An update on Harmful Algal Blooms in Lake Erie

Thomas Bridgeman
University of Toledo
November 8, 2013

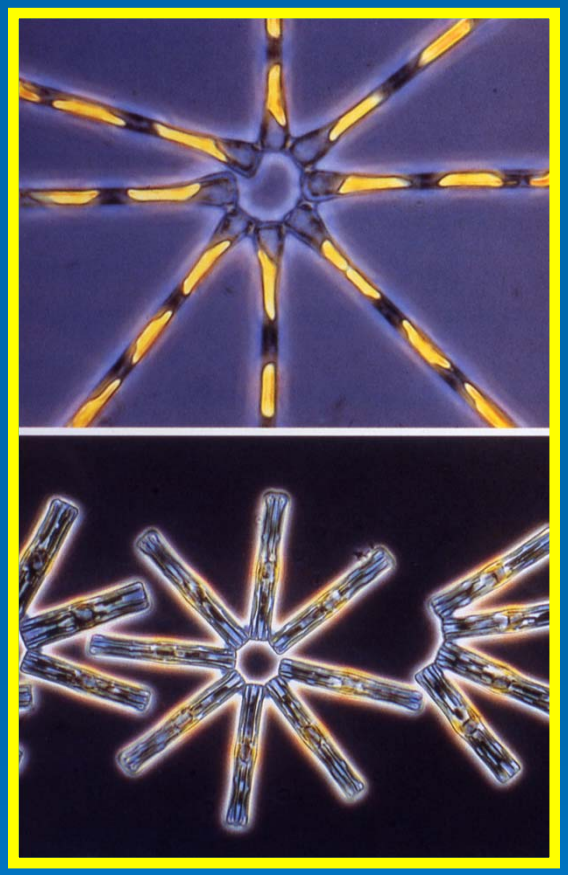
Outline

- Introduction, History and Lake Erie HABs 2002-2013
- HAB forecast and early warning tools
- Ohio Phosphorus Task Force 1 and 2

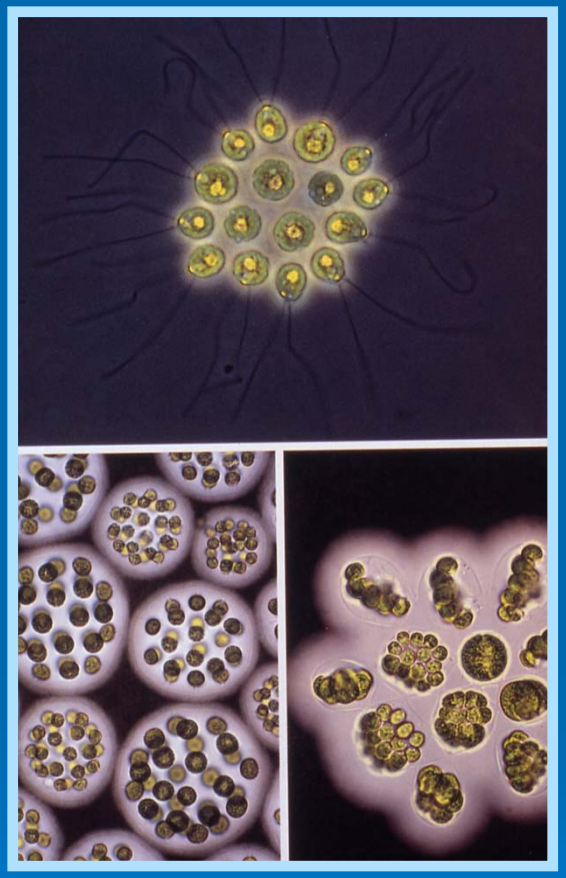
1
Introduction, History and Lake Erie HABs 2002-2013

What is a Harmful Algal Bloom?

Major Algae groups in Lake Erie



Diatoms



Greens

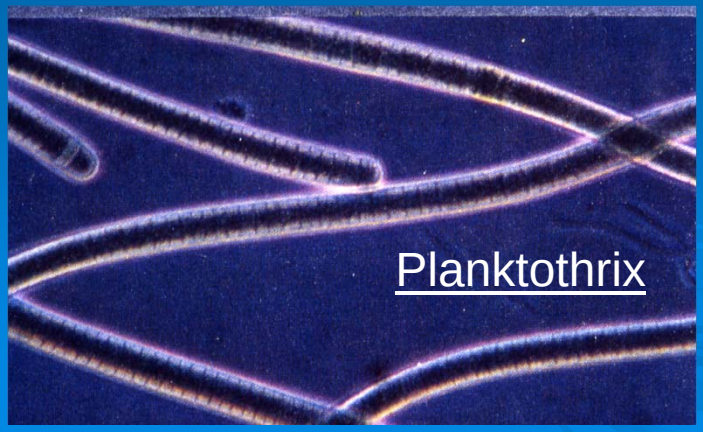
Blue-greens
(Cyanobacteria)

Common Harmful “Algae” (Cyanobacteria)

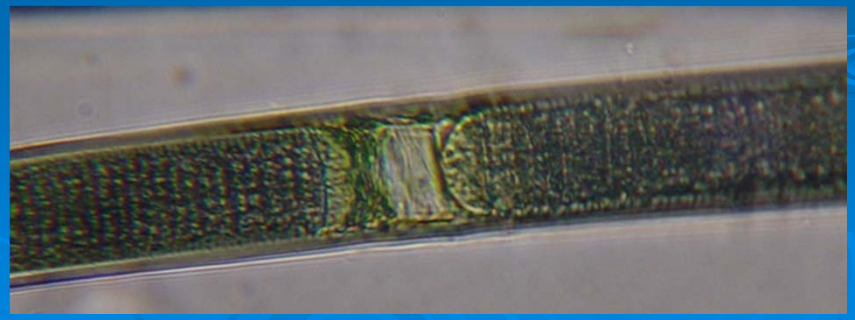
Anabaena

Aphanizomenon

Microcystis



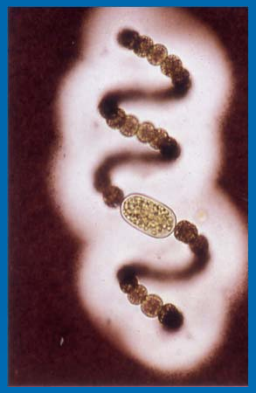
Planktothrix



Lyngbya

Why are harmful algae harmful?

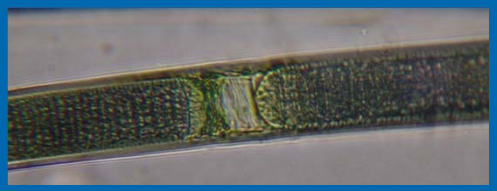
Microcystis toxins
Microcystin



Anabaena toxins
Microcystin
Cylindrospermopsin
Anatoxin
Saxitoxin

Aphanizomenon toxins
Cylindrospermopsin
Anatoxin
Saxitoxin

Planktothrix toxins
Anatoxin
Lyngbyatoxin
Aplysiatoxin



Lyngbya toxins
Saxitoxin
Lyngbyatoxin
Aplysiatoxin

Harmful algal blooms are increasing worldwide

Lake Taihu, China

Lake Winnipeg

Baltic Sea

Lake Erie

The Greening of Lake Erie (Eutrophication)

- Between1920 and 1964 Lake Erie algae biomass increased nearly 6 fold.
- Diatoms were replaced by cyanobacteria.
- Harmful algal blooms led to passage of the GLWQA
- Mandate on Phosphorus control

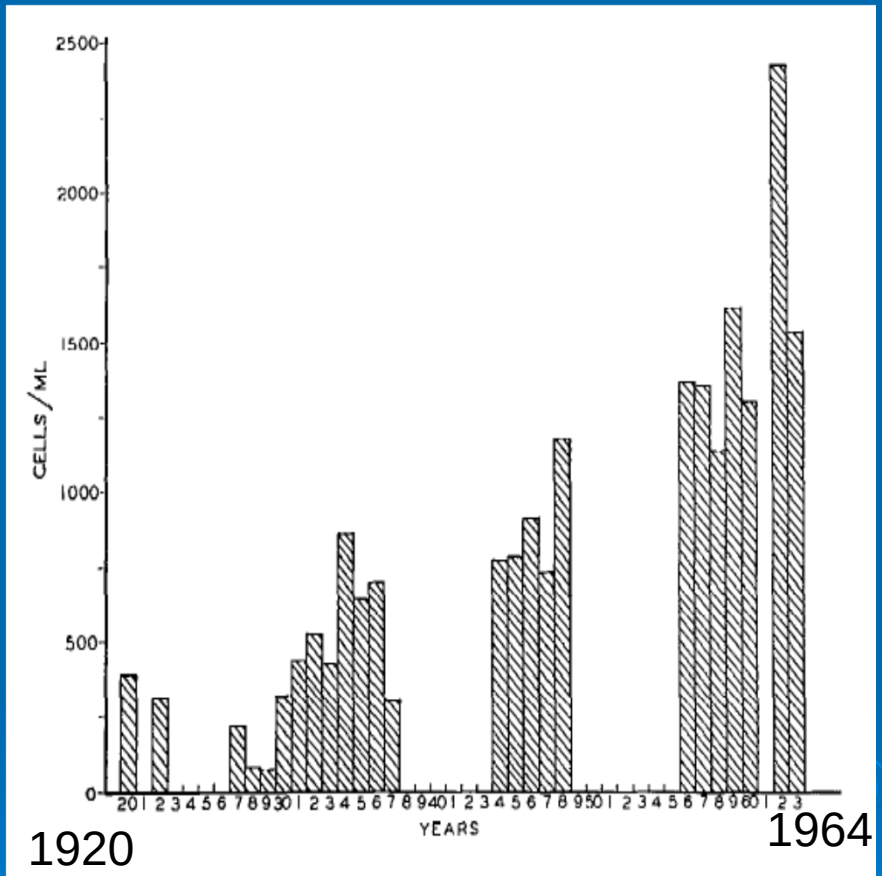
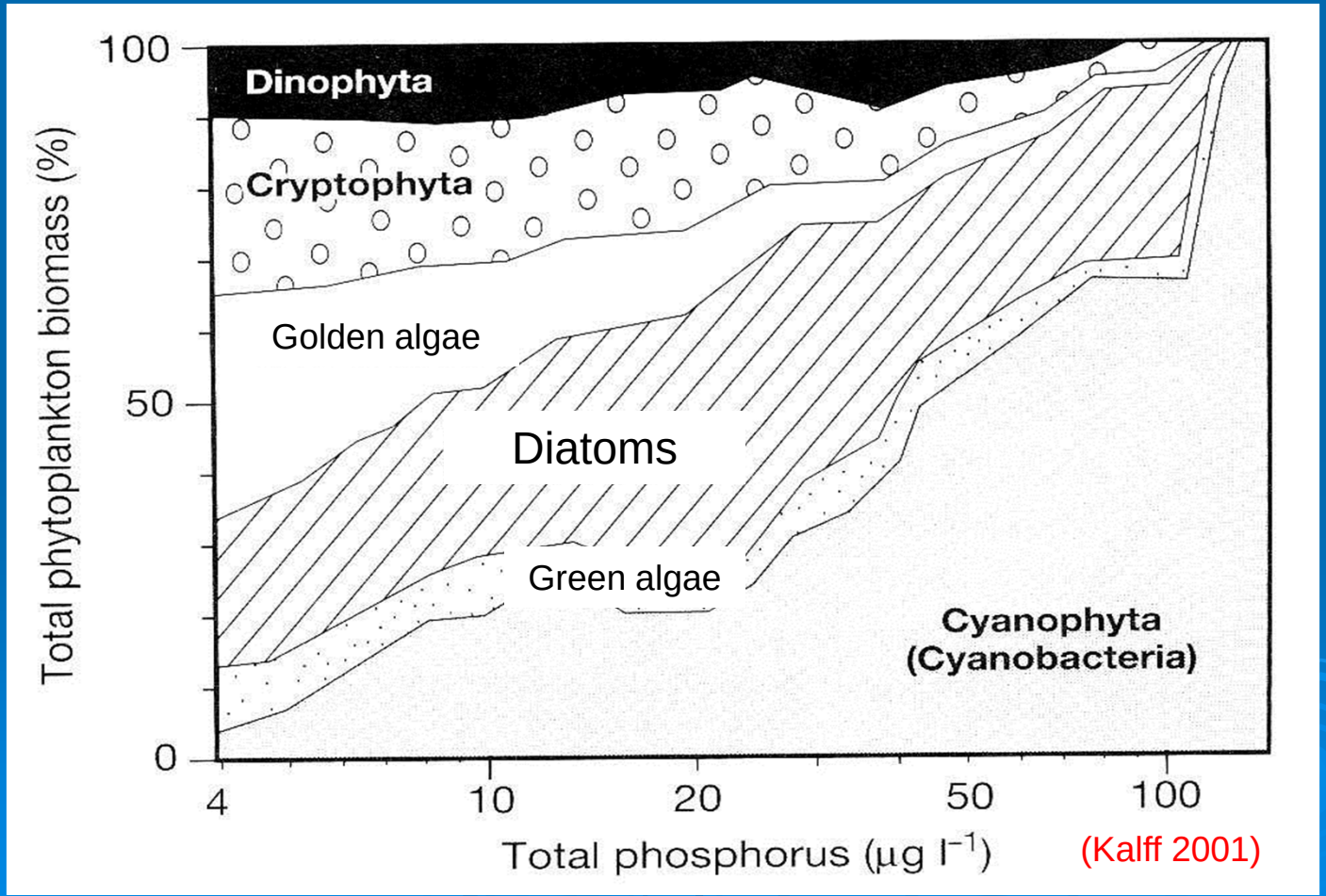


FIG. 1. Average phytoplankton cells per milliliter for all years with complete records, 1920 to 1963 (2 weeks of records are lacking for 1960 near the height of the autumnal phytoplankton maximum).

Davis 1964

Focus on Phosphorus

- High Phosphorus concentration leads to
  - -high algal biomass
  - -dominance by cyanobacteria



(Kalff 2001)

Total Phosphorus Loads: A success story

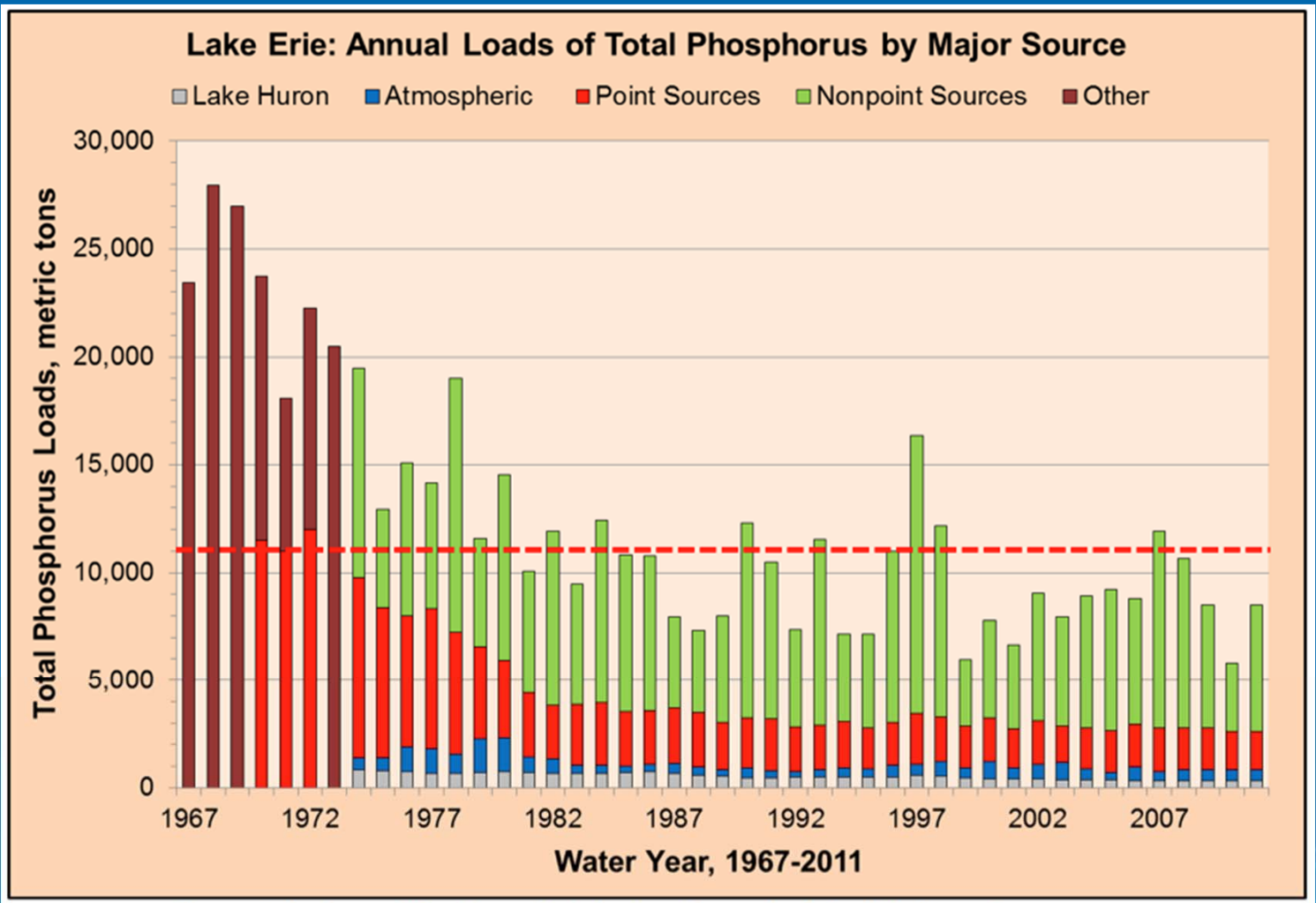
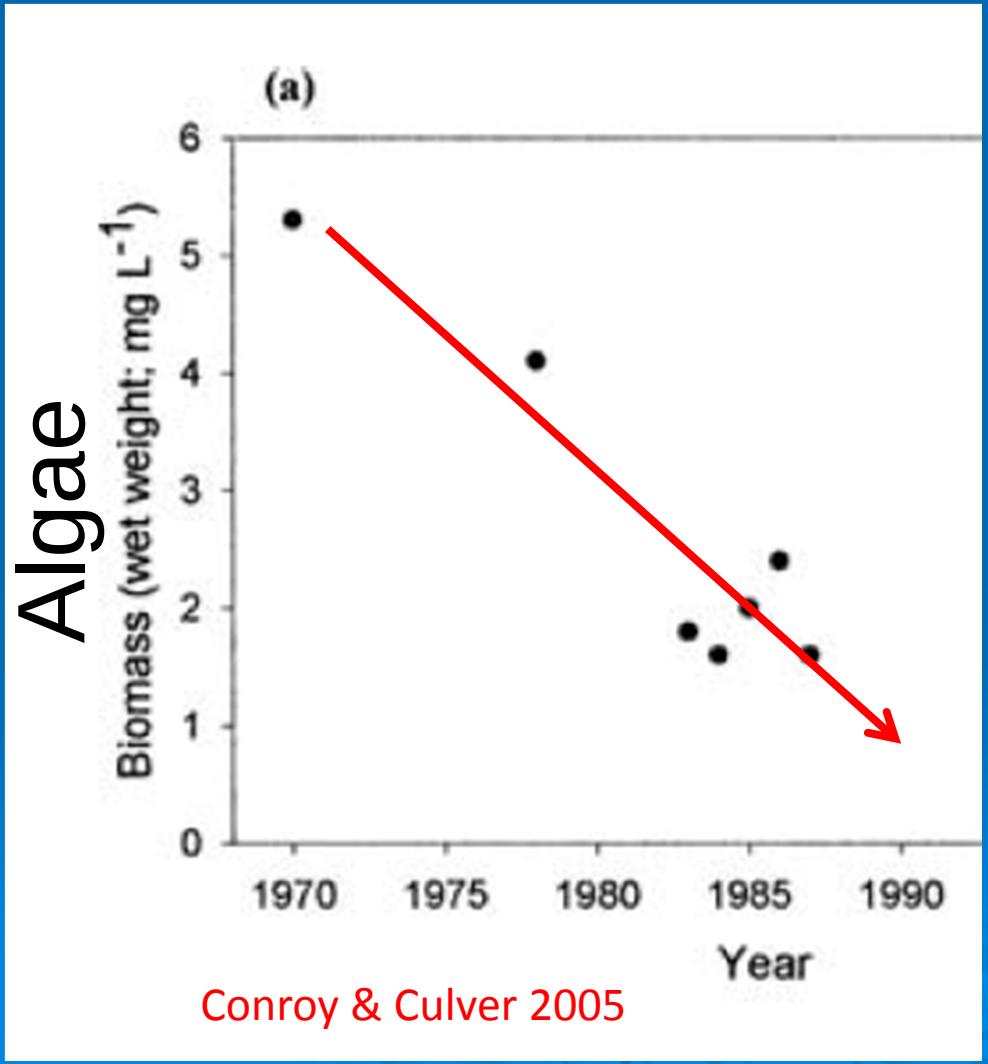


Figure 3-5. Annual loading of total phosphorus to Lake Erie by major sources.
(Data provided by Dr. David Dolan of the University of Wisconsin Green Bay (May 2013). Graph prepared by Heidelberg NCWQR staff.)

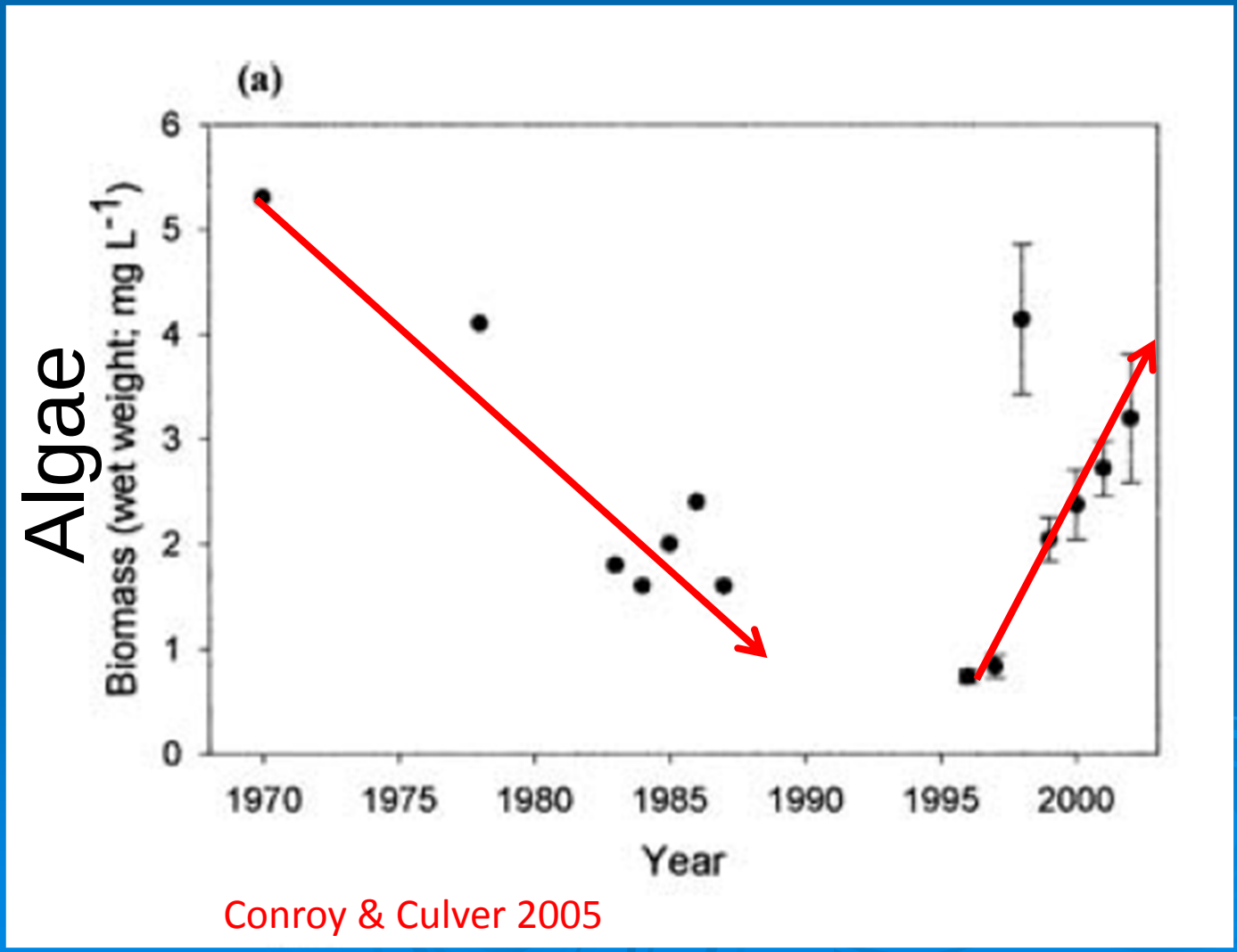
Ohio Lake Erie Phosphorus Task Force II Final Report

1970s-1990s: Phosphorus controls led to Recovery



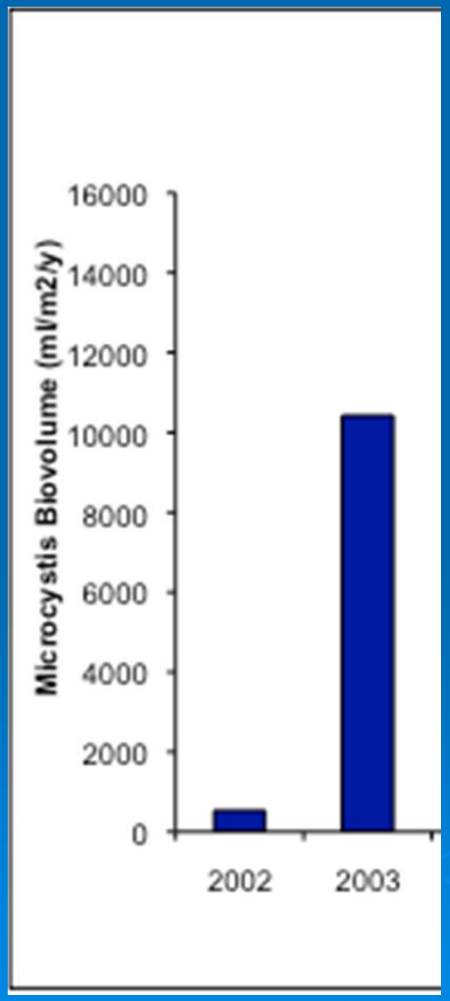
Conroy & Culver 2005

Mid-1990s: Return to eutrophic conditions and harmful algal blooms



Conroy & Culver 2005

2003: Return of HABs in Lake Erie



What Happened? Dissolved phosphorus loads have been increasing

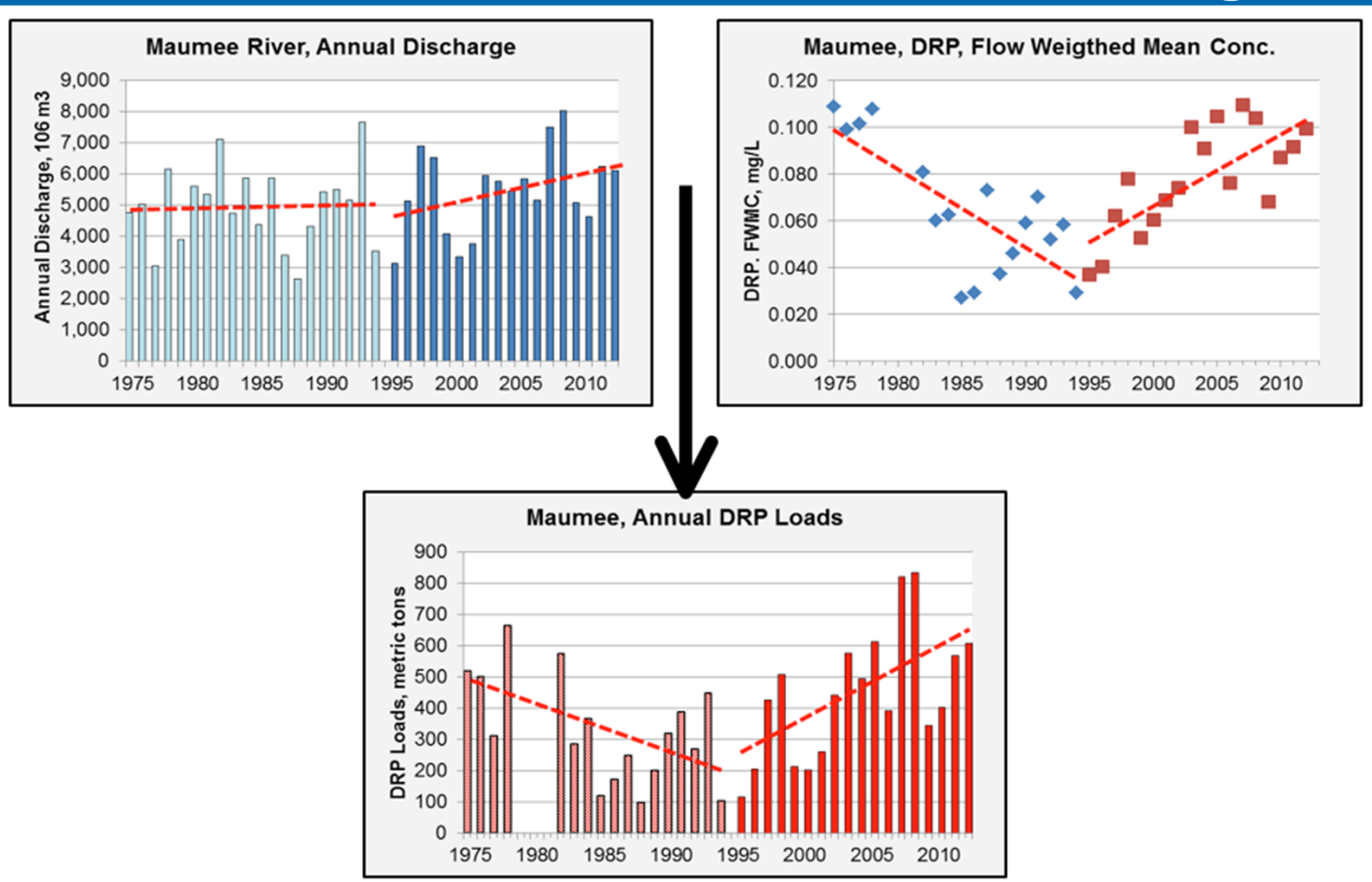
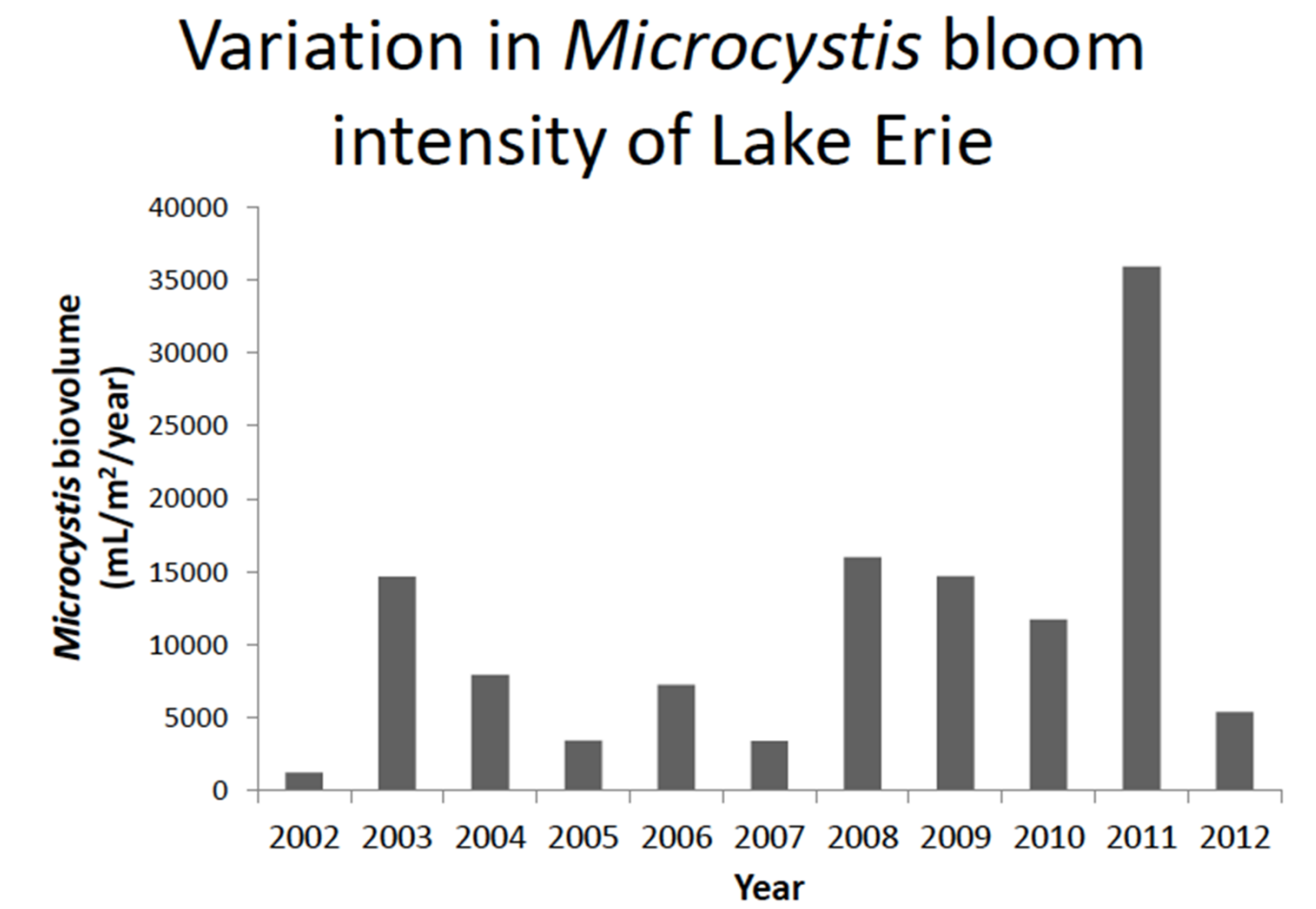


Figure 3-8. Annual discharges and flow-weighted mean concentrations and loads of DRP
(Discharge data from USGS Streamgage Maumee River at Waterville (04193500) and graphed by Heidelberg University, NCWQR)

Ohio Lake Erie Phosphorus Task Force II Final Report

Microcystis in Lake Erie

All years following 2002 have had moderate to intense *Microcystis* blooms. The bloom of 2011 was the largest bloom ever recorded.



Bridgeman et al., 2013. Journal of Great Lakes Research

2011 bloom from the Space Station

Michalak et al. 2013

PNAS PNAS

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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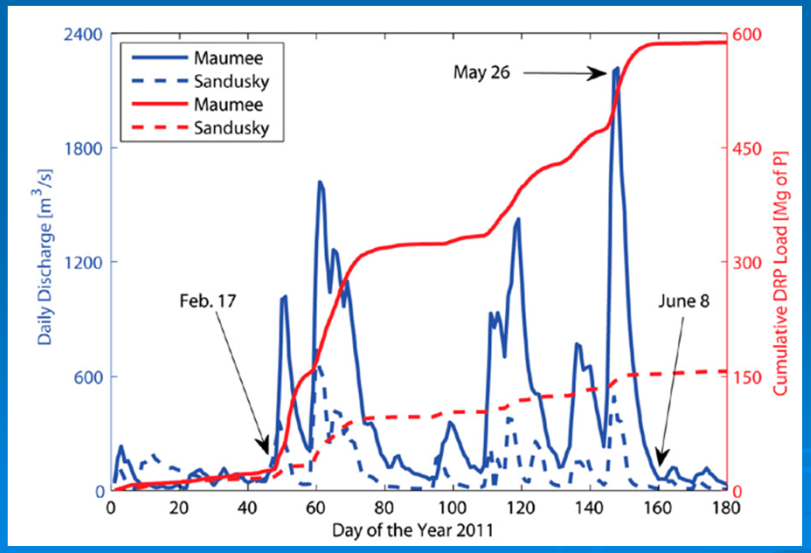
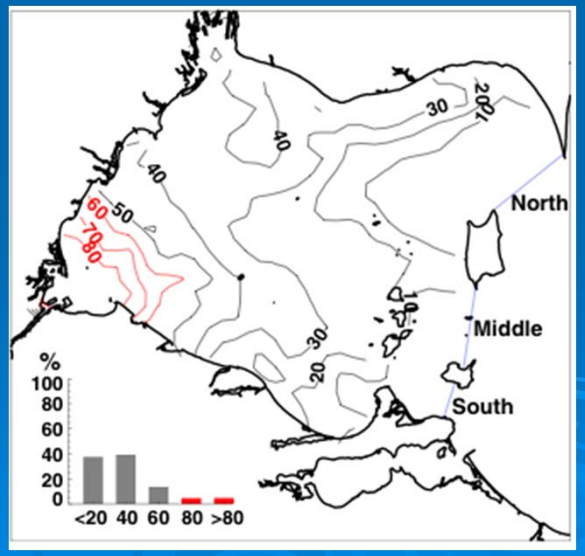
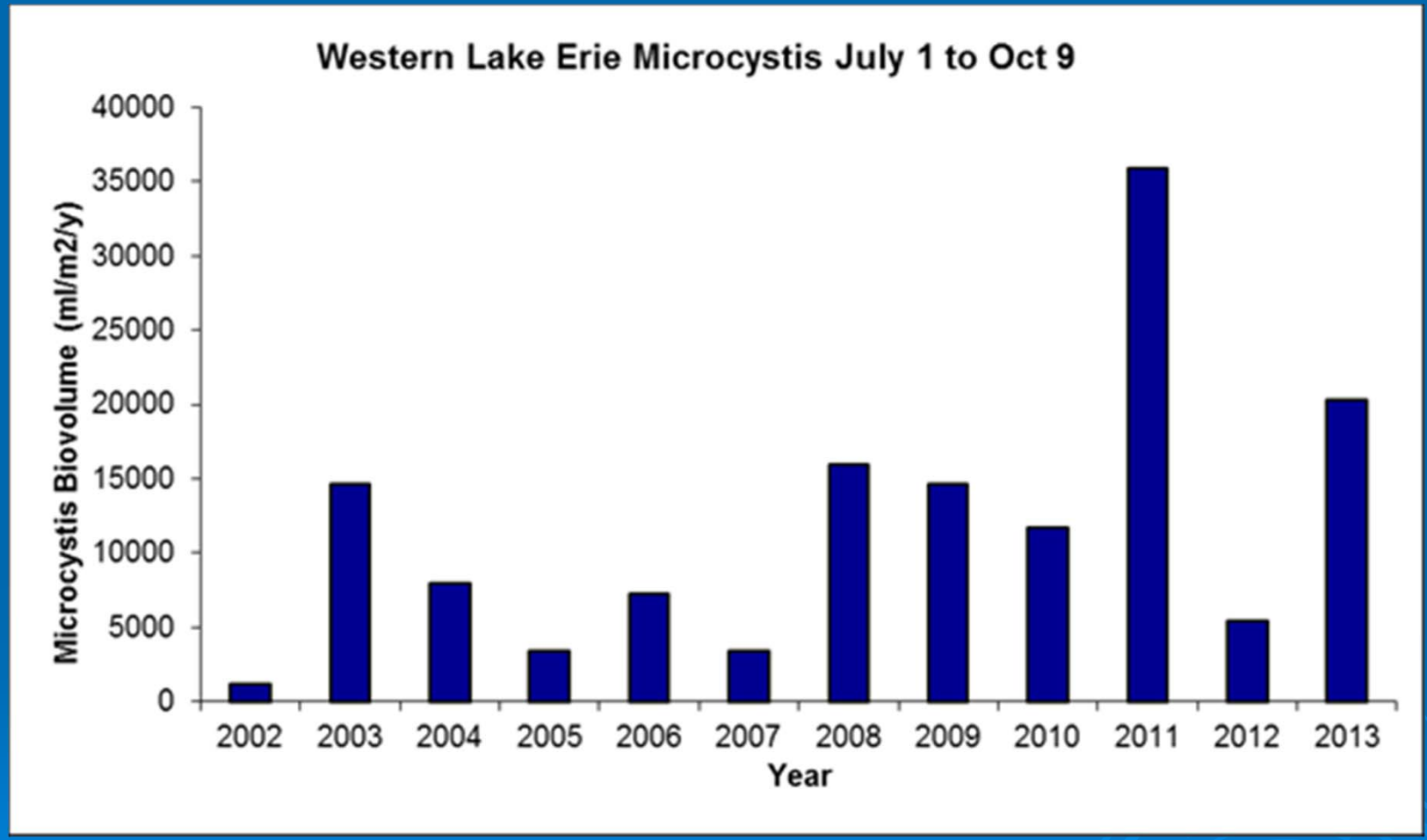


High spring P loads



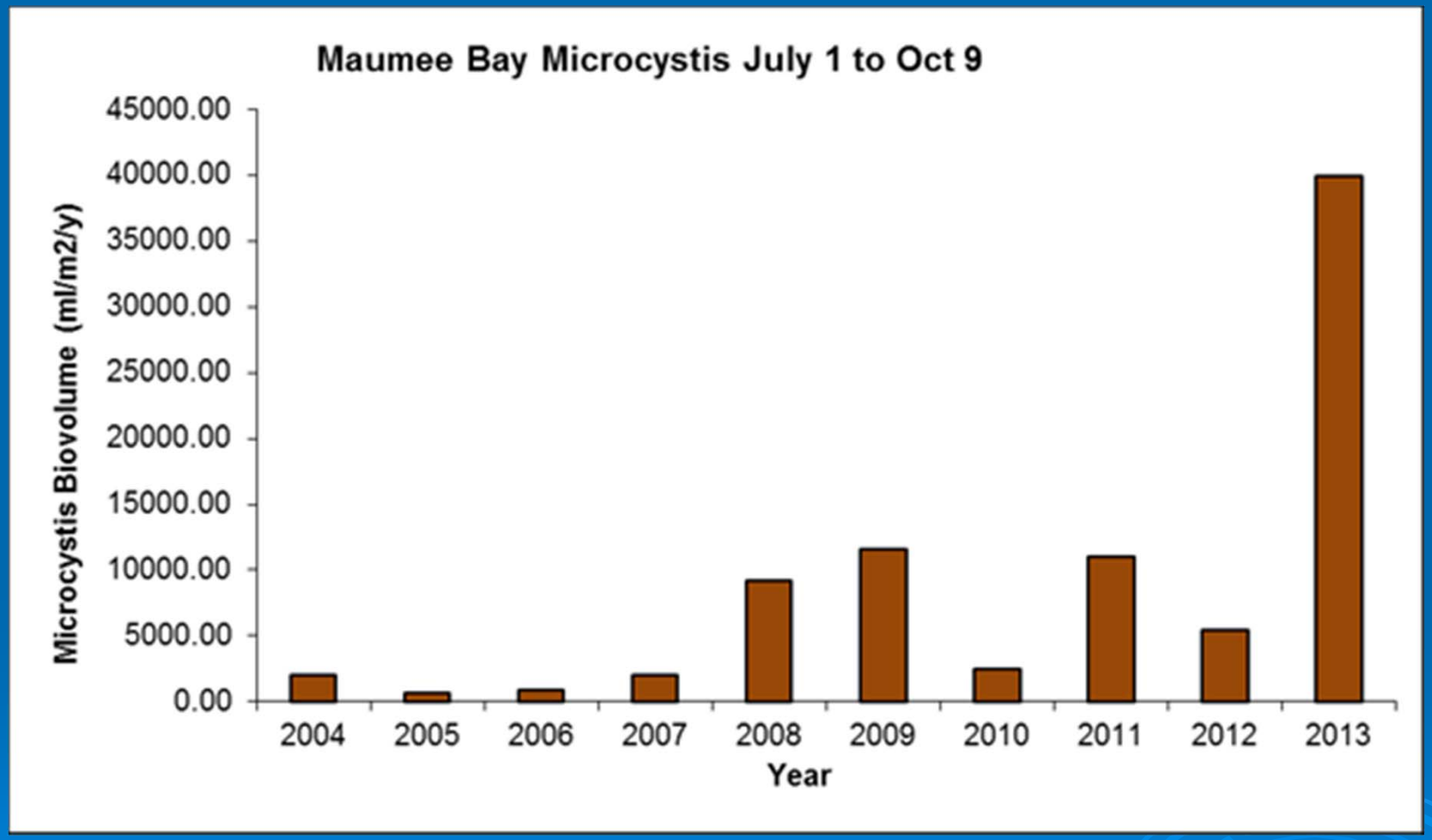
Long water residence time

2013 *Microcystis* open water bloom



2013 open water bloom was second only to 2011 over last 12 years

2013 *Microcystis* Maumee Bay



More *Microcystis* in Maumee Bay and south shore areas in 2013

October 2, 2013

Effects of 2013 Bloom

Toxins overwhelm Carroll Township water plant

Ottawa Co. treatment facility offline while remedy made

BY TOM HENRY
BLADE STAFF WRITER

Share 106 Tweet 0 +1 0 Reddit 0 Email 0

OAK HARBOR, Ohio — The chief toxin produced by western Lake Erie's 2013 algae bloom spiked
such extreme levels along the Ottawa County shoreline this week that it knocked the water-treatment pl
serving 2,000 Carroll Township residents offline.

Poisonous microcystin, the toxin in Lake Erie's most prevalent harmful blue-green algae, microcystis, w
found at levels of 3.56 parts per billion in samples drawn from the Carroll Township facility, Heidi
Griesmer, Ohio Environmental Protection Agency spokesman, said Friday.

Toxin to cost Toledo another $1M

Council hikes budget, OKs $6.4M for sewer work, water lines

BY IGNAZIO MESSINA
BLADE STAFF WRITER

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A sign alerts swimmers to the danger of algae this summer.
THE BLADE/JEFFREY SMITH

Toledo City Council unanimously agreed Tuesday to open the city's wallet and pay $1 million to neutralize a potentially lethal toxin from algae in western Lake Erie that found its way into the city's water supply.

Council also agreed to spend $6.4 million toward sewer work and water lines for the Lucas Metropolitan Housing Authority's Collingwood Green Senior Community.

The Bell administration told council last week the city had no choice regarding the extra money to keep tap water safe to drink.

Toxic algae spur warning at Lake Erie beach near Toledo

By Spencer Hunt
The Columbus Dispatch · Wednesday August 14, 2013 5:42 AM

Comments: 2 Recommend 77 Tweet 24

Satellites and sensors give SURFACE cyanobacteria concentration

However, HABs mixed downward may cause more problems for utilities

Mixed plankton

After 1 Hour

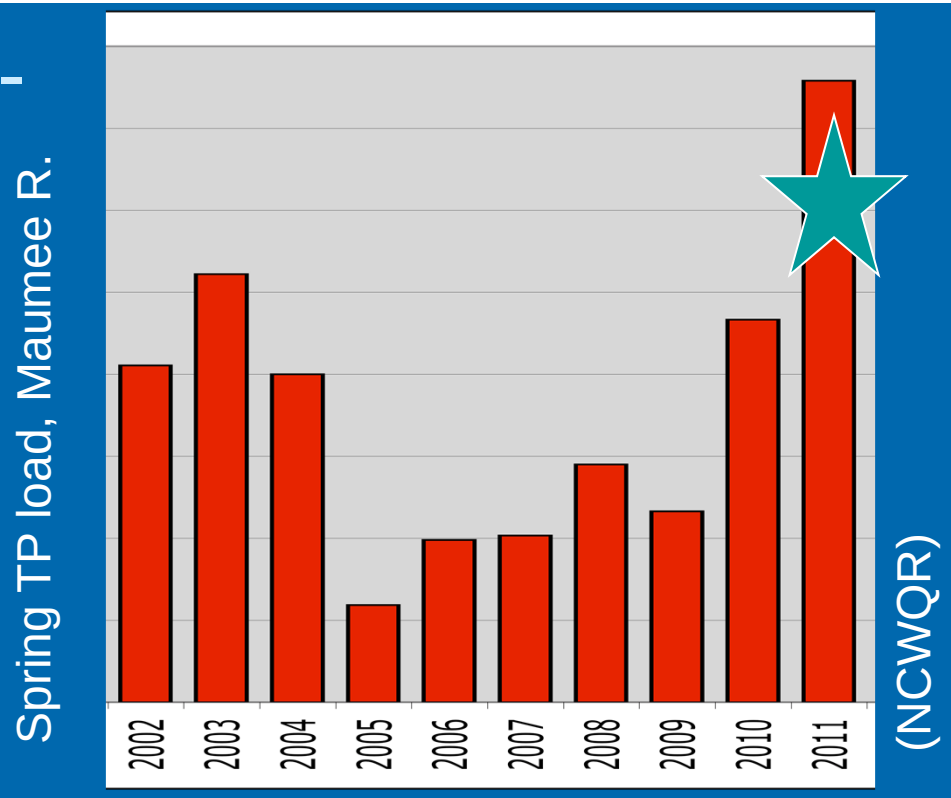
After 1 Day

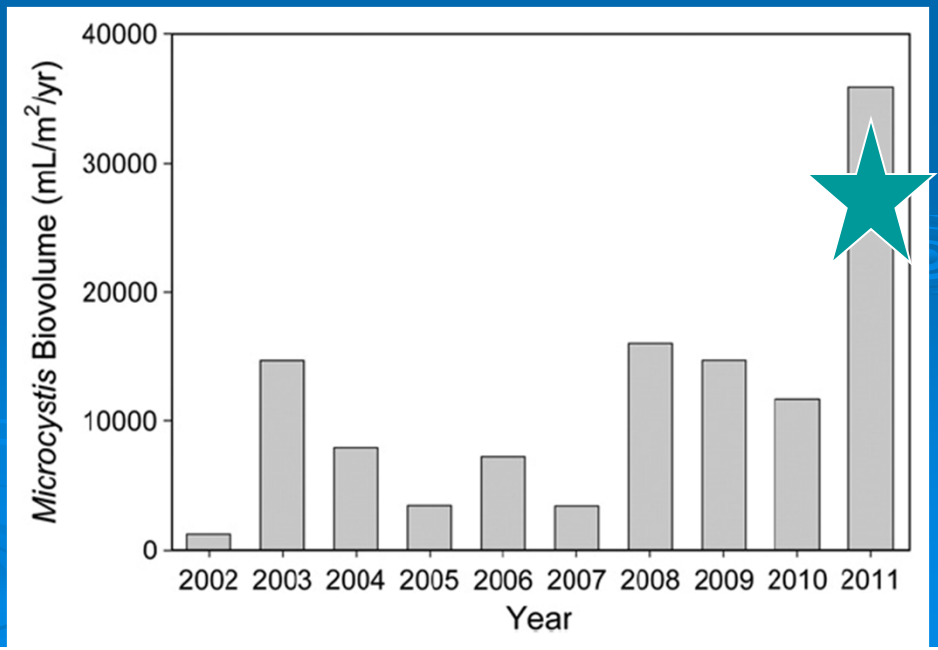
2
HAB Forecast and Early-Warning Tools

HAB Forecast and Early-Warning Tools

Springtime (March-June) TP load is the best predictor of summer blooms

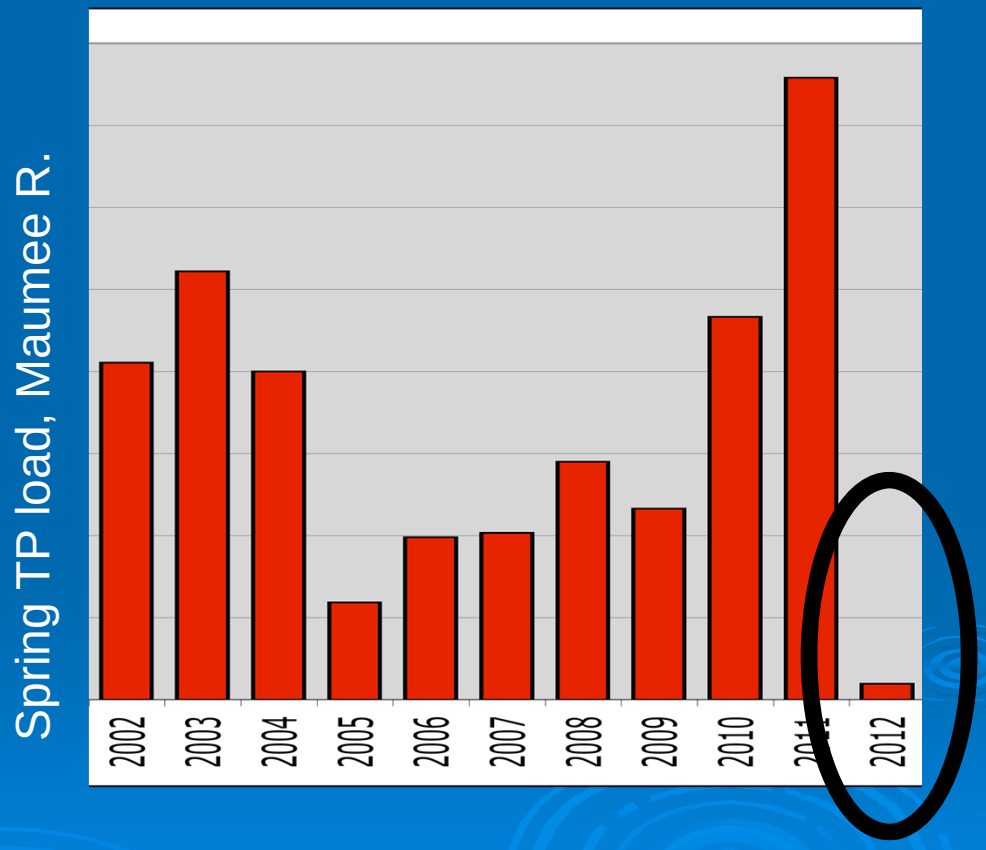
TP loading during March-June 2011 was the highest on record, resulting in greatest bloom on record





2012

TP loading during March-June 2012 was one of the lowest on record.



(NCWQR)

HAB Forecast and Early-Warning Tools

NOAA annual forecast (July 5, 2012)

NOAA NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION
UNITED STATES DEPARTMENT OF COMMERCE

NOAA, partners predict mild harmful algal blooms for western Lake Erie this year

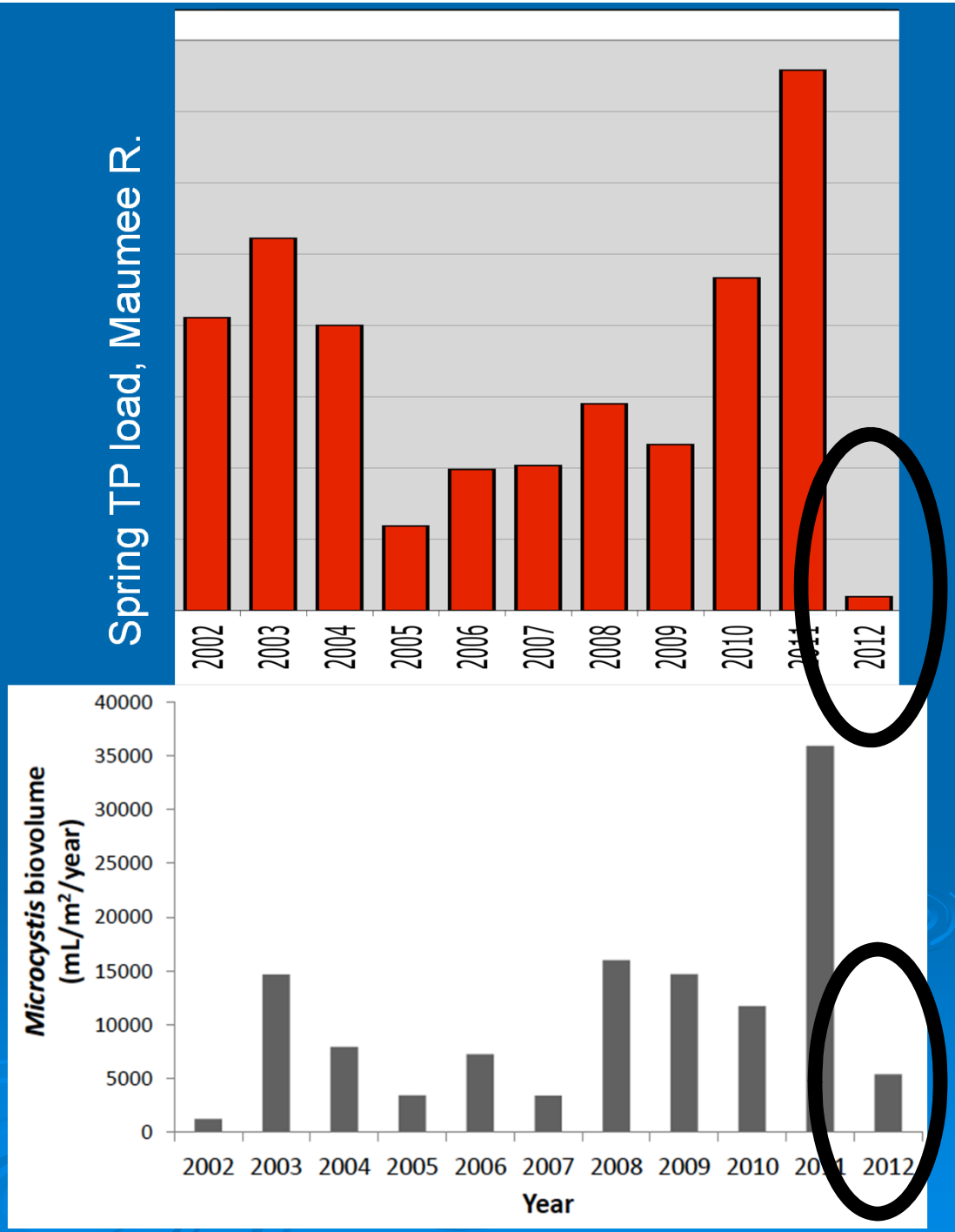
July 5, 2012

In its first-ever seasonal harmful algal bloom forecast for Lake Erie, NOAA researchers are predicting that western Lake Erie will have a mild bloom this summer, equivalent to conditions last seen in 2007.

Lake Erie has been plagued by a steady increase of harmful algal blooms (HABs) over the past decade. HABs can cause the death of fish, foul coastlines, and harm both aquatic and human life. NOAA has issued weekly bulletins for HABs in Lake Erie since 2008, and will continue to do so.

2012

NOAA HAB forecast for 2012 was on target.



HAB Forecast and Early-Warning Tools

2013 Forecast

Toxic algae could hit third of W. Lake Erie

NOAA says bloom to be heavy, but smaller than 2011's dense growth

BY TOM HENRY
BLADE STAFF WRITER

GIBRALTAR ISLAND, Ohio — Western Lake Erie is headed for another heavy bloom of toxic blue-green algae this summer that will damage the Great Lakes region's recreation and tourism industries, threaten public health, and cost Toledo, Monroe, Port Clinton, and other area shoreline municipalities more to treat lake water for home and business use.

The western third of the lake can expect a "significant bloom" starting in early August. It likely will peak by mid-September, according to a new type of forecasting being developed by the National Oceanic and Atmospheric Administration.

But the mass likely will amount to only about 20 percent of what it was in 2011, when dense mats of algae covered more of Lake Erie than it had in decades.

Dr. Rick Stumpf, of NOAA, demonstrates how to measure water samples with a fluorometer while on a boat in Lake Erie at Stone Laboratory on Put-in-Bay.
THE BLADE/LORI KING

HAB Early-Warning Tools

Experimental Lake Erie Harmful Algal Bloom Bulletin

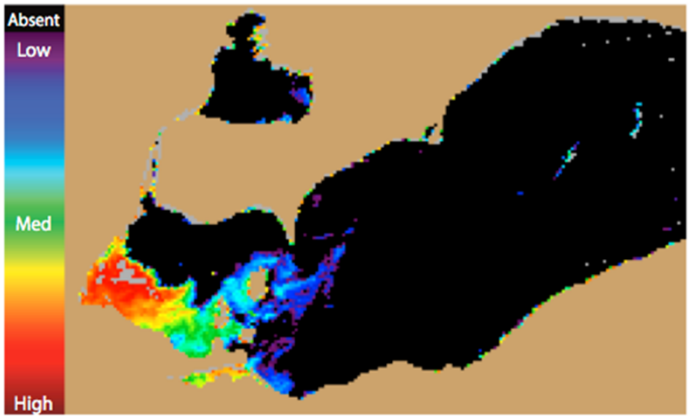


Figure 1. MODIS Cyanobacterial Index from 10 September 2013. Grey indicates clouds or missing data. Black represents no cyanobacteria detected. Colored pixels indicate the presence of cyanobacteria. Cooler colors (blue and purple) indicate low concentrations and warmer colors (red, orange, and yellow) indicate high concentrations. The estimated threshold for cyanobacteria detection is 35,000 cells/mL.

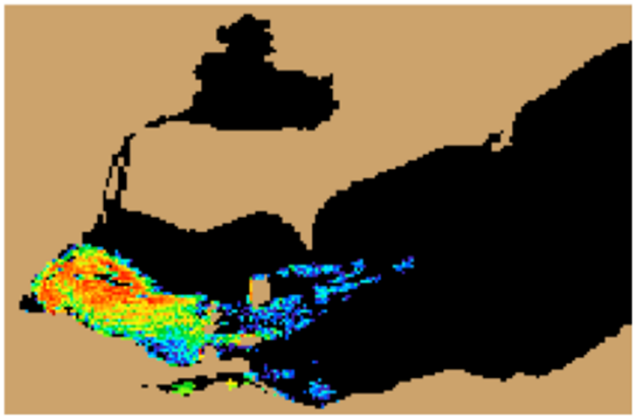


Figure 2. Nowcast position of bloom for 12 September 2013 using GLCFS modeled currents to move the bloom from the 10 September 2013 image.

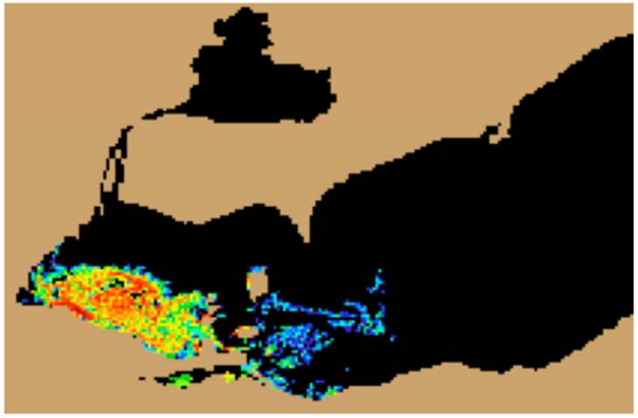
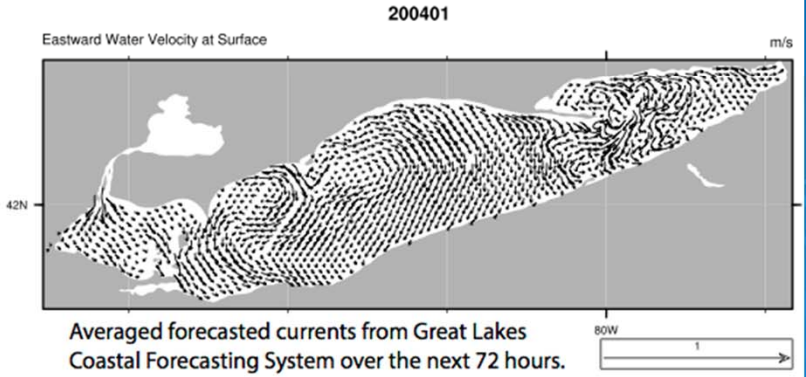


Figure 3. Forecast position of bloom for 15 September 2013 using GLCFS modeled currents to move the bloom from the 10 September 2013 image.



Averaged forecasted currents from Great Lakes Coastal Forecasting System over the next 72 hours.

http://www2.nccos.noaa.gov/coast/lakeerie/bulletin/bulletin_current.pdf

October 12, 2013

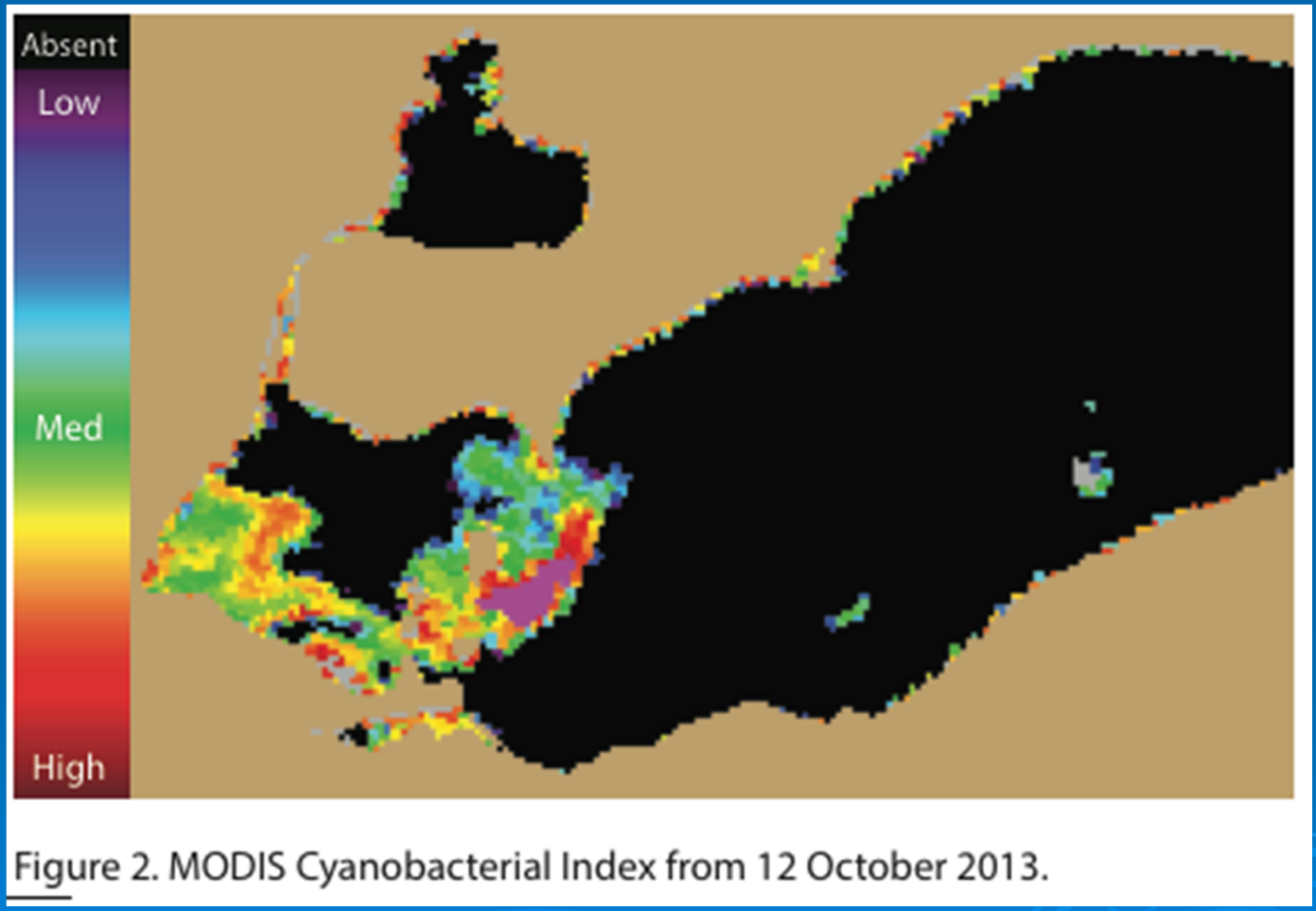


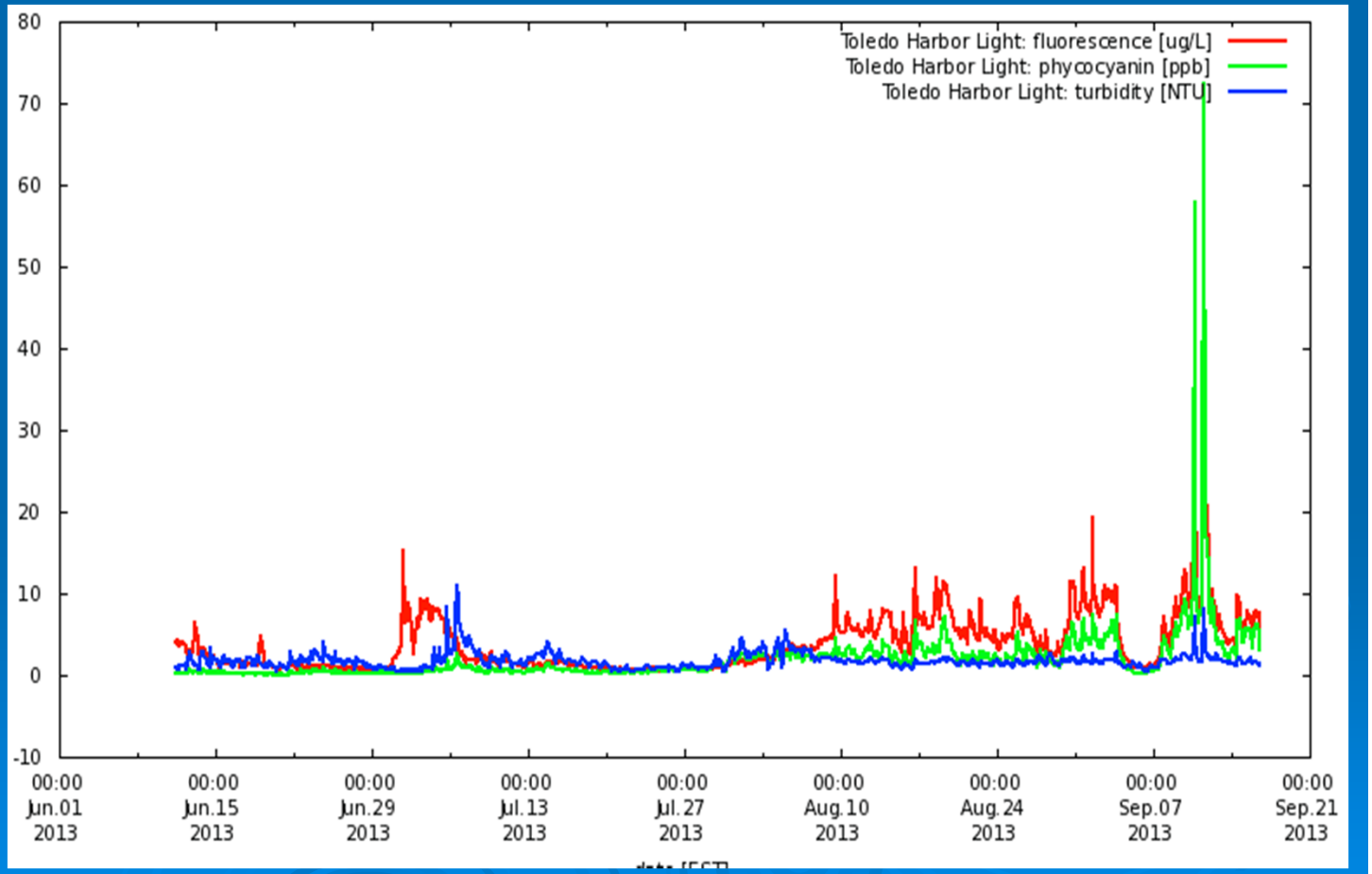
Figure 2. MODIS Cyanobacterial Index from 12 October 2013.

R. Stumpf, NOAA National Center for Coastal Ocean Science

HAB Early-Warning Tools

LOBO Land/Ocean Biogeochemical Observatory

Battery Voltage	13.5	V
CDOM	7.90	QSDE
Conductivity	0.02	mmho/cm
Fluorescence	5.97	µg/L
Oxygen	6.50	ml/l
Oxygen Saturation	6.28	ml/l
Oxygen % Saturation	103.48	%
Phosphate Concentration	-0.03	µM
Phycocyanin	3.16	ppb
Pressure	0.312	dBar
Salinity	0.11	PSU
Temperature	20.50	°C
Turbidity	1.29	NTU
Turbidity raw	152	count



http://algae.loboviz.com/

3

Ohio Phosphorus Task Force 1 and 2

(Courtesy Gail Hesse, Ohio L. Erie Commission)

April 2010

Ohio Environmental Protection Agency

Division of Surface Water

Ohio Lake Erie Phosphorus Task Force Final Report

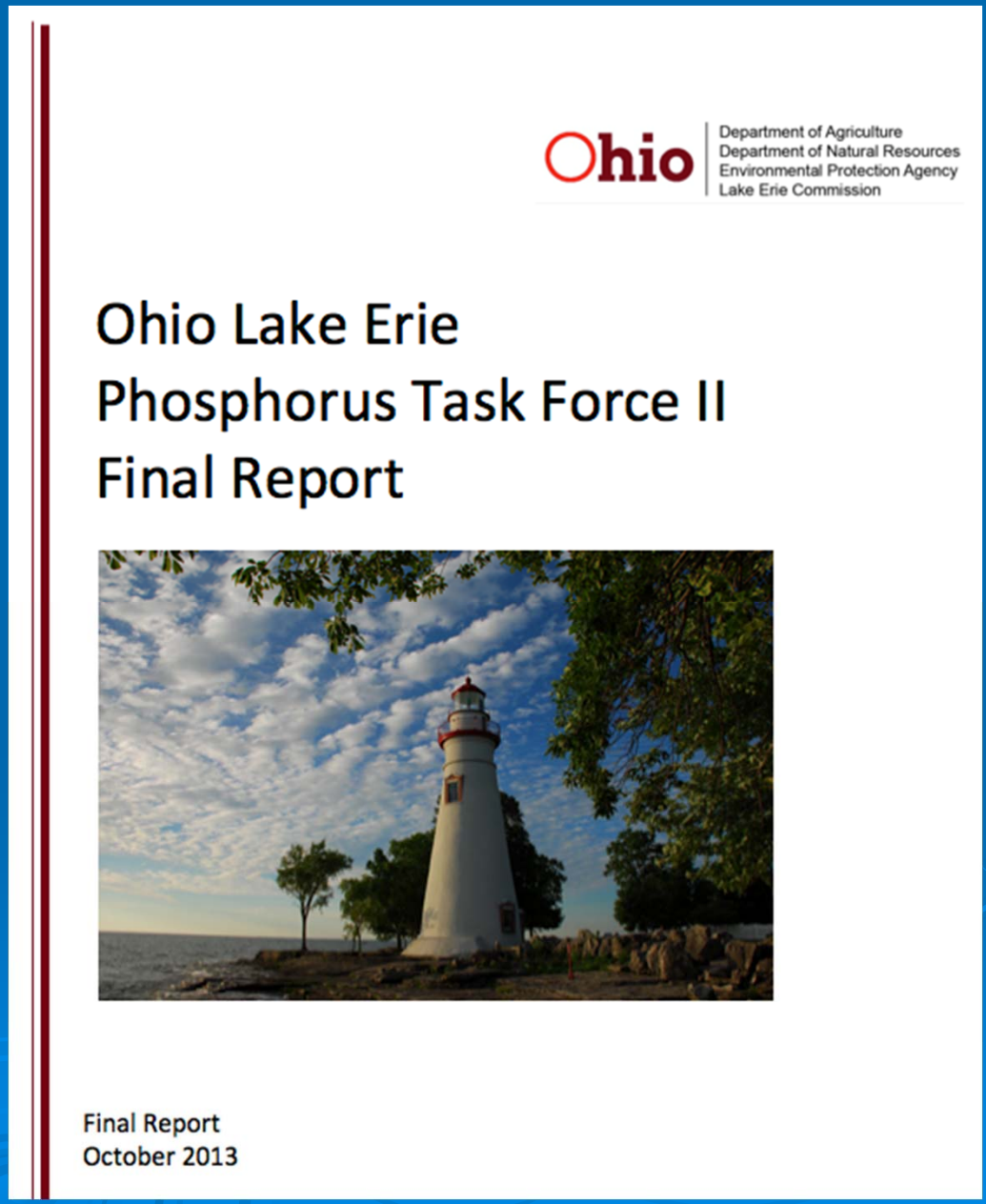
Executive Summary

Ted Strickland, Governor
Lee Fisher, Lt. Governor
Chris Korleski, Director

P Task Force Phase I (2010)

- Comprehensive analysis of possible sources
- Identified relative contribution of dissolved phosphorus
- Point sources have remained relatively constant, other sources contribute
- Agriculture is the prevailing source (>80% land use) in the Maumee River basin
- Management of land application of fertilizer is key *(how it is applied: timing and placement)*
- Exacerbated by changing weather patterns

Phase II report is due to be released very soon (110 pgs)



P Task Force Phase II: Content

- Updated water quality and algal bloom information (2011 and 2012 contrast)
- Reviewed status of Task Force I recommendations
- Targets for load reductions
- Progress & costs of point source reductions
- Nutrient management and mitigating practices

Phosphorus Loading Target

- Spring loads defined as 1 March – 30 June
- Proposing targets based on *reduction in multi-year average loads* rather than acceptable peak loads. The 2007-12 time period was selected to better address predicted increases in the frequency of severe storms
- Recommended actions for reduction apply to watersheds between Monroe, MI and Sandusky, OH

Phosphorus Loading Target

Dissolved Reactive P

- Average for 2007-2012:
  Spring: 256 tons
- Recommended target:
  Spring: 150 tons
- 41% reduction from the average
- No annual loading target recommended

Total P

- Average for 2007-2012:
  Spring: 1275 tons
  Annual: 2630 tons
- Recommended target:
  Spring: 800 tons
  Annual: 1600 tons
- 37% - 39% reduction from the average

No phosphorus concentration recommendations at this time

Summary

- HABs in Lake Erie are linked to spring TP loading and seem to be getting even larger in recent years.
- There are a variety of forecasting and early warning tools available.
- In order to prevent large HABs, the Phosphorus Task Force is recommending a 40% reduction in Phosphorus loading during the critical spring months.

Thank you

Maumee Valley RC&D
Resource Conservation & Development

THE UNIVERSITY OF TOLEDO 1872

NSF

Sea Grant

United States Environmental Protection Agency

Ohio Lake Erie Commission