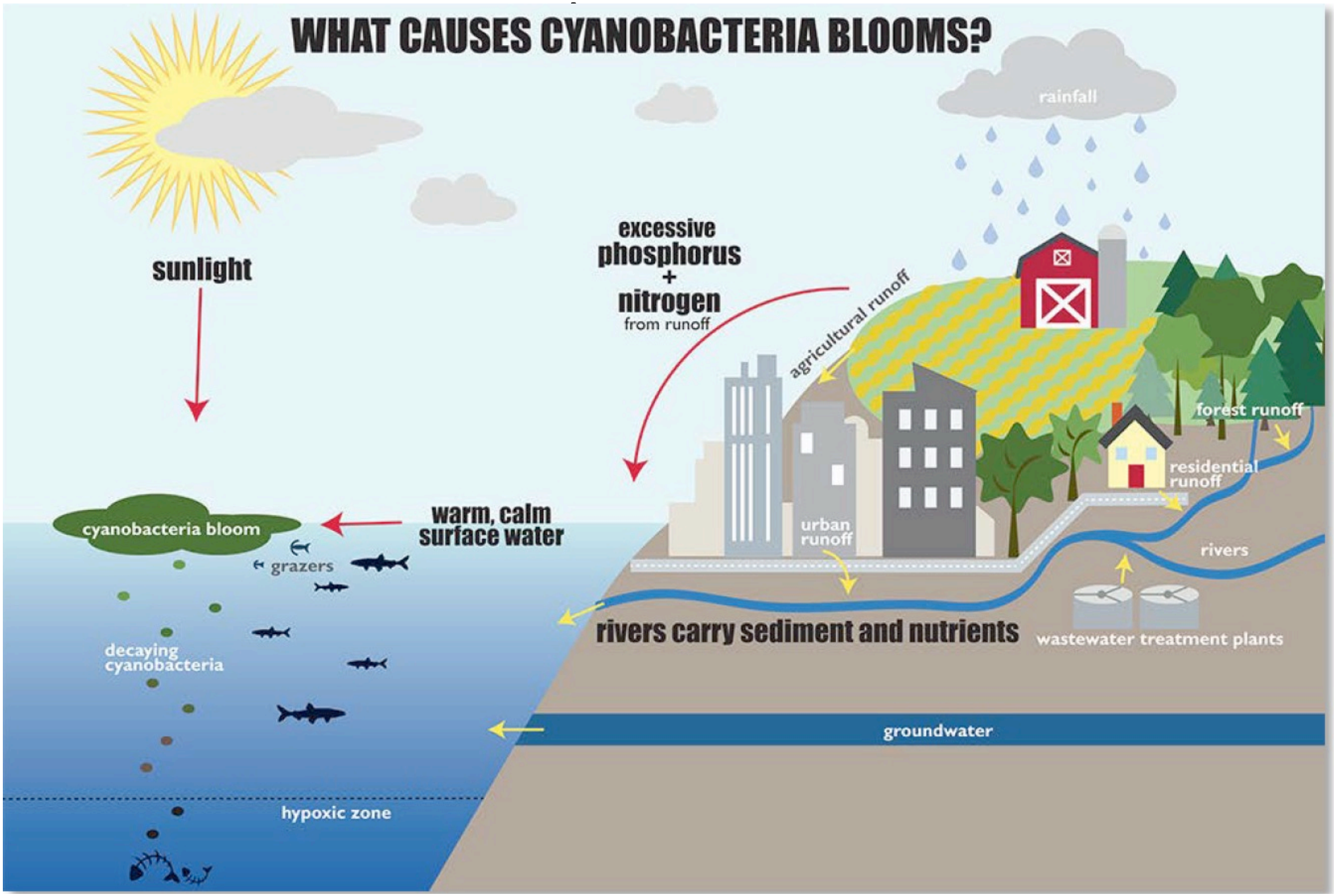
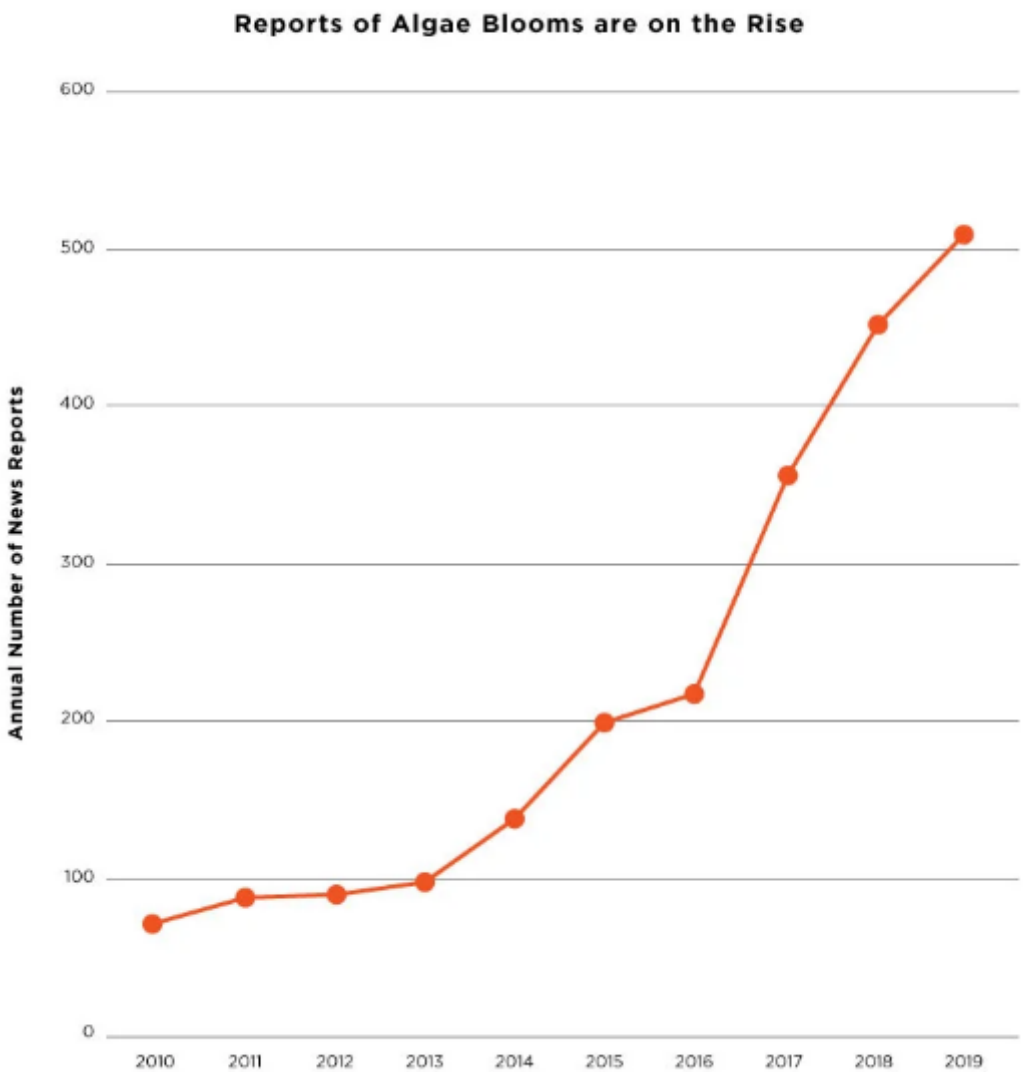
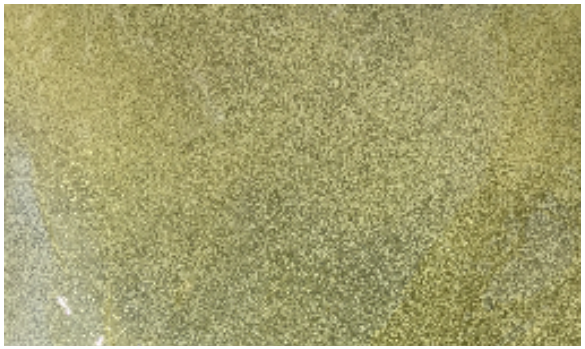


Image Courtesy of the Lake Champlain Basin Program

CyanoHABs occur in all 50 states and public awareness is increasing



Thought to be 'macrophyte seeds'



Cyanotoxins impact all levels of the food web, including humans

OPEN ACCESS Freely available online

PLoS one

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

Melissa A. Miller[1,2*], Raphael M. Kudela[2], Abdu Mekebri[3], Dave Crane[3], Stori C. Oates[1], M. Timothy Tinker[4], Michelle Staedler[5], Woutrina A. Miller[6], Sharon Toy-Choutka[1], Clare Dominik[7], Dane Hardin[7], Gregg Langlois[8], Michael Murray[5], Kim Ward[9], David A. Jessup[1]

Miller et al., 2010

Recent freshwater cyanoHAB events

Toledo water crisis, 2014


Algae's lake effect reveals putrid, pea green disaster

Image: The Blade

Image: Tracy Samilton
Michigan Radio

Lake Okeechobee, 2016 & 2018


Photo: miamiherald.com

Utah Lake, 2016


Image: Rick Egan/AP

'Utah Poison Control says it has taken hundreds of calls about the bloom, about 130 of which involved people that likely came in contact with the water reporting vomiting, diarrhea, headache and rashes.'

Salem, OR, 2018

Image: Mike Warner

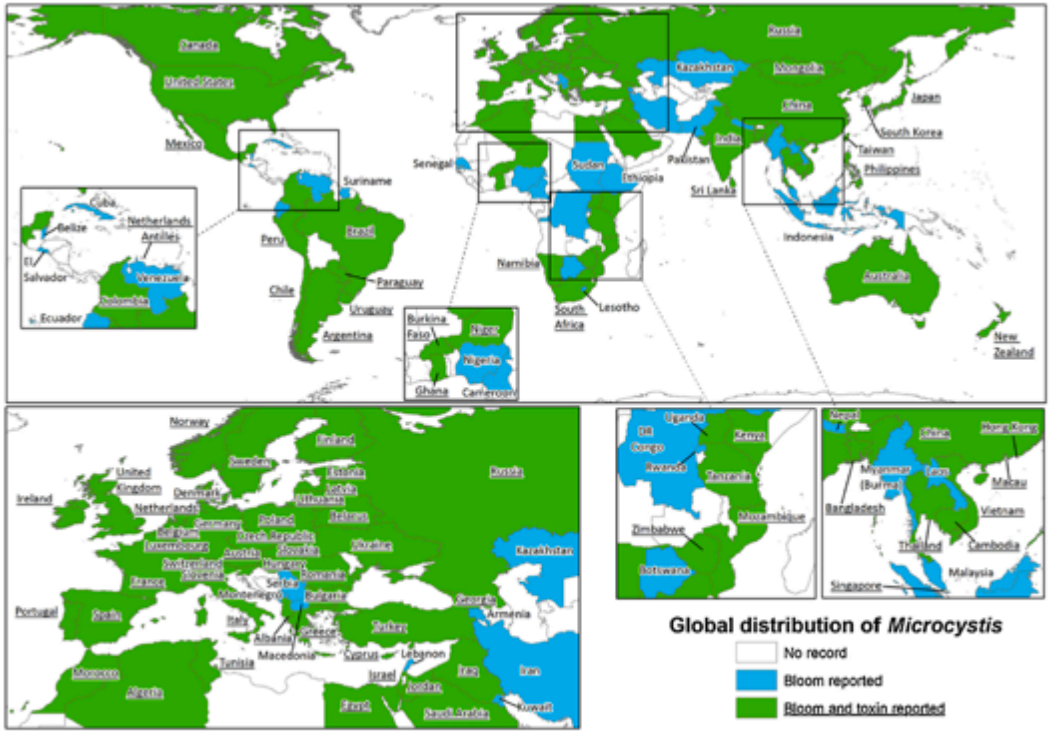
Gulf of Mexico, 2019


EcoWatch

Every Mississippi Beach Is Closed Due to Toxic Algae

Why have cyanoHABs proliferated?

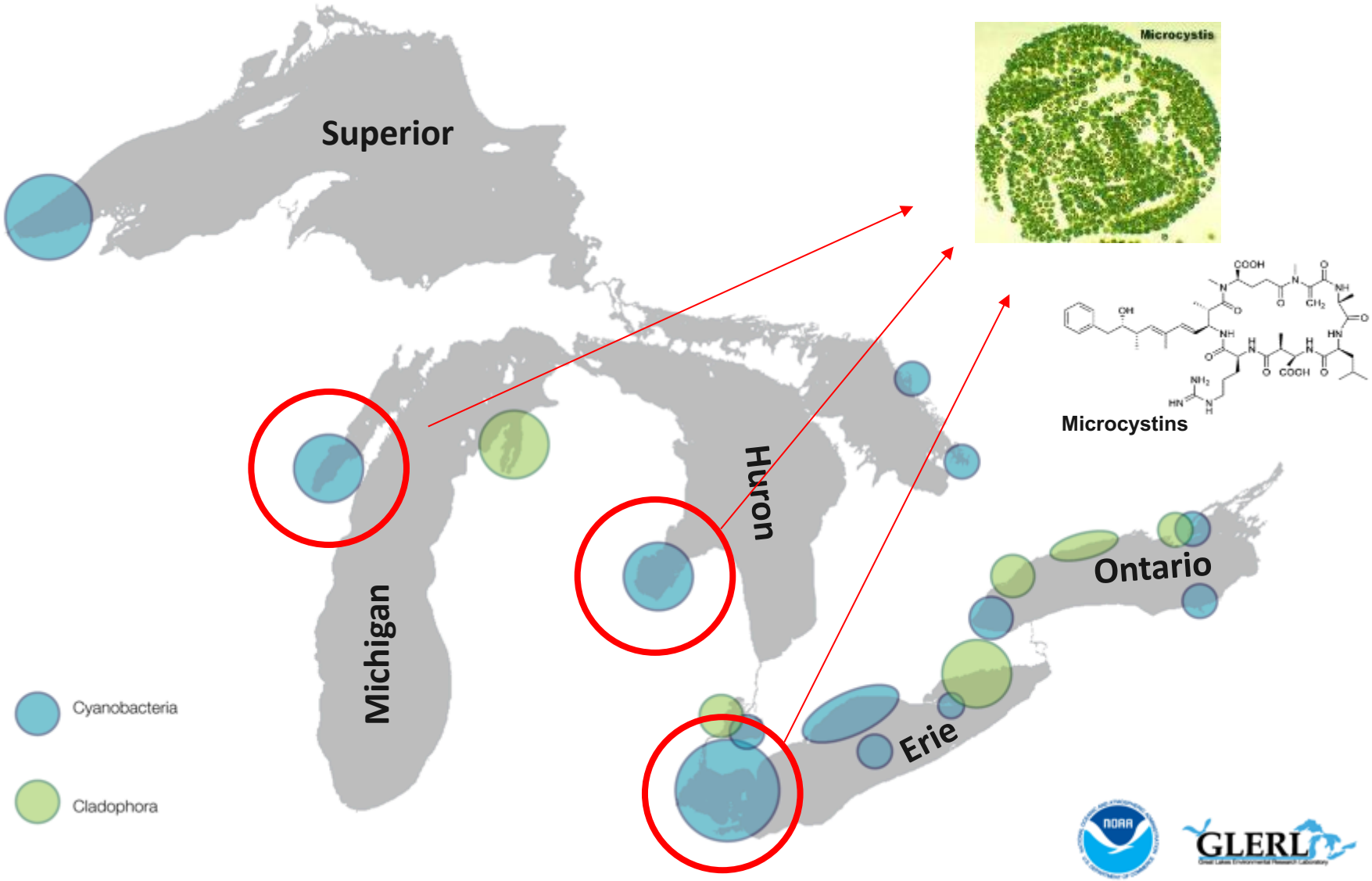
- Anthropogenic nutrient loading (N vs P)
- Loss of key food web predators
- Invasive species may alter ecosystems that give cyanoHAB species an advantage
- Global climate change producing a wider range for some cyanoHABs.
- More comprehensive monitoring and reporting



ig. 1. The global occurrence of *Microcystis* blooms and microcystin as determined through literature searches for records of *Microcystis* blooms from 257 countries and erritories. White indicate no record of bloom or microcystin, blue indicates a record was found for the occurrence of a bloom, and green indicates countries or territories here there was a record of both bloom and microcystin.

Harke et al., 2016; Harmful Algae

CyanoHABs occur throughout the Great Lakes



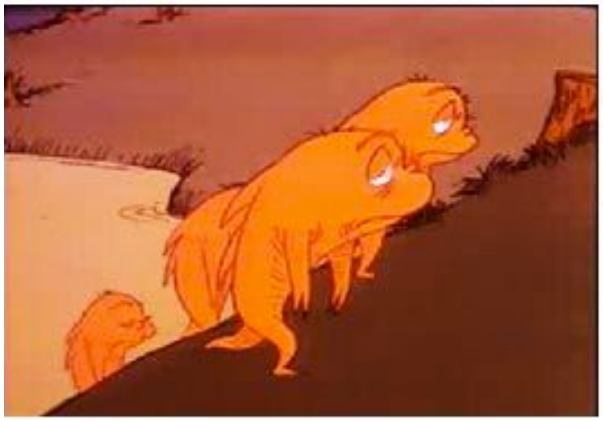
Lake Erie 1950s – 1970s

Excerpt from *Time* magazine 1969:
Some River! Chocolate-brown, oily, bubbling with subsurface gases, it oozes rather than flows. "Anyone who falls into the Cuyahoga does not drown," Cleveland's citizens joke grimly. "He decays". . . The Federal Water Pollution Control Administration dryly notes: "The lower Cuyahoga has no visible signs of life, not even low forms such as leeches and sludge worms that usually thrive on wastes." It is also -- literally -- a fire hazard.

©Bettmann/Corbis

Courtesy of Cleveland Press Collection at Cleveland State University Library.

You’re glumping the pond where the Humming-Fish hummed! No more can they hum, for their gills are all gummed. So I’m sending them off. Oh their future is dreary. They’ll walk on their fins and get woefully weary in search of some water that isn’t too smeary. <u>I hear things are just as bad up in Lake Erie</u> (Seuss, 1971)



1978 Great Lakes Water Quality Agreement

Hear ye! Hear ye!

By Joint Proclamation
Henceforth and forever after

The Lake Erie phosphorus load shall not exceed:

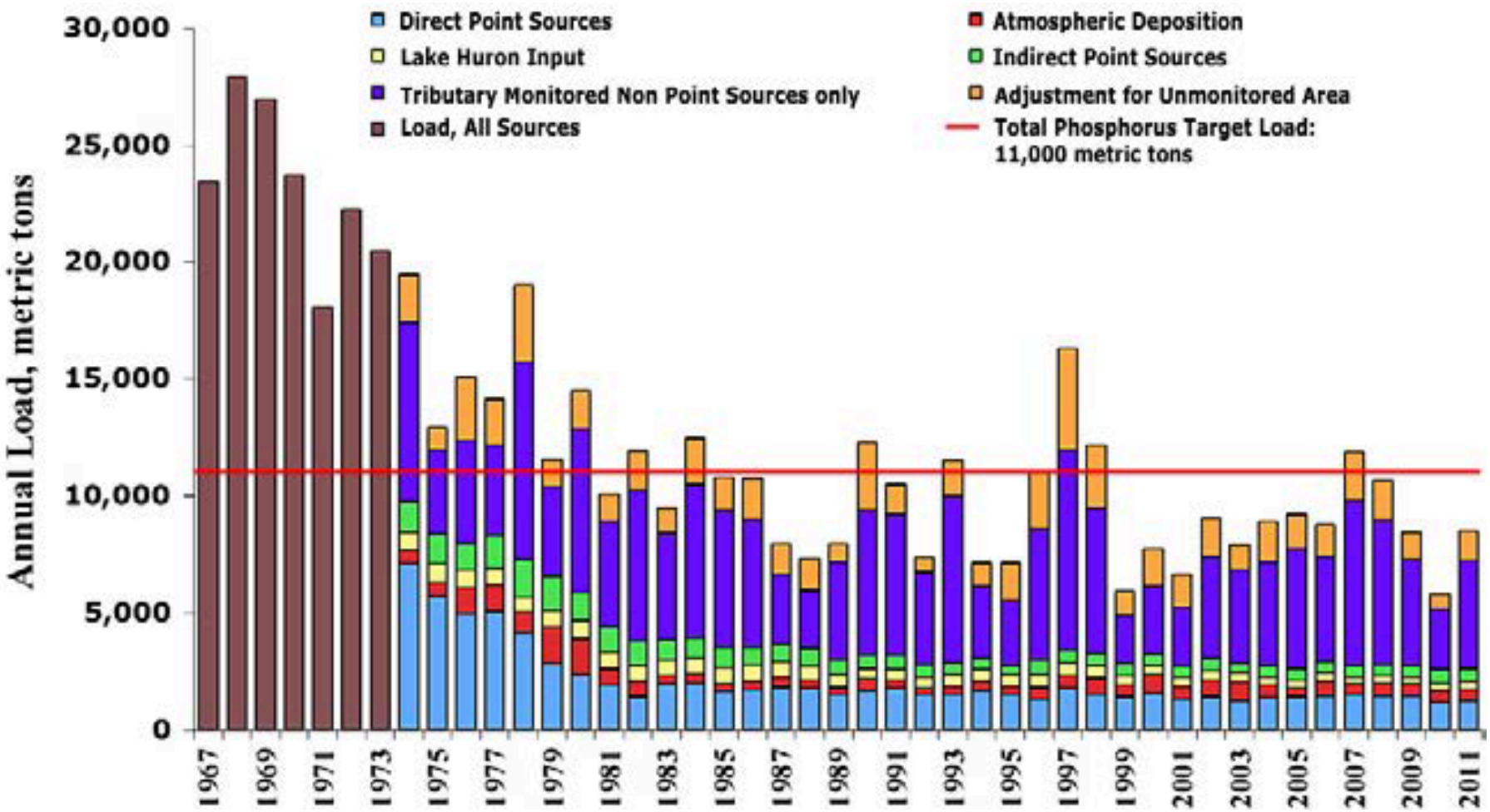
11,000 tonnes/year

which probably translates to about 15 ug/L

Four models provided guidance:
Vollenweider, DiToro et al., Chapra, Bierman et al.

(Supported by info/technology available at that time)

P reductions achieved by targeting point source pollution



From Scavia et al. (2014), JGLR

By the mid-1980s we considered Lake Erie nutrient issues to be solved

ES&T
FEATURES

Great Lakes water quality improvement

The strategy of phosphorus discharge control is evaluated

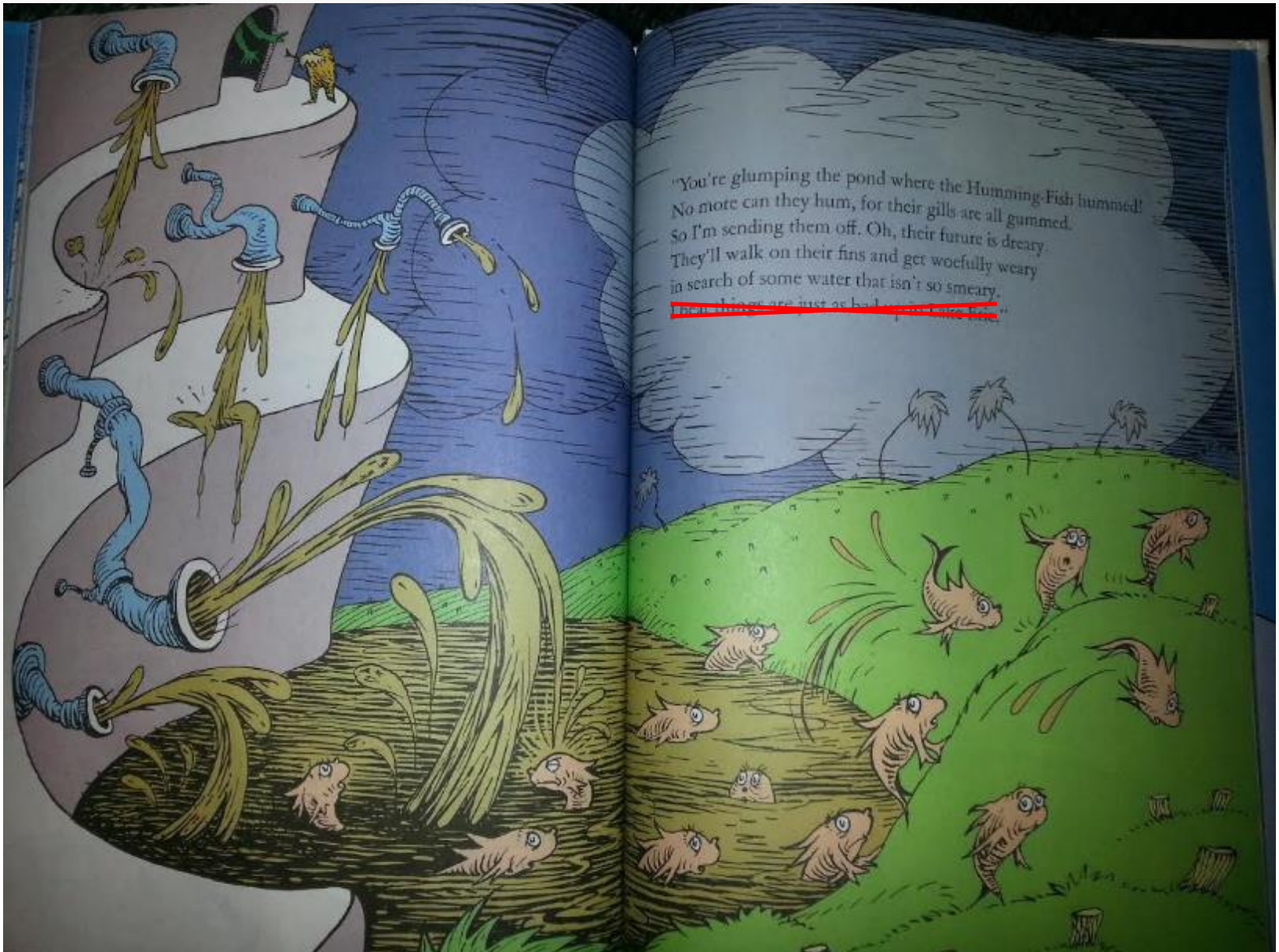
Joseph V. De Pinto
Thomas C. Young
Lyn M. McIlroy
Clarkson University
Potsdam, N.Y. 13676

The impressive size of the Great Lakes has not been enough to shield them from many of the water quality problems that have resulted from the tremendous human population explosion within their basin (Table 1). Over the past 180 years the population resid-

quest of either the U.S. or Canadian government, or both. These studies, designed to formulate recommendations to the two governments, are known as "references."

Since its inception the IJC has issued more than 50 references; some of its

We even convinced Dr. Seuss!



By the mid-1990's the Lorax returned

What do we know?

Nonpoint nutrient sources are now the dominant source

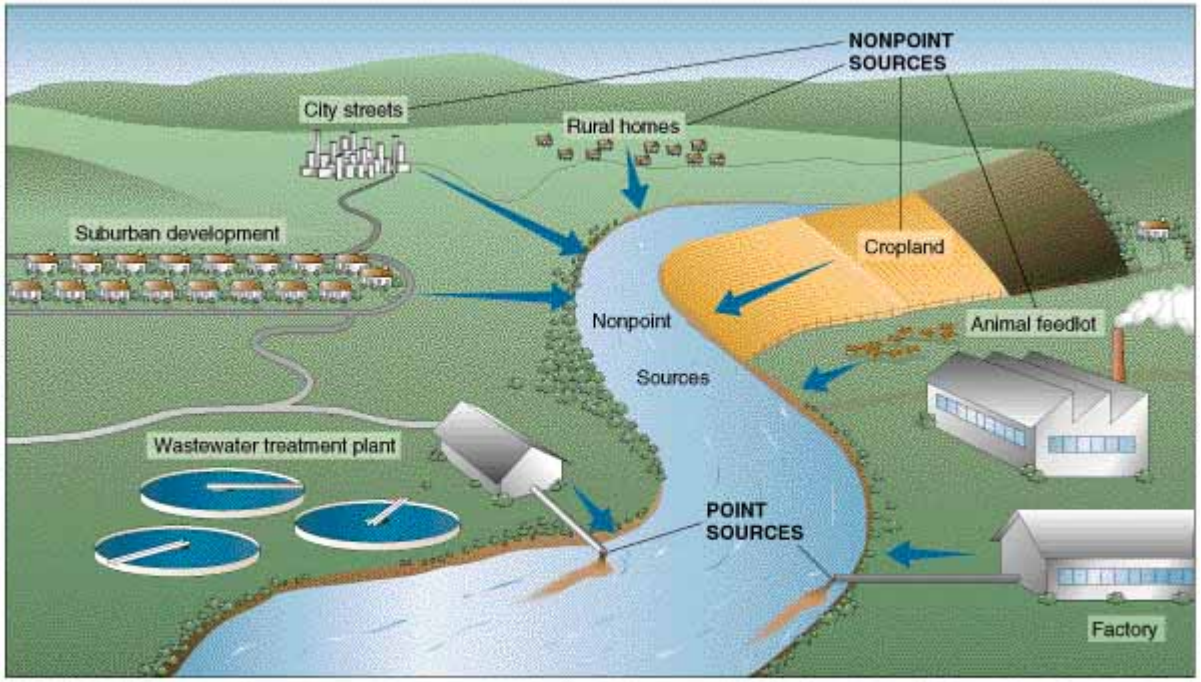
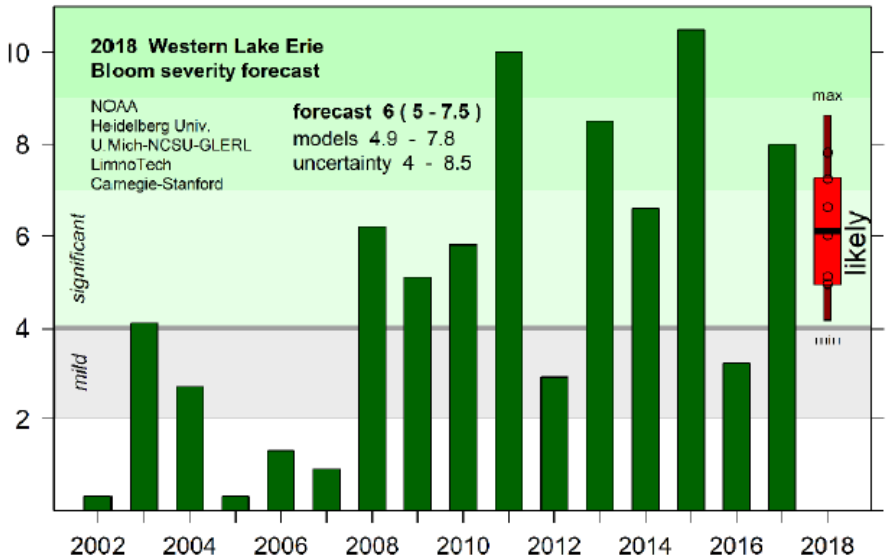
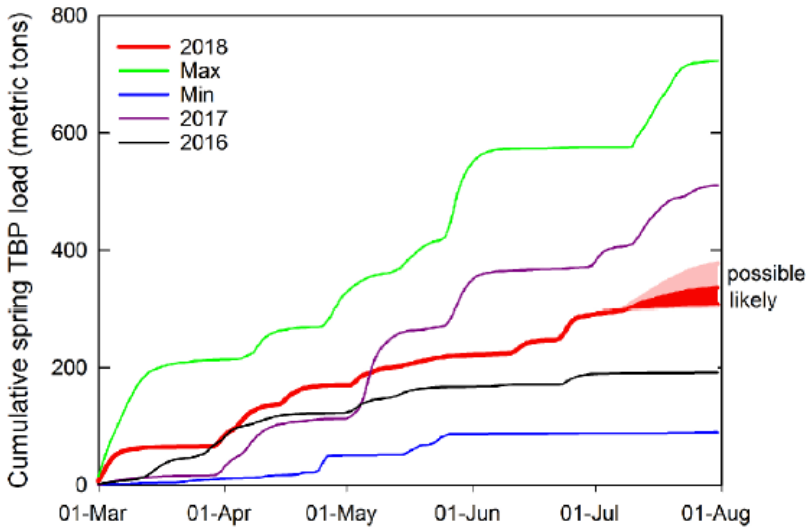


Image: Allison Mills

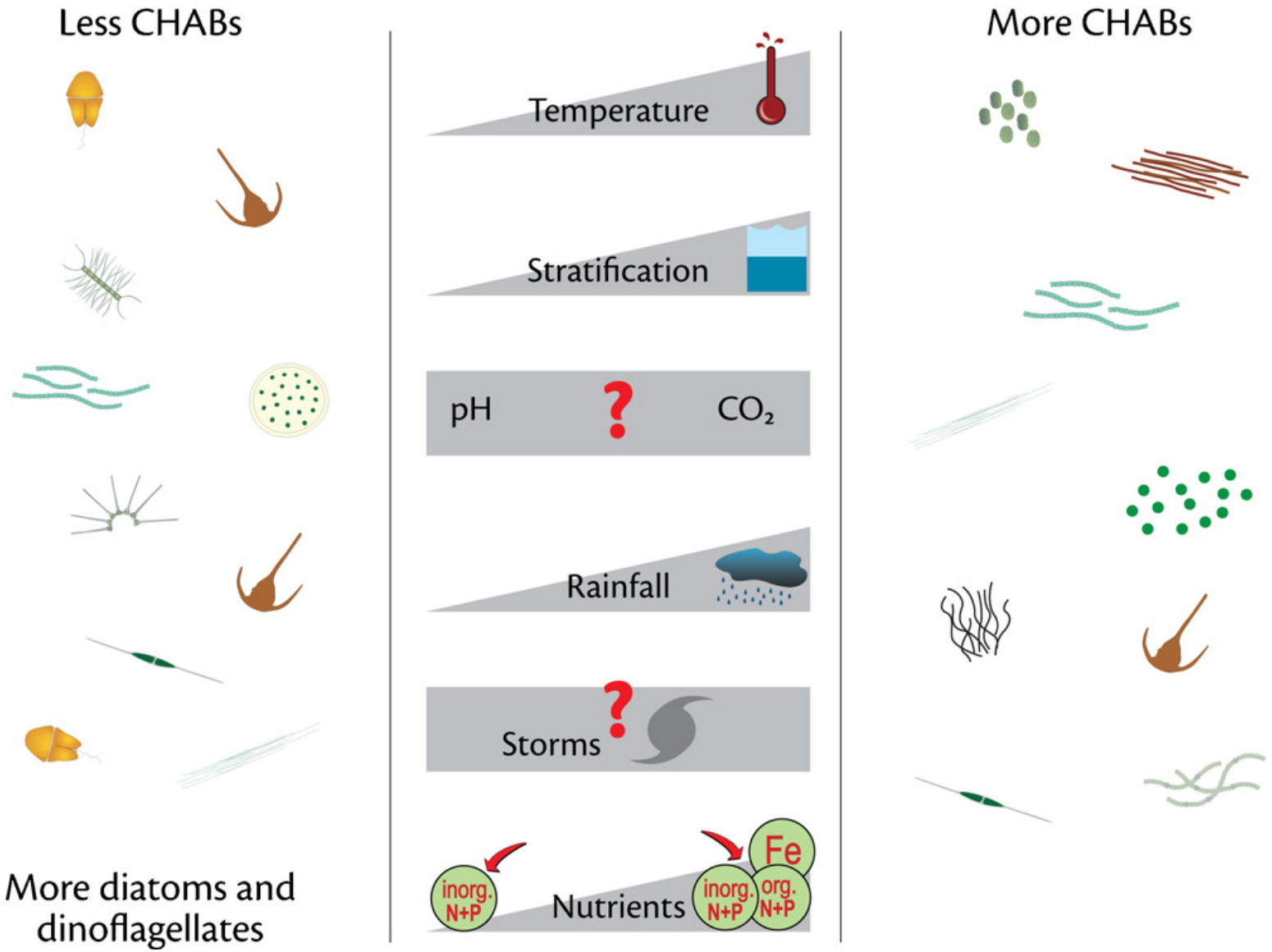
Lake Erie CHABs are increasing in severity





Richard Stumpf, Timothy Wynne, et al.

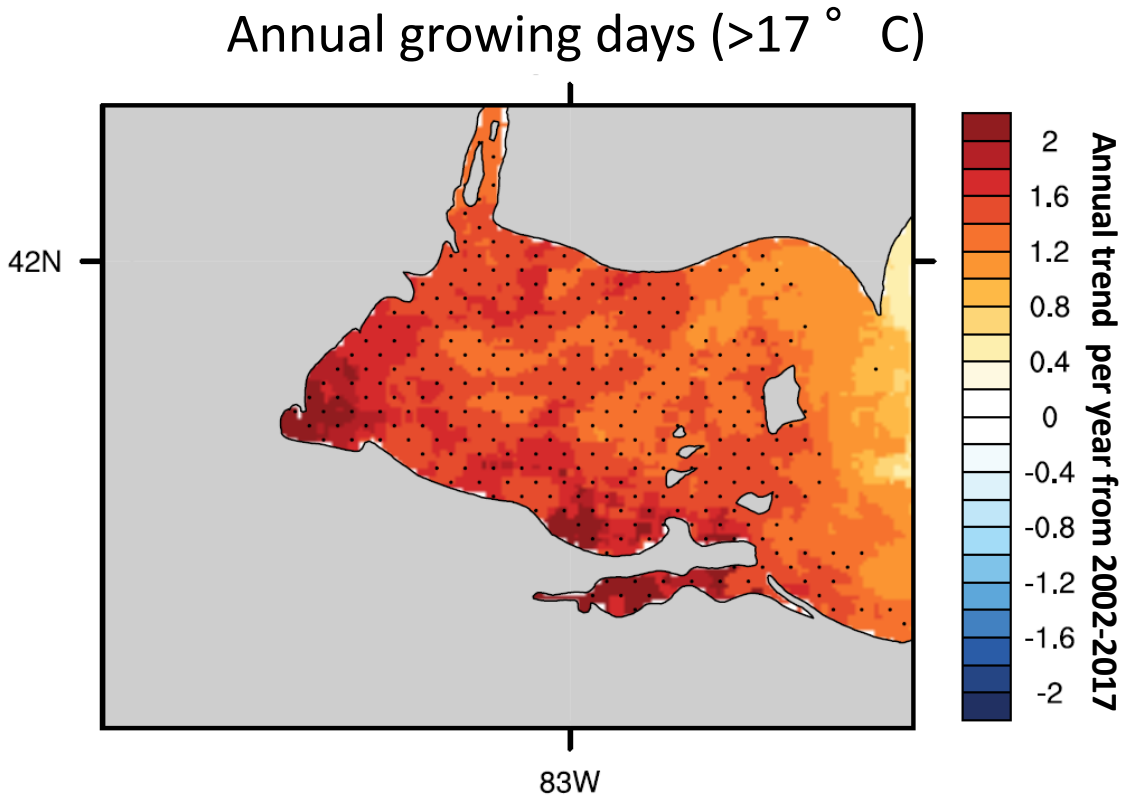
Climate and eutrophication effects

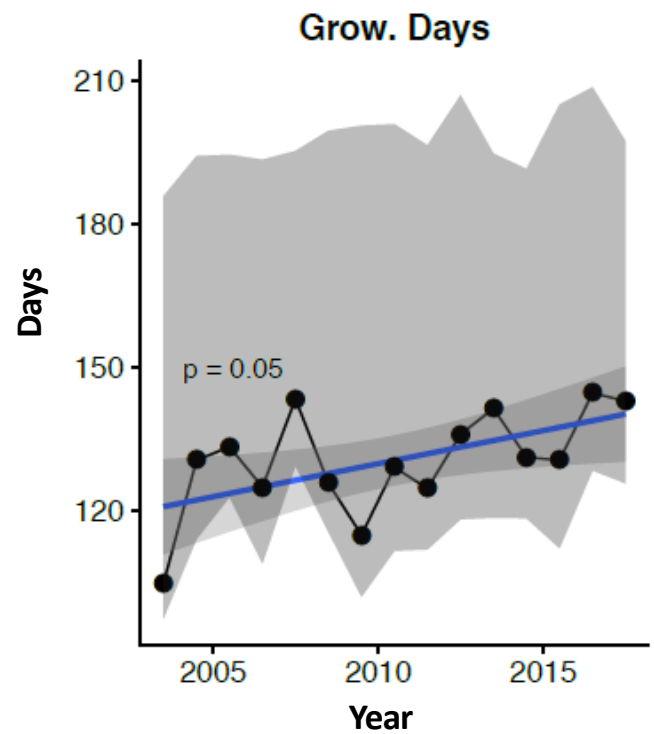


Must further understand the impact of climate change on water quality

O'Neil, Davis et al., 2012, Harmful Algae

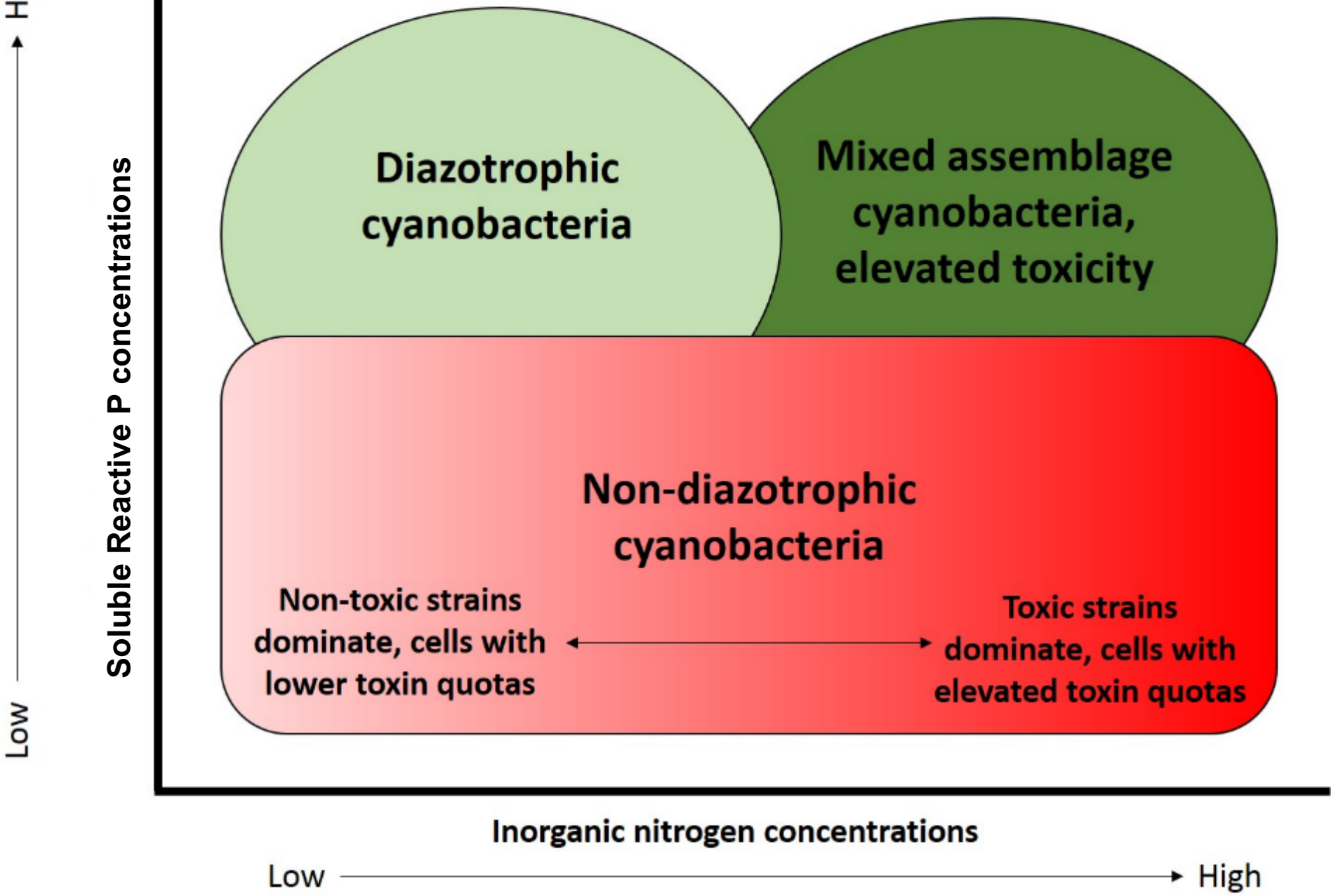
Most of the Western Lake Erie has experienced an 1-2 day increase in growing days per year since 2002





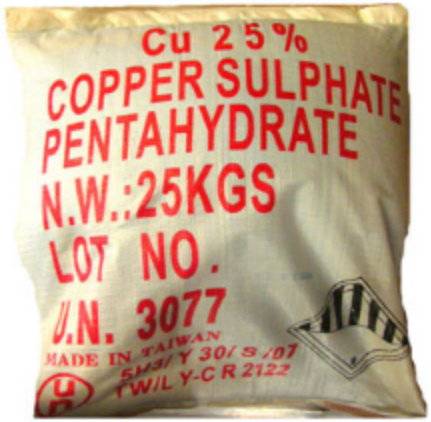
- Black dots represent areas where the trend is significant ($p < 0.05$)

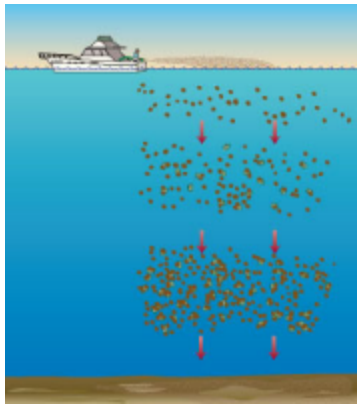
Nitrogen and phosphorus management needed

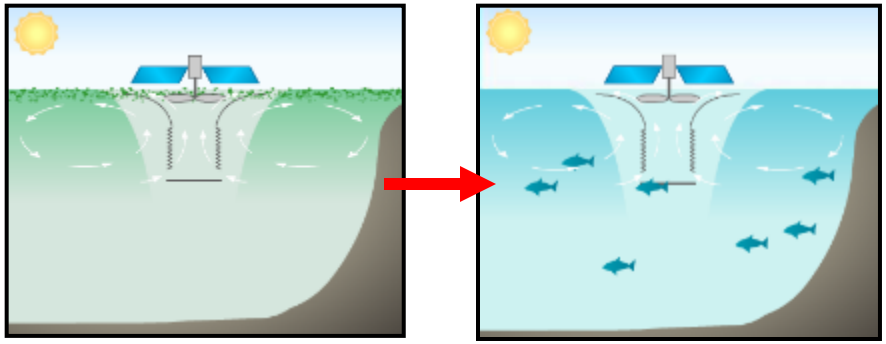


From: Gobler, Burkholder, Davis, et al., 2016, Harmful Algae

In-lake treatment options are not an option







The 'water harrow', the device that was used to bring hydrogen peroxide into Lake Koetshuis.

Scale is an issue when evaluating these options

Overall Problem

Most of these treatments try to treat the symptoms not the root of the problem

Some possible socioeconomic impacts

Increased water treatment costs

Lost recreational activities

Business income

Decreased home values

Monitoring costs

Decreased charter, recreational and commercial fishing

Non-use values

Decreased tourism

Beach closures

Impacts of the 2014 water crisis

Increased water treatment costs

Food and drink processing plants

Business income

Grocery store produce

Monitoring costs

Bottle water (short and long-term)

Doctor visits?

Decreased trust in public utility

Restaurants and Cafes

Picture: AP Photo/The Blade, Jetta Frase