Harmful Algal Blooms in Wisconsin Waters 2009-2012

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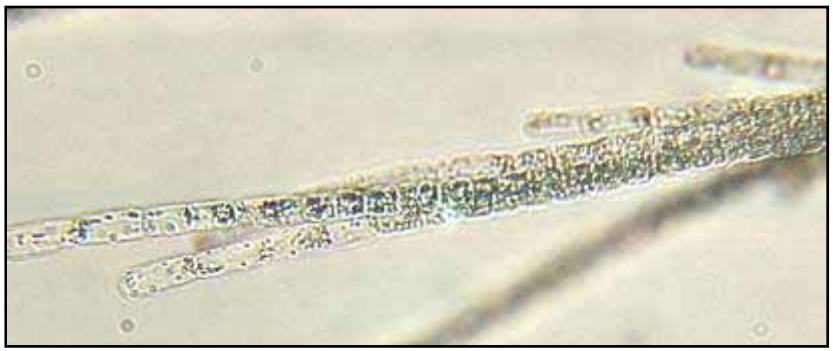
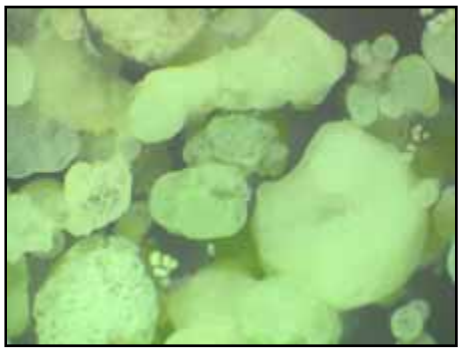
Wisconsin Department of Natural Resources
Bureau of Science Services

Project partners:

Project funded by:

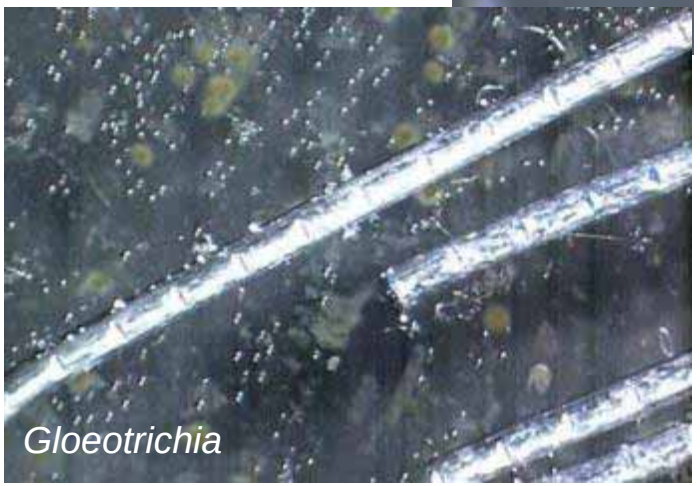
What are blue-green algae?

- Photosynthetic bacteria (cyanobacteria)
- Native to every lake & river in Wisconsin
- Buoyancy: they regulate position
- Temperatures: they like it hot
- Toxins: produced by some species

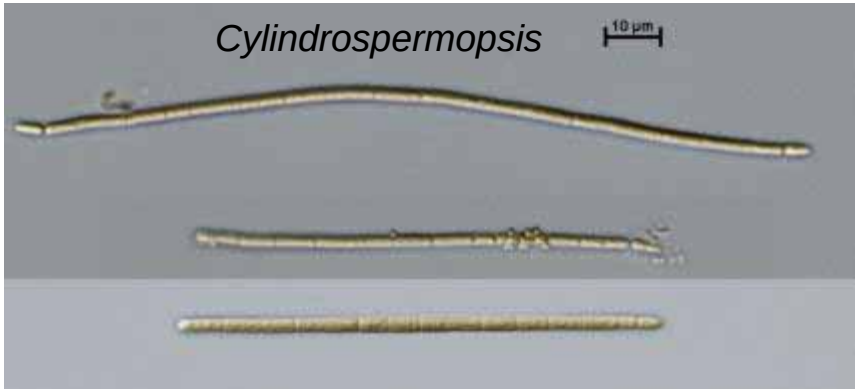




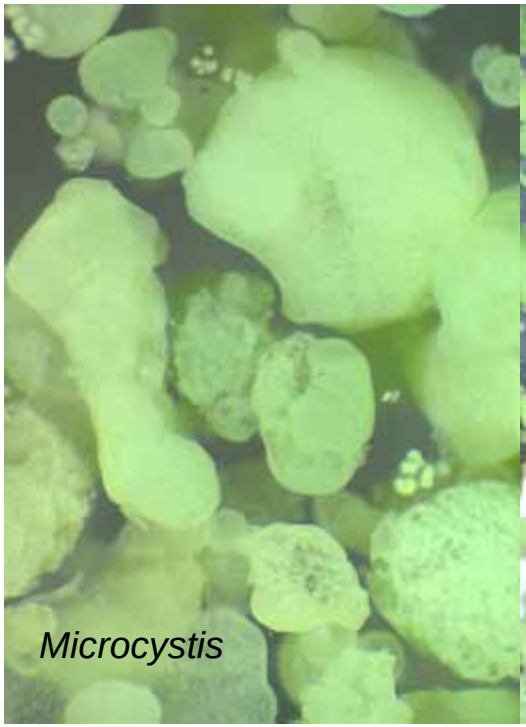

Planktonic blue-green algae

Aphanizomenon

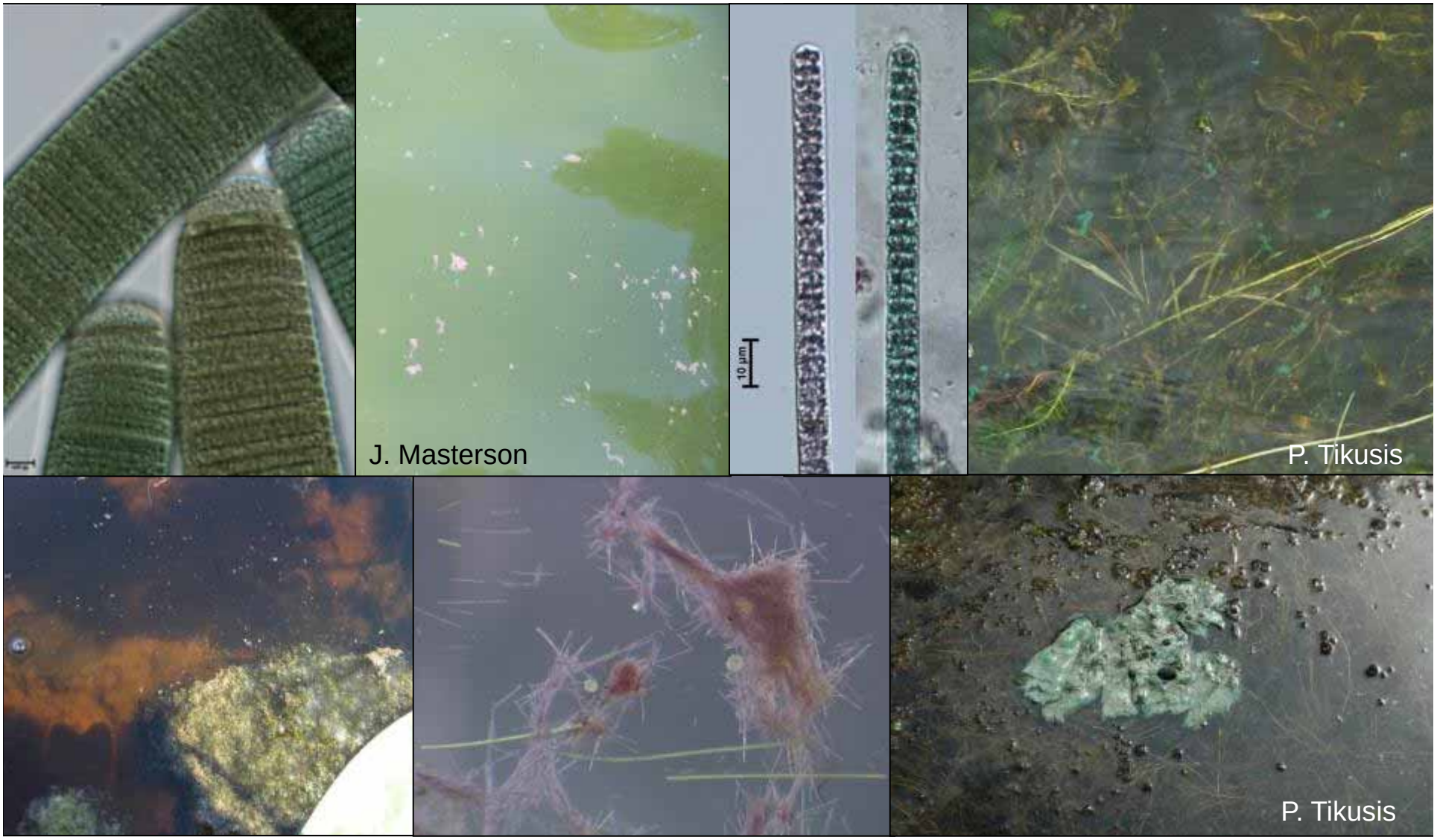

Gloeotrichia


Anabaena



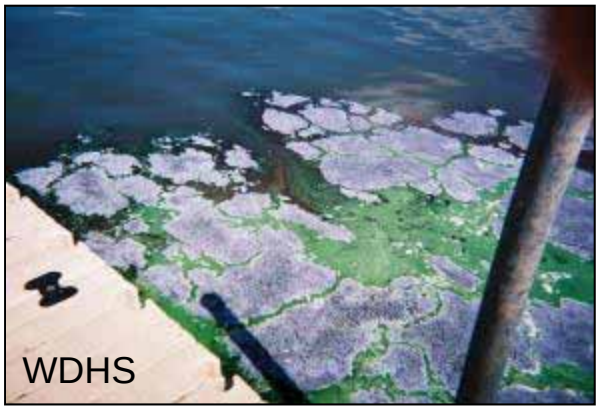

Microcystis

Floating Algal Mats:
Oscillatoria, Lyngbya, Plectonema, Planktothrix



Hazards of blue-green algae blooms

- They may form nuisance blooms.
- Blooms impact aquatic life.
- Some strains can make liver, cell, or nerve toxins if conditions are right.
- Toxins may irritate the skin in sensitive individuals; swallowing or inhaling them in water can cause illness.
- **Not all blue-green algae make toxins, and toxins are not made all the time.**

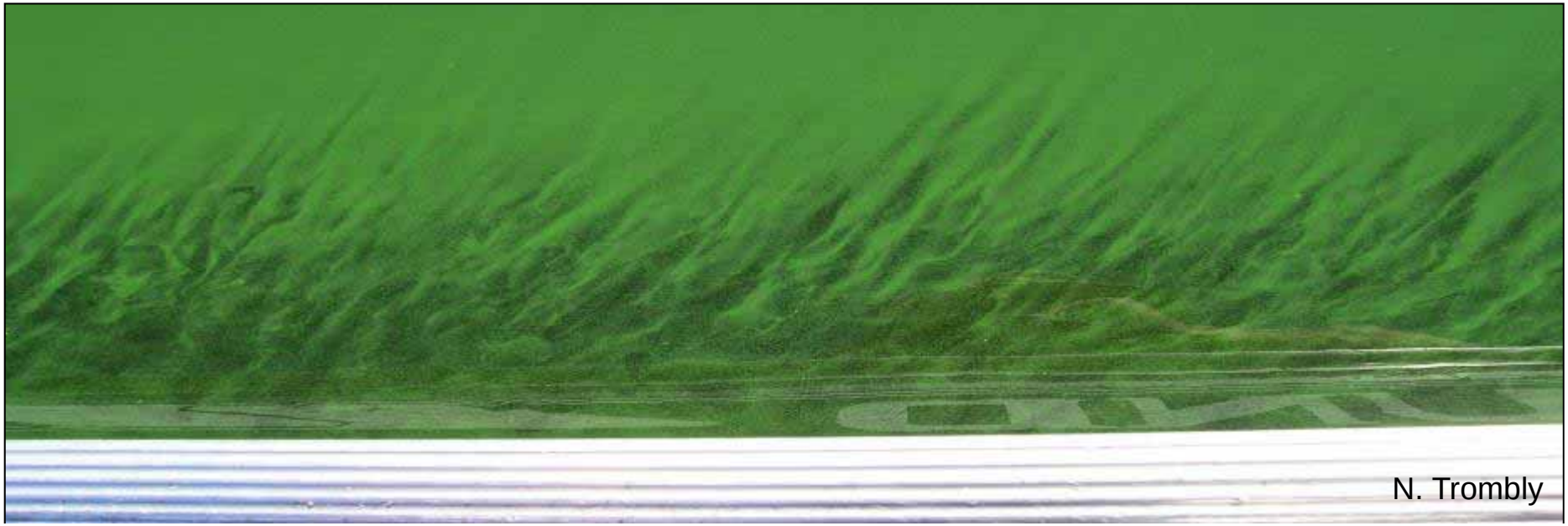


What causes harmful blooms?

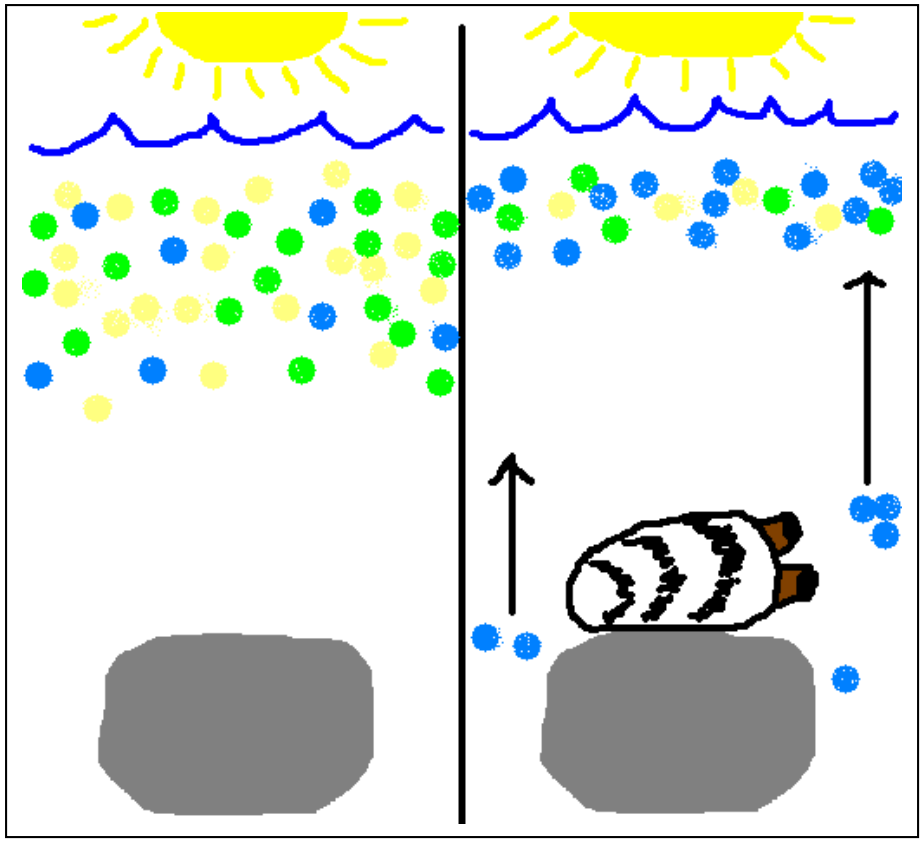
- Excess nutrients, primarily phosphorus
- Warm water and calm weather

Adaptations of blue-green algae present management challenges

- Grow better in high water temperatures
- Store phosphorus for later use
- Nitrogen fixation in some species



Zebra mussels & quagga mussels affect *Microcystis* blooms



Mussels reject *Microcystis* when feeding. *Microcystis* regulates its buoyancy and can move back up in the water column.

Harmful algal blooms in Wisconsin are not new.

THE "WORKING" OF THE MADISON LAKES.

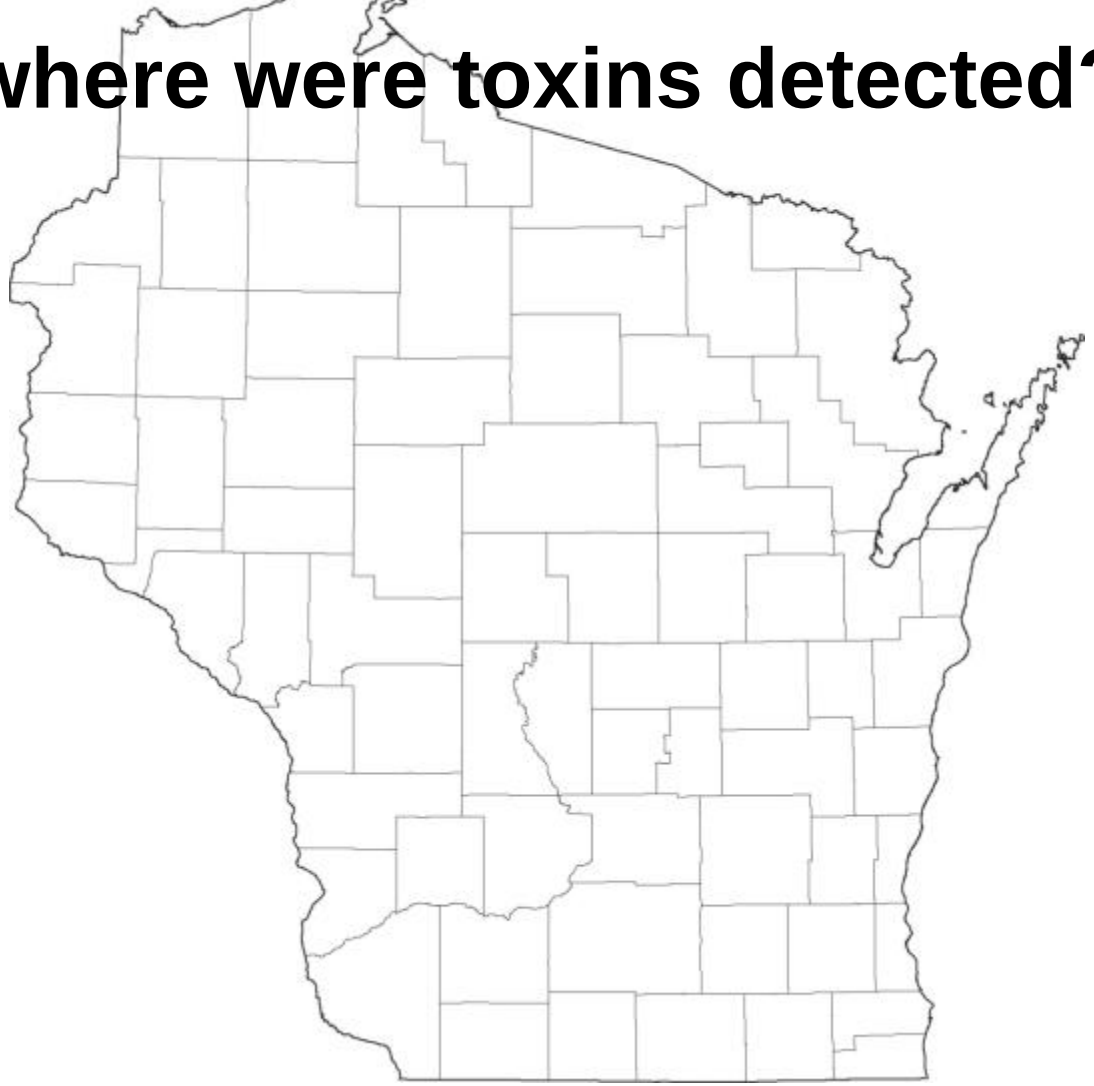
BY WILLIAM TRELEASE.

Every season a greenish-yellow scum occurs in greater or less quantity on Third and Fourth Lakes (Mendota and Monona), during the hot weather of summer, after the water has been calm for a number of days in succession. When but little of it is present, it appears as fine granules suspended in the water, often scarcely visible to the naked eye except as they reflect the light, when they call to mind the dancing motes in a beam of sunlight.

Trelease 1889. Transactions of the Wisconsin Academy of Sciences, Arts, and Letters 7:121-129

Historical harmful algal blooms in Wisconsin

(where were toxins detected?)

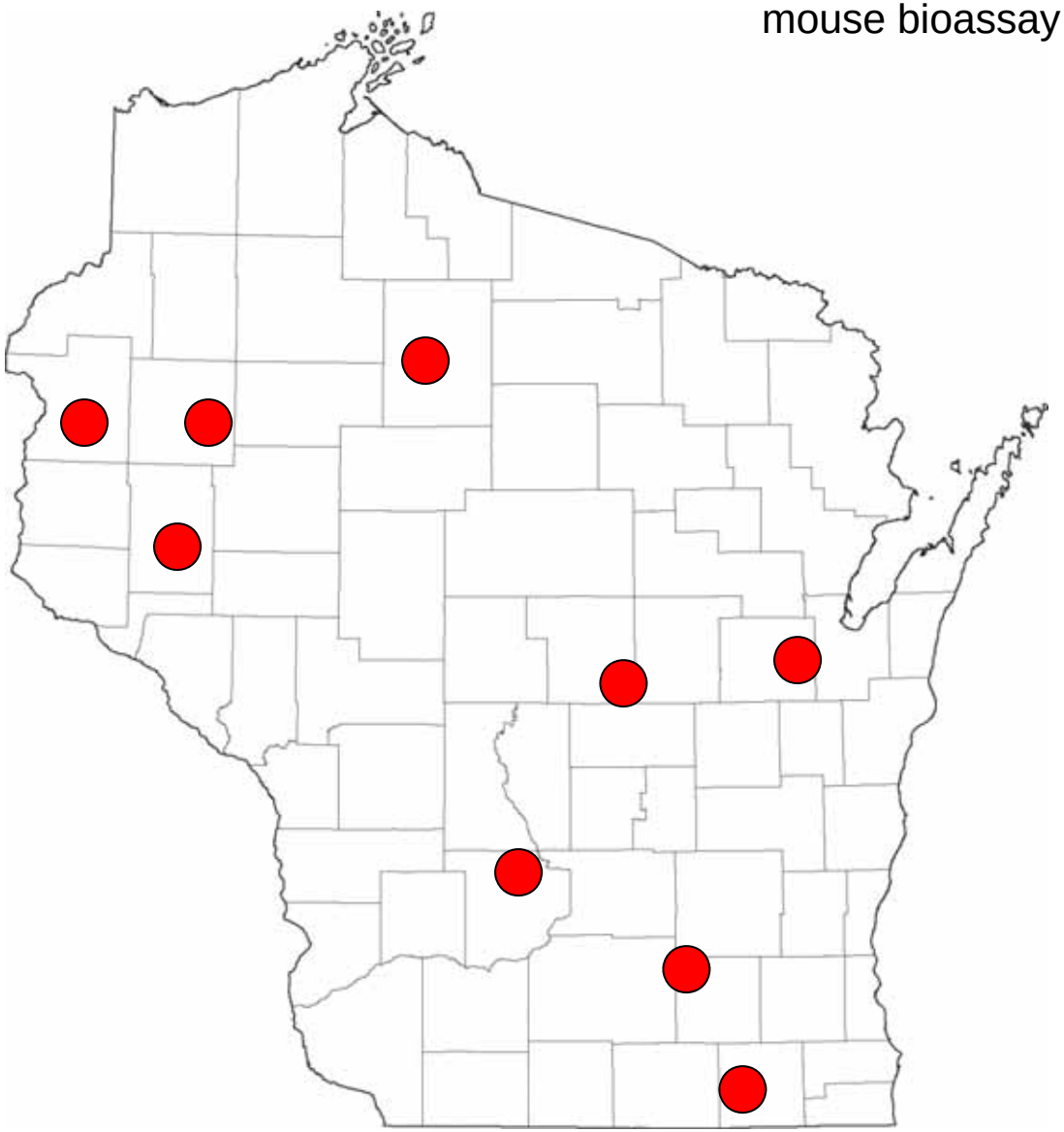


Cyanobacterial Toxins 1967-1969

Karl 1970

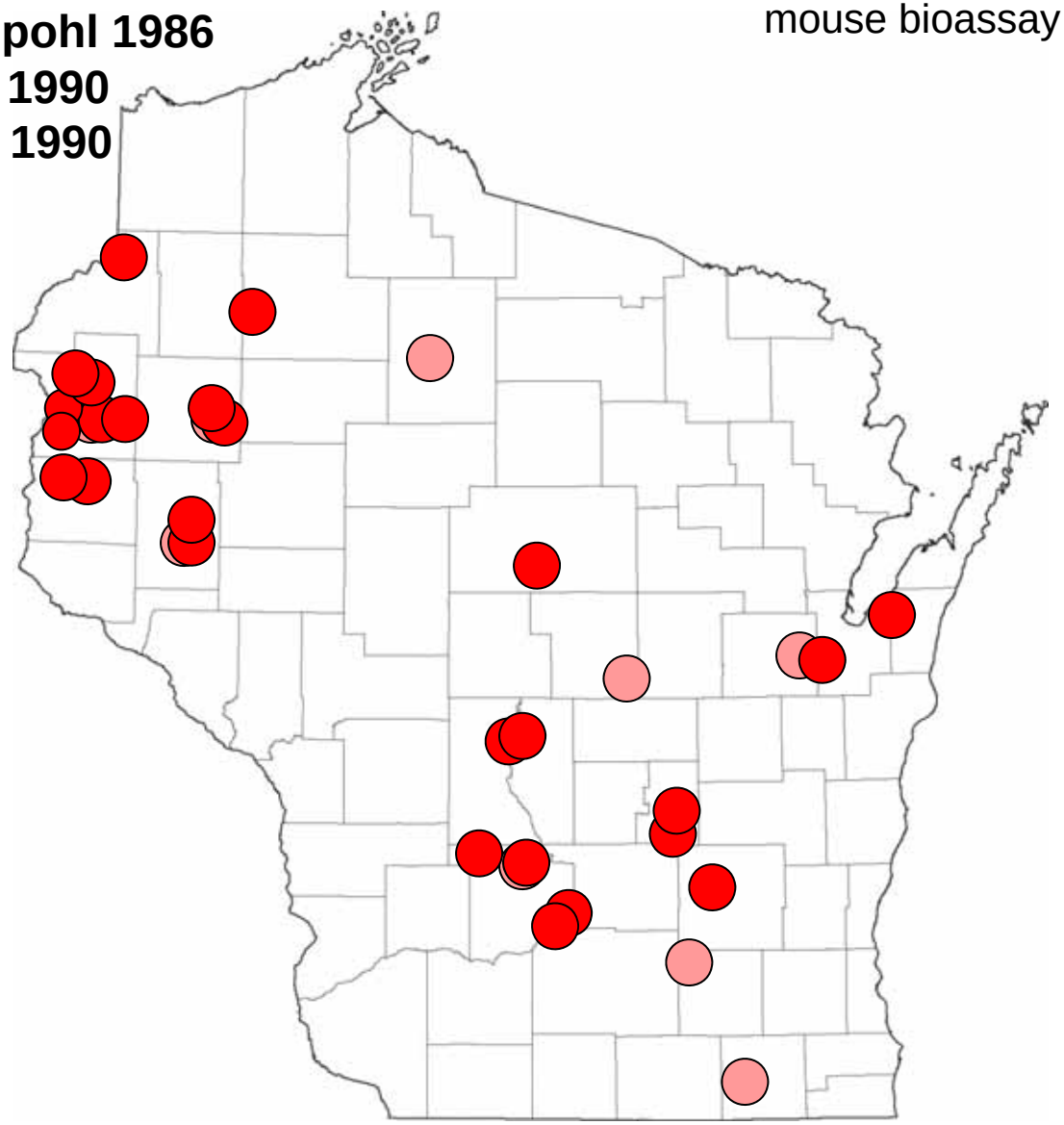
20 sites

Toxicity determined via mouse bioassay



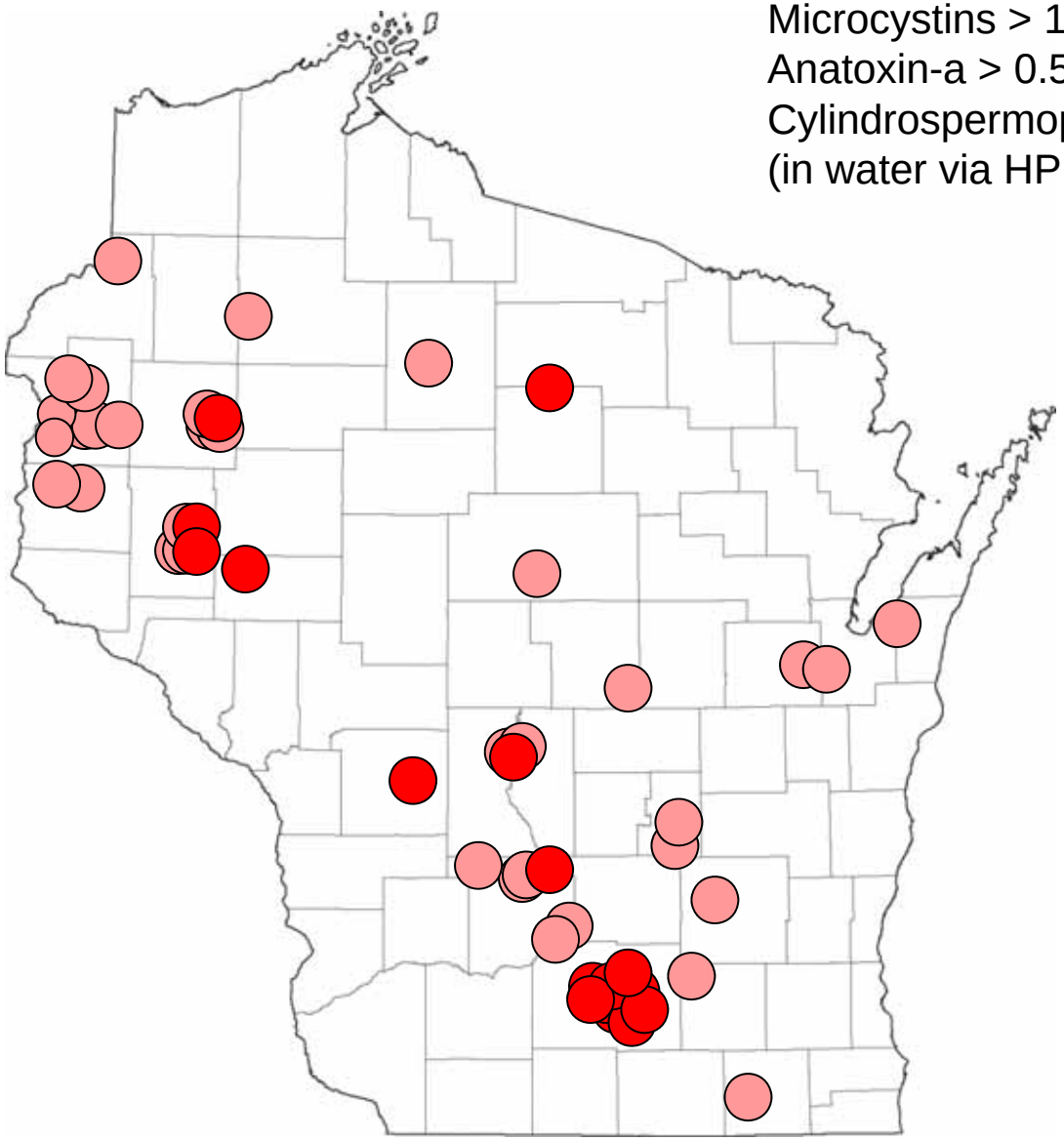
Cyanobacterial Toxins 1983

Vennie & Wedepohl 1986
Repavich et al. 1990
Sonzogni et al. 1990
86 sites

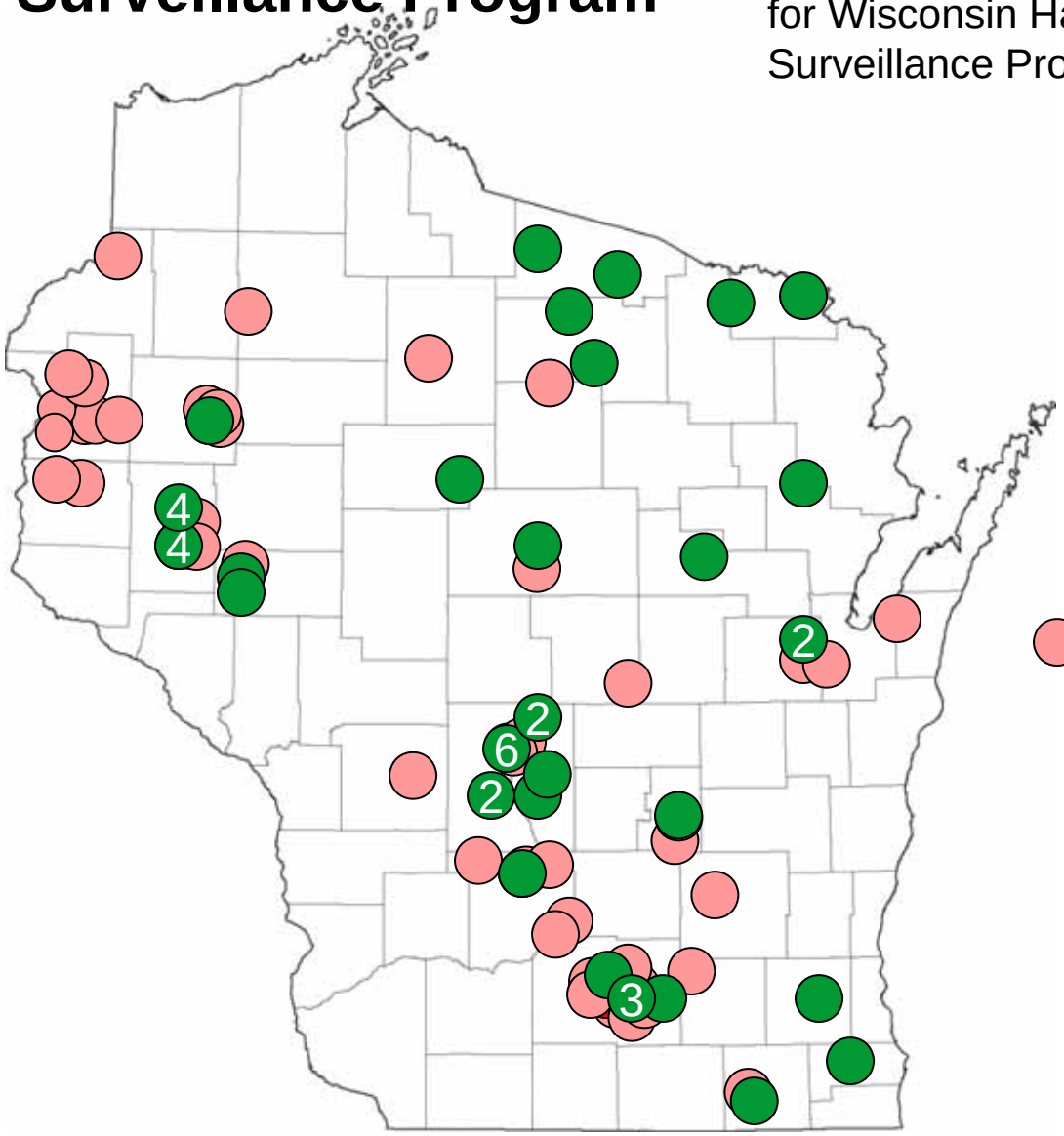


Cyanobacterial Toxins 2004-2008

Toxins above detection levels:
Microcystins > 1.0 ug/L, or
Anatoxin-a > 0.5 ug/L, or
Cylindrospermopsin > 0.5 ug/L
(in water via HPLC/MS/MS)



2009-2012 HAB Surveillance Program

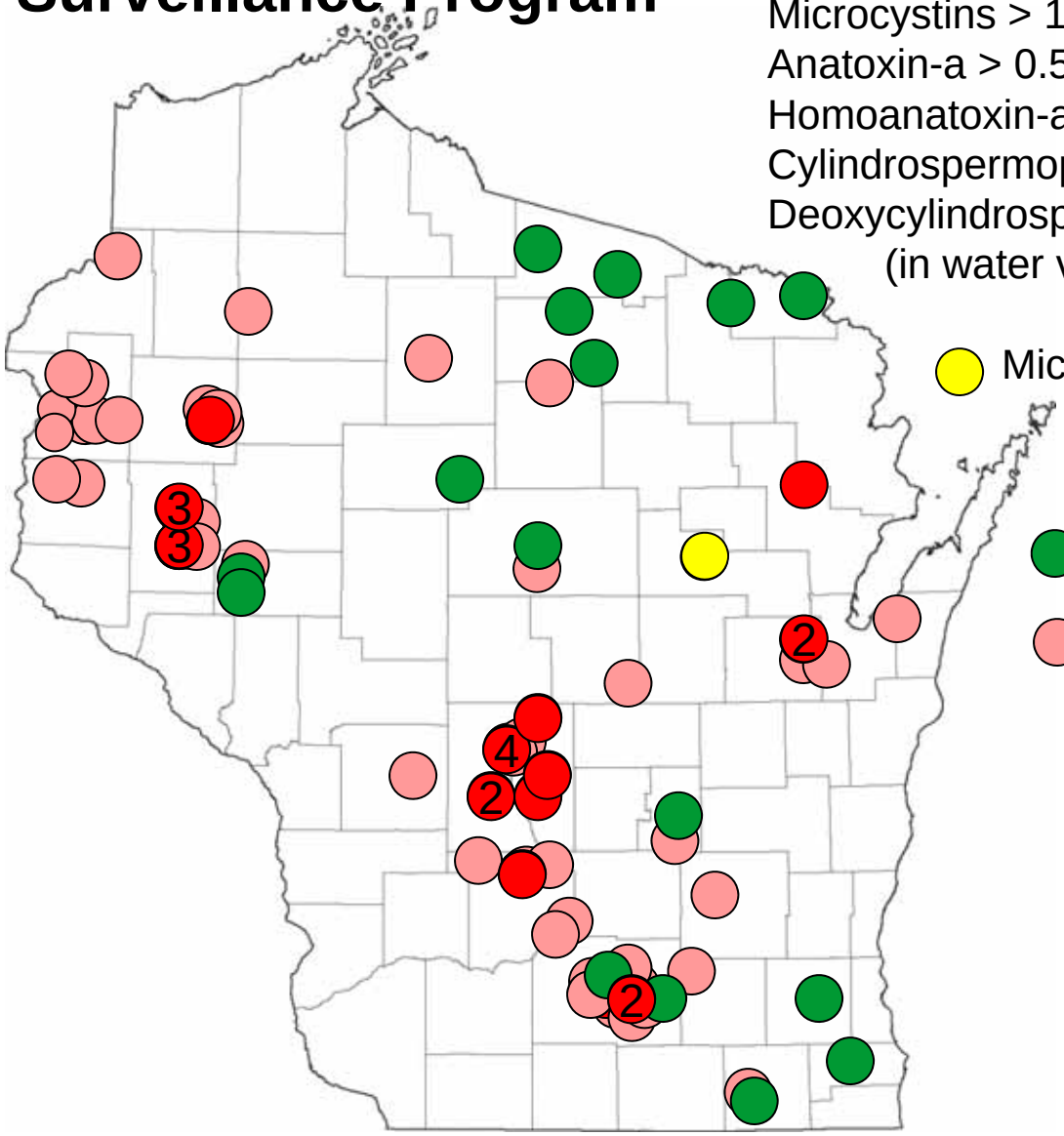


Sites at which algae was sampled for Wisconsin Harmful Algal Bloom Surveillance Program

Toxins detected in previous studies 1967-2008

Numbers indicate multiple sampling dates for a single water body.

2009-2012 HAB Surveillance Program



Toxins above detection levels:
Microcystins > 1.0 ug/L, or
Anatoxin-a > 0.5 ug/L, or
Homoanatoxin-a > 0.5 ug/L, or
Cylindrospermopsin > 0.5 ug/L, or
Deoxycylindrospermopsin > 0.5 ug/L
(in water via HPLC/MS/MS)

Microcystin > 0.1 ug/L
(via ELISA)

Toxins below detection limits

Toxins detected in previous studies 1967-2008

Numbers indicate multiple sampling dates for a single water body.

World Health Organization Guidelines

Probability of Adverse Health Effects	Cell Density (cells/ml)	Microcystin-LR (ug/L)	Chlorophyll (ug/L)
Low	< 20,000	< 10	< 10
Moderate	20,000-100,000	10 – 20	10 – 50
High	100,000-10,000,000	20 – 2,000	50 – 5,000
Very High	> 10,000,000	> 2,000	> 5,000

Graham *et al.* 2009, based on World Health Organization's 2003 *Guidelines for Safe Recreational Water Environments*

T. Bridgeman,
University of Toledo

Should you let your kids or pets play in this?

BAD IDEA!

Algae are common in lakes and rivers. But at high concentrations a type called "blue-green" algae can make people and animals sick.

What to look for:

- Does the water look "pea soupy"?
- Does it smell swampy?

Blue-green algae can:

- irritate skin, eyes and nasal passages and make you sick.
- poison your pets or livestock – animals have died from it.

If you or your pets have come in contact with blue-green algae, **wash thoroughly.** Think you or animals are sick from it? Call a doctor or veterinarian immediately.

When in doubt, best keep out!

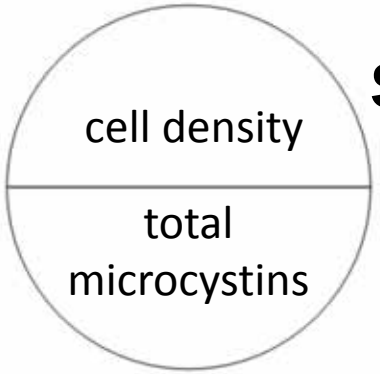
This poster prepared by the Minnesota Interagency Work Group on Blue-Green Algae.

In Wisconsin - http://dnr.wi.gov/lakes/bluegreenalgae/

PACRS


31,000 cells/ml
S. Graham
255,000 cells/ml
Cylindrospermopsis
N. Trombly
3,000,000 cells/ml
K. Schreiber
51,000,000 cells/ml
C. Fitzgibbon

2009-2012 HAB Surveillance Program



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Very High	> 10,000,000	> 2,000

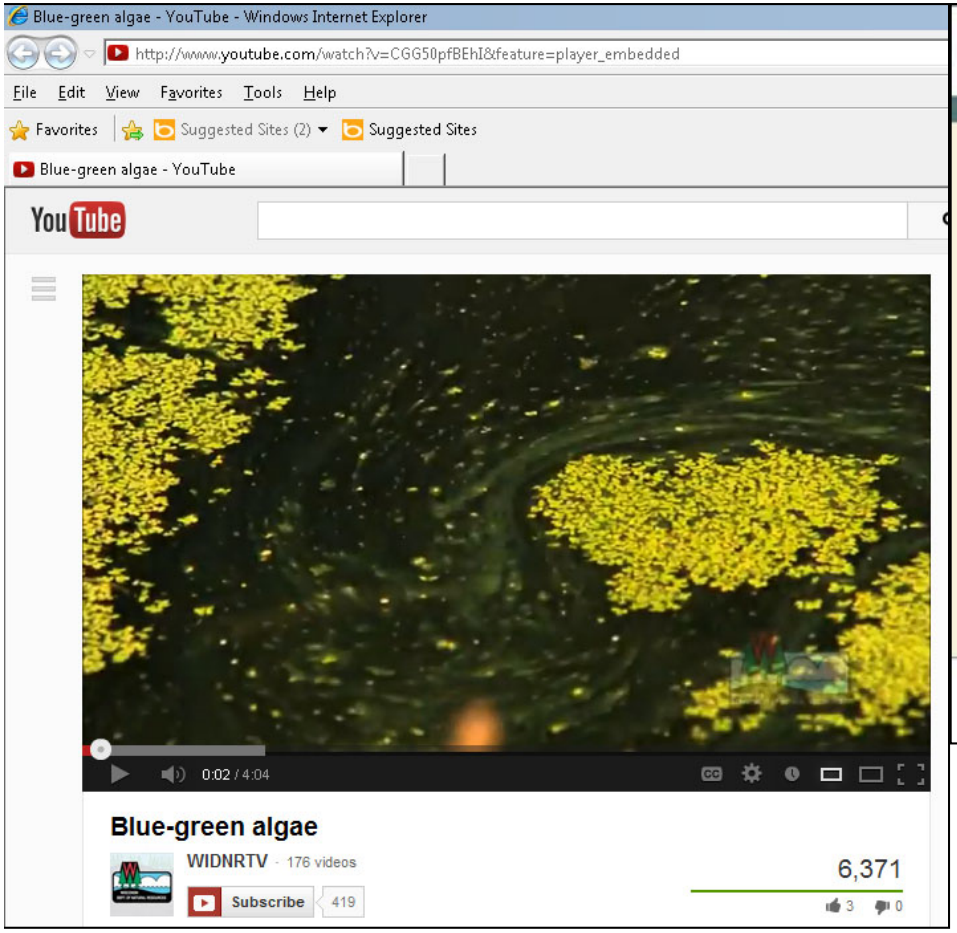
Graham et al. 2009, based on World Health Organization, 2003 *Guidelines for Safe Recreational Water Environments*

*may not be accurate – flagged at lab

How to be safe?

- Avoid swimming in and boating through blue-green algal scums and “pea soup” water.
- **Can you see your feet in knee-deep water?** If not, avoid ingesting any water.
- Always shower after swimming in a lake, river, or pond.
- Keep pets out of scummy water, and wash them off immediately if they swim or wade in during a bloom.

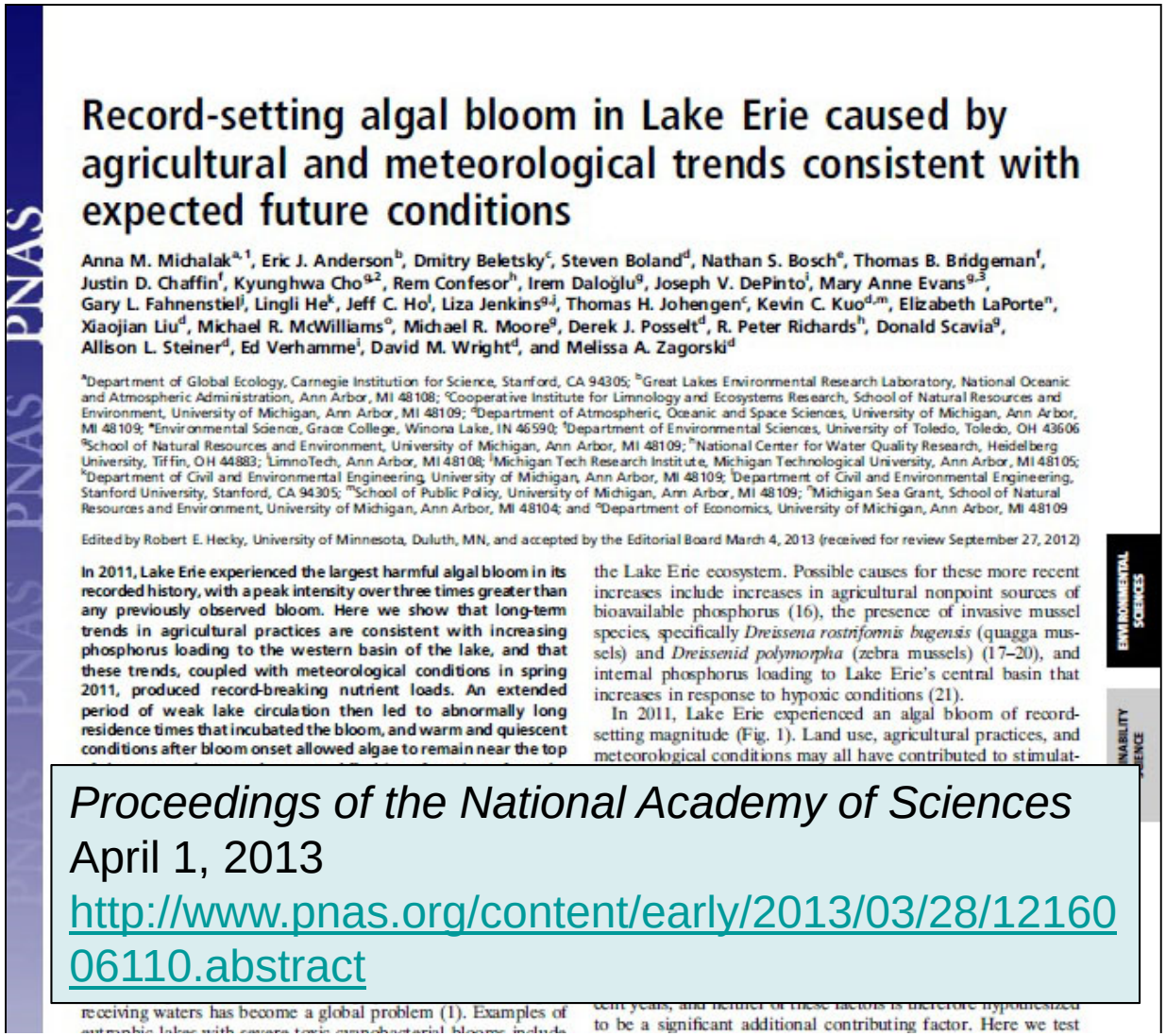

K. Schreiber, WDNR



http://dnr.wi.gov/lakes/bluegreenalgae

http://www.dhs.wisconsin.gov/eh/bluegreenalgae/

What can we expect in the future?



Record-setting algal bloom in Lake Erie caused by agricultural and meteorological trends consistent with expected future conditions

Anna M. Michalak[a,1], Eric J. Anderson[b], Dmitry Beletsky[c], Steven Boland[d], Nathan S. Bosch[e], Thomas B. Bridgeman[f], Justin D. Chaffin[f], Kyunghwa Cho[g,2], Rem Confesor[h], Irem Daloğlu[g], Joseph V. DePinto[i], Mary Anne Evans[g,3], Gary L. Fahnenstiel[j], Lingli He[k], Jeff C. Ho[l], Liza Jenkins[g,j], Thomas H. Johengen[c], Kevin C. Kuo[d,m], Elizabeth LaPorte[n], Xiaojian Liu[d], Michael R. McWilliams[o], Michael R. Moore[g], Derek J. Posselt[d], R. Peter Richards[h], Donald Scavia[g], Allison L. Steiner[d], Ed Verhamme[i], David M. Wright[d], and Melissa A. Zagorski[d]

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Edited by Robert E. Hecky, University of Minnesota, Duluth, MN, and accepted by the Editorial Board March 4, 2013 (received for review September 27, 2012)

In 2011, Lake Erie experienced the largest harmful algal bloom in its recorded history, with a peak intensity over three times greater than any previously observed bloom. Here we show that long-term trends in agricultural practices are consistent with increasing phosphorus loading to the western basin of the lake, and that these trends, coupled with meteorological conditions in spring 2011, produced record-breaking nutrient loads. An extended period of weak lake circulation then led to abnormally long residence times that incubated the bloom, and warm and quiescent conditions after bloom onset allowed algae to remain near the top

the Lake Erie ecosystem. Possible causes for these more recent increases include increases in agricultural nonpoint sources of bioavailable phosphorus (16), the presence of invasive mussel species, specifically *Dreissena rostriformis bugensis* (quagga mussels) and *Dreissenid polymorpha* (zebra mussels) (17–20), and internal phosphorus loading to Lake Erie's central basin that increases in response to hypoxic conditions (21).

In 2011, Lake Erie experienced an algal bloom of record-setting magnitude (Fig. 1). Land use, agricultural practices, and meteorological conditions may all have contributed to stimulat-

receiving waters has become a global problem (1). Examples of

to be a significant additional contributing factor. Here we test

Proceedings of the National Academy of Sciences
April 1, 2013
http://www.pnas.org/content/early/2013/03/28/1216006110.abstract

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Late Edition

VOL. CLXII . . No. 56,076 NEW YORK, FRIDAY, MARCH 15, 2013 $2.50

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REBUKE FOR THE C.E.O.

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By DANIELA HAGEN

Pope Francis led Mass at the Sistine Chapel on Thursday.

Spring Rain, Then Foul Algae in Ailing Lake Erie

By MICHAEL WINES

Algae bloomed, like this one in 2011, are threatening Lake Erie.

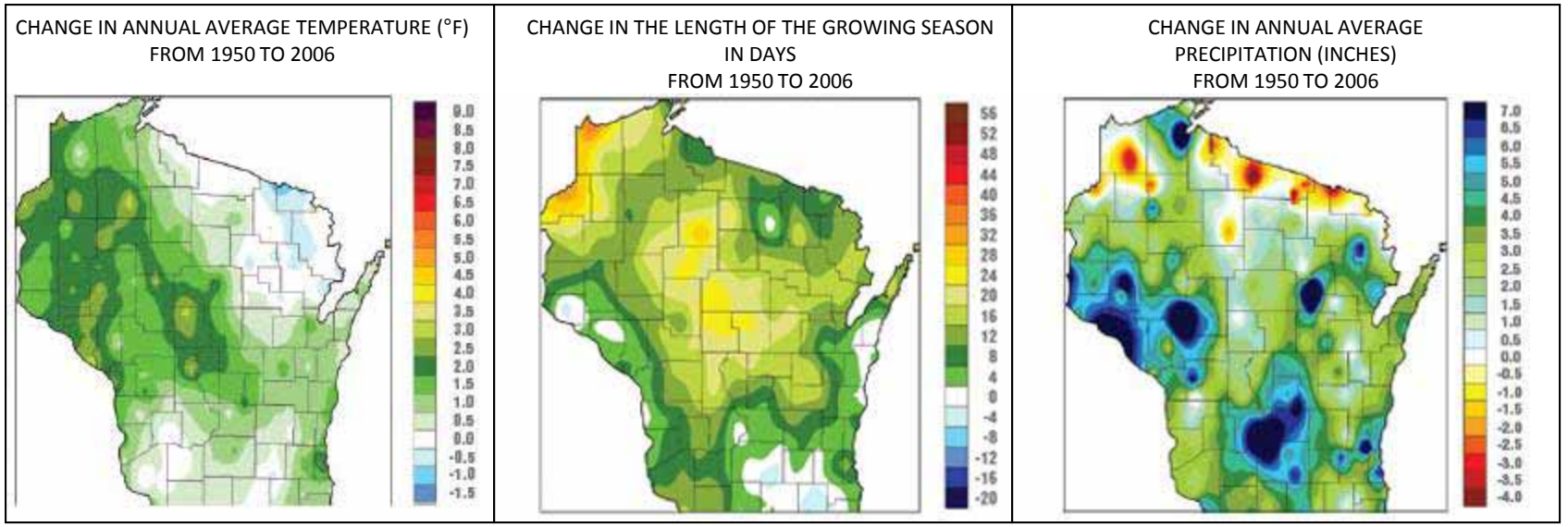
G.O.P. Divided On Proper Role For U.S. Abroad

By MICHAEL D. SHEAR

Cartier

New York Times
March 18, 2013

Seasonal & Regional Trends



- Heavy rains & snowmelt: extra nutrients
- Earlier warming & extended warming may lead to blooms
- Invasive species?

Figures from Wisconsin Initiative on Climate Change Impacts 2011: *Wisconsin's Changing Climate: Impacts and Adaptations*

Dolichospermum lemmermannii bloom Lake Superior July 2012