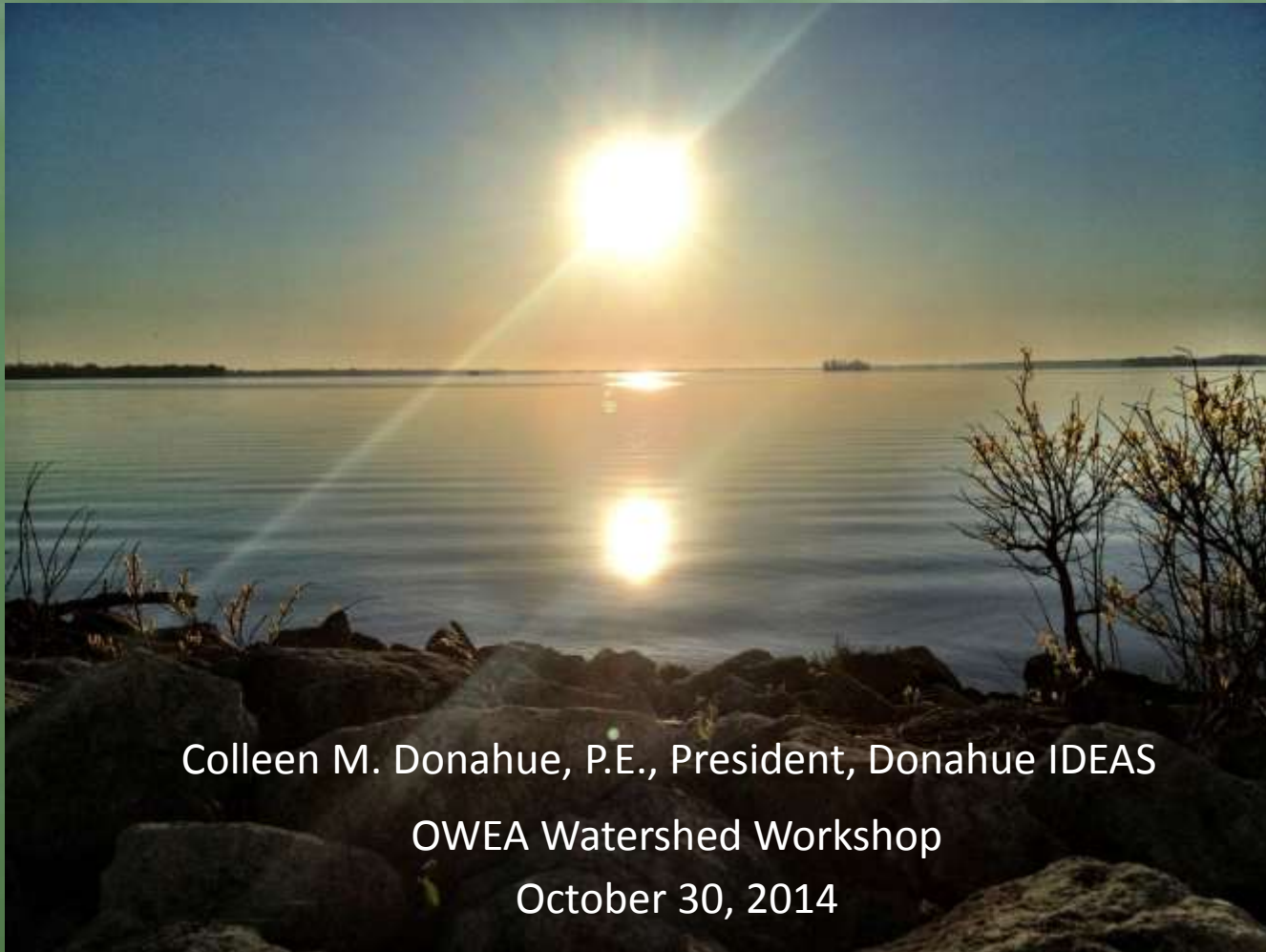


# Grand Lake St. Marys



Colleen M. Donahue, P.E., President, Donahue IDEAS

OWEA Watershed Workshop

October 30, 2014

# Safety Moment (Arcadis-style)



When in Doubt, Stay Out.





# Presentation Outline



- ⚡ History
- ⚡ The Problem
- ⚡ Previous Studies and Work
- ⚡ 2012 GLSM Alum Application
- ⚡ Other Recent Work
- ⚡ Future Needs

# Grand Lake St. Marys Area



# Grand Lake St. Marys Area





# History of Grand Lake St. Marys



- ⚡ Man-made reservoir (early 1800's) - feeder reservoir for the Miami-Erie canal
- ⚡ Largest inland lake in Ohio (~13,500 ac)
- ⚡ Shallow lake (5-7 feet mean depth)
- ⚡ Watershed (~112 sq mi):
  - ⚡ Primarily agriculture
  - ⚡ Septic tanks, package plants

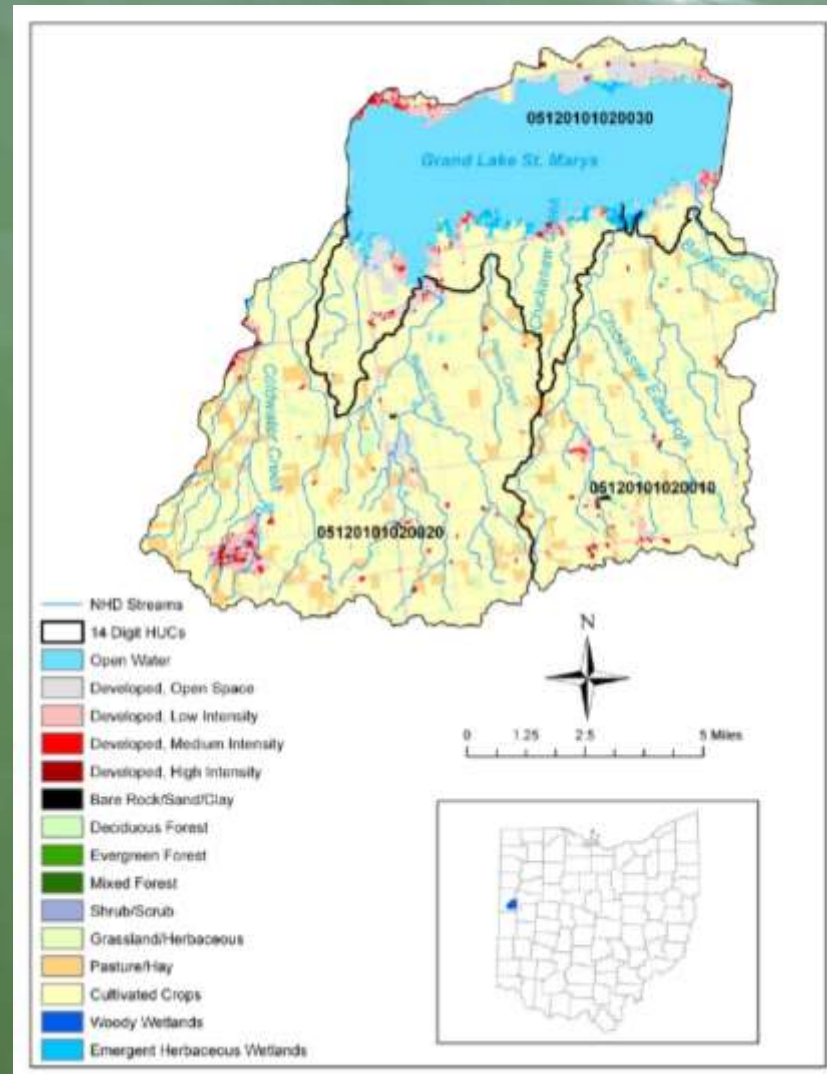


# History of Grand Lake St. Marys



- ⚡ Hyper-eutrophic
- ⚡ High phosphorus levels
- ⚡ Cyanobacteria blooms
  
- ⚡ Drinking water source for Celina WTP
- ⚡ Economic asset for Ohio (>\$150M)

# Grand Lake St. Marys Watershed



Watershed map courtesy of Tetra Tech



# The Problem



- ⌘ Harmful Algal Blooms (HABs) (since 1990s):
  - ⌘ abundant or excessive growth of algae
  - ⌘ planktonic bacteria (blue-green algae)
  - ⌘ primarily Planktothrix in GLSM
  - ⌘ depletes oxygen (fish kills)
  - ⌘ produce toxins:
    - ⌘ neurotoxins (nerve)
    - ⌘ hepatotoxins (liver)
    - ⌘ dermatotoxins (skin)\*

# The Problem

## What health risks do humans face as a result of exposure to cyanotoxins?

Adverse health outcomes from exposure to cyanotoxins may range from a mild skin rash to serious illness or death. Acute illnesses caused by exposure to cyanotoxins have been reported. The table below summarizes the health effects caused by the most common toxin producing cyanobacteria.

### The Primary Cyanotoxins and their Health Effects

Cyanotoxins	Health effects	Most common cyanobacteria producing toxin
Microcystin-LR	Abdominal pain Vomiting and diarrhea Liver inflammation and hemorrhage	<i>Microcystis</i> <i>Anabaena</i> <i>Planktothrix</i> <i>Anabaenopsis</i> <i>Aphanizomenon</i>
Cylindrospermopsin	Acute pneumonia Acute dermatitis Kidney damage Potential tumor growth promotion	<i>Cylindrospermopsis</i> <i>Aphanizomenon</i> <i>Anabaena</i> <i>Lyngbya</i> <i>Raphidiopsis</i> <i>Umezakia</i>
Anatoxin-a group	Tingling, burning, numbness, drowsiness, incoherent speech, salivation, respiratory paralysis leading to death	<i>Anabaena</i> <i>Planktothrix</i> <i>Aphanizomenon</i> <i>Cylindrospermopsis</i> <i>Oscillatoria</i>

Symptoms range from allergic-like reactions (e.g., rhinitis, asthma, eczema, and conjunctivitis) to flu-like reactions (skin rashes, gastroenteritis, and respiratory irritation). Allergic or irritative dermal reactions of varying severity have been reported from recreational exposures to several freshwater cyanobacterial genera such as *Anabaena*, *Aphanizomenon*, *Nodularia*, and *Oscillatoria*. *Endotoxins*, the blue-green pigment of the cyanotoxins (phycocyanin) and dermal toxins produced by *Lyngbya* and *Planktothrix* species have been linked to skin and eye irritation from exposure during swimming.

# The Problem

## Adsorption

### Disinfection By-Products— Meeting the Challenges of Compliance

Faced with a compliance violation, the city of Celina, Ohio, turned to a GAC system to treat challenging source water with high TOC, DBPs, and taste-and-odor problems. BY T. MIKE BUDMAN, TODD E. HONE, AND CHERYL L. GREEN

Construction Cost: ~\$6M

FOR YEARS, the city of Celina, Ohio, struggled with the challenges of treating source water with high total organic carbon (TOC) and resulting *Planktotoxins* (cyanobacteria), severe taste-and-odor problems, and disinfection by-product (DBP) formation. The city

and customers in the East Jefferson District.

Much of the watershed for the 21-square-mile Grand Lake, the city's water source, is agricultural land. The lake's average 7-ft depth provides ideal conditions for massive algal blooms and

average TOC concentrations of 12.5 mg/L, peaking at more than 20 mg/L. The lake water also undergoes fluctuations in pH and turbidity (10–500 units).

#### TRADITIONAL WATER TREATMENT

For several years, drinking water was supplied to the city through a series of treatment processes, including lime slaking, up-flow clarification, recarbonation, sand filtration, and coagulation, as well as chlorination, to maintain a residual disinfectant. These processes effectively removed colloids (solids) from Grand Lake's water but struggled with taste-and-odor problems. Utility personnel had used powdered activated carbon (PAC) to improve taste and odor, but it was ineffective. Ozonation, added in 1995, was effective against taste and odor, but it didn't reduce DBP precursors.

DBP levels became a problem in 1999 when the total trihalomethane (TTHM) four-quarter average was 221.5 µg/L, well above the 80-µg/L regulatory level set by the US Environmental Protection Agency (USEPA) and Ohio Environmental Protection Agency (OEPA). On May 31, 2003, OEPA placed the facility under a consent decree with a scheduled TTHM compliance date of November 2007.

Figure 1. GAC Pilot Results

GAC adsorption achieved the 25-mg/L TOC target.



# The HAB Photo Parade



Photos: Donahue IDEAS

# The HAB Photo Parade



Photo: Donahue IDEAS

# The HAB Photo Parade



Photo: Sam Hendren, WOSU



Photo: Russ Gibson, Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Mercer County - Planktothrix 2009

CLOSE X

Photo: Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Mercer County - Planktothrix 2009

CLOSE X

Photo: Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Auglaize County - HAB Bloom 6/23/2010

CLOSE X

Photo: Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Auglaize County - Planktothrix 2009

CLOSE X

Photo: Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Auglaize/Mercer Counties - HAB Bloom 6/14/2010

CLOSEX

Photo: Ohio EPA

# The HAB Photo Parade



Photo: Ohio EPA

# The HAB Photo Parade



Grand Lake St. Marys, Auglaize County - HAB Bloom 7/12/2010

CLOSE X

Photo: Ohio EPA

# The HAB Photo Parade



Photo: Lake Champlain International

# The HAB Photo Parade



Photos from [www.DarkeJournal.com](http://www.DarkeJournal.com)

# The HAB Press Parade

'DON'T TOUCH THE WATER'

## Two more toxins detected in Grand Lake St. Marys

Algae-based poisons pose serious risks to swimmers and other users. Health officials are taking no chances, urging extreme caution.

### Grand Lake St. Marys' toxic woes

#### WHAT IS APHANIZOMENON GRACILE?

It is a type of naturally occurring blue-green algae, classified as cyanobacteria. They are singlecell organisms that grow quickly in warm, nutrient-rich environments,

By [Spencer Hunt](#)

*The Columbus Dispatch* • Thursday July 1, 2010 5:14 AM

Comments: 0 [Share](#) 0 [Tweet](#) 0 [ShareThis](#) 26

Two more toxins detected in Grand Lake St. Marys - ST. MARYS, Ohio - Last year, Joe Caperna made his grandchildren jump into his pool after swimming in Grand Lake St. Marys because they felt "itchy."

But when they visit him this year, he won't even let them touch the lake water, especially after seeing it turn emerald green last week. And he doesn't like the fishy, pungent smell that started bothering fellow residents two weeks ago.



REQUEST TO BUY THIS PHOTO  
CHRIS RUSSELL

Despite signs posted along Grand Lake St. Marys warning swimmers of potential toxins, Dave Harrison plans to eat the catfish he caught yesterday. There is no data on safe levels of the toxins in fish, so a blanket limit of one meal of lake fish per week applies.

# The HAB Press Parade

## The good, the bad and the algae

Phosphorus-fueled cyanobacteria are making Grand Lake St. Marys sick

### ENVIRONMENT BLOG

► More time

### OTHER NEWS

► Mystery surrounds earthquake in China

► DNA linked to how much coffee you drink

► Sunrise, moonset — see both at once early Wednesday

► Winners' brain work: hope for Alzheimer's

► Rising sun, setting moon to share sky on Wednesday

► UNESCO says wreck off Haiti isn't 'Santa Maria'

► Supreme court rejects challenge to ozone regulations

► Shale revenue cuts taxes for Muskingum watershed residents

### HELPFUL LINKS

► "Get Green Columbus" Official site

► Environmental Protection Agency

► The Green Guide

By [Doug Caruso](#)

*The Columbus Dispatch* • Monday July 12, 2010 10:15 AM

Comments: 0

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### The good, the bad and -

If non-toxic algae are the sweet grass at the bottom of a lake's food chain, cyanobacteria - what most people call blue-green algae - are the weeds.



REQUEST TO BUY THIS PHOTO  
KIRK IRWIN

By that definition, Grand Lake St.

Marys, Ohio's most polluted lake, is choking on noxious weeds. The state is warning people not to touch the water after tests found three toxins produced by cyanobacteria.

Grand Lake St. Marys is Ohio's largest inland lake and one of the state's most polluted.

David Culver, an emeritus professor who runs Ohio State University's Limnology Laboratory - which studies the ecology of lakes and fish hatcheries - says spikes in cyanobacteria are a sure sign of a sick lake.

"They grow like other critters, they look like other critters but they're not as healthy as food for the zooplankton," he said. "In lakes that have the best production of fish and good water quality for drinking and swimming, you have fewer."

Cyanobacteria, unlike the "good" algae, have evolved to excrete toxins. That's what makes them such a pain in the liver when they take over your swimming hole.

"You ask, 'Why do these organisms bother?' in the same way you ask,

# The HAB Press Parade

## Feds send \$1 million to help save Grand Lake St. Marys

Funds aim to curb flow of farm manure, fertilizers that create toxic algae

### LOCAL

- ▶ 301 voters cast early ballots in Franklin County
- ▶ Buckeye Country Superfest brings big names to the Shoe
- ▶ I-71 reopens after fuel spill forced closure
- ▶ Striking Reynoldsburg teachers, board going back to federal mediator this afternoon
- ▶ Justice Insider: Woman turns herself in to get unflattering photo off police Facebook page
- ▶ Easton Gateway to welcome 13 new stores, restaurants
- ▶ Woman who railed against 'tyranny' found guilty of assaulting officer in courtroom

By [Spencer Hunt](#)

*The Columbus Dispatch* • Tuesday July 20, 2010 2:22 PM

Comments: 0 [Share](#) 2 [Tweet](#) 0 [ShareThis](#) 8

### Feds send \$1 million to help save Grand Lake St. Marys -

The U.S. Department of Agriculture will set aside \$1 million to help combat the toxic algae plaguing Grand Lake St. Marys in western Ohio, officials said today.



REQUEST TO BUY THIS PHOTO  
ODNR

Ohio officials are warning people away from Grand Lake St. Marys.

The money will be spent through a federal program that encourages farmers to reduce the flow of manure and fertilizers that run off fields during storms. The pollutants feed vast blooms of stinking, fish-killing cyanobacteria, also called blue-green algae, which have spread across the 13,000-acre lake this summer.

This isn't the first time the USDA has set aside money for Grand Lake St. Marys, located in Mercer and Auglaize counties. The agency spent \$1 million for similar efforts in the area in April and \$1.5 million in 2009.

# The HAB Press Parade

## State offers visitor discounts at Grand Lake St. Marys

Toxic algae killed tourism business there last year

### RELATED ITEMS

- ▶ State has new plan to clean up Grand Lake St. Marys
- ▶ New tests find Grand Lake St. Marys safe
- ▶ EPA's no-contact warning remains for Grand Lake St. Marys
- ▶ State announces plans to address algae-choked Grand Lake St. Marys

### Related Stories

- State has new plan to clean up Grand Lake St. Marys (Jan. 27, 2011)
- New tests find Grand Lake St. Marys safe (Oct. 30, 2010)
- EPA's no-contact warning remains for Grand Lake St. Marys (Aug. 6, 2010)
- State announces plans to address algae-choked Grand Lake St. Marys (July 30, 2010)

By [Spencer Hunt](#)

*The Columbus Dispatch* • Tuesday February 1, 2011 3:47 PM

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The state is offering for the first time "half-off" discounts at Grand Lake St. Marys shelter houses and its docks through this summer in an effort to lure tourists back to the troubled lake.



REQUEST TO BUY THIS PHOTO

Many fish died in the toxic algae at Grand Lake St. Marys last year.

It also is continuing its 50 percent discount for camp sites, which it offered last year.

Health warnings centered on blooms of toxic blue-green algae scared tourists away from the 13,000-acre lake and state park during the past two summers, sending the local tourism economy into a tailspin.

The Ohio Department of Natural Resources offered the discounts for the first time last year while warning signs were in place. Officials released a plan last week in which they will take extra steps intended to keep the algae from returning.

"State park visitors bring critical tourism dollars to local businesses and communities across Ohio," State Parks Chief David Payne said in a release. "It is vital that we remain innovative in our ways to attract more visitors to Grand Lake St. Marys."

The algae, which can produce as many as four different liver and nerve toxins, feed on phosphorus from manure that rain washed off nearby farms. The algae grew so thick in the lake last summer that the state warned people not to touch the water, take boats out on the lake or eat any fish they caught there.

# The HAB Press Parade

## Toxic algae returns to Grand Lake St. Marys

State warns visitors to stay away from water

### LOCAL

► 1-71 reopens after fuel spill forced closure

► Striking Reynoldsburg teachers, board meeting with federal mediator

► 301 voters cast early ballots in Franklin County

► Buckeye Country Superfest brings big names to the Shoe

► Justice Insider: Woman turns herself in to get unflattering photo off police Facebook page

► Easton Gateway to welcome 13 new stores, restaurants

► Woman who railed against 'tyranny' found guilty of assaulting officer in courtroom

► Sunrise, moonset — see both at once early Wednesday

► Ted Williams: 'Golden Voice' is clean and sober, but struggling to pay the bills

► Candidate contrasts easy to see in Dispatch Voters

By [Spencer Hunt](#)

The Columbus Dispatch • Thursday May 19, 2011 3:14 PM

Comments: 0 [Share This](#) [Tweet](#) [Share This](#)

### Toxic algae returns to Grand Lake St. Marys -

The toxic blue-green algae that has plagued Grand Lake St. Marys for two years has returned to the western Ohio state park.



REQUEST TO BUY THIS PHOTO

State officials today are warning visitors not to swim, wade or swallow any lake water. Warning signs are being posted at three beaches located at the eastern end of the lake.

The state says water samples taken earlier this week at the three beaches by the Ohio Environmental Protection Agency indicate the presence of toxic algae.

The bloom, the state says, is not confined to the beaches, but is visible over most of the lake.

This type of bloom holds the potential for producing algal toxins, including microcystin, such as those experienced at the lake in recent years.

Algal blooms can produce neurotoxins, which affect the nervous system, and hepatotoxins, which affect the liver.

Fed by phosphorus in manure that storms wash off nearby farms, blue-green algae grew so thick in Grand Lake St. Marys last year that

# The HAB Press Parade

HOME > NEWS > LOCAL

Updated: 10:57 p.m. Wednesday, Jan. 18, 2012 | Posted: 10:11 p.m. Wednesday, Jan. 18, 2012

## EPA hopes to keep Grand Lake St. Marys trouble-free

Cleanup goal is no health advisories for Grand Lake in 2012.

Email 0 Share 0 Tweet 0 Share This 261

### Related

By Steve Bennish  
Staff Writer

[View Larger](#)



Algae level damage is shown here in 2011 at Grand Lake St. Marys.

CELINA — All of Grand Lake St. Marys is being targeted for an early spring chemical treatment to short-circuit any potential harmful blue green algae blooms this year, the Ohio Environmental Protection Agency said Wednesday.

Officials have lined up about a third of the money to pay for the \$5 million treatment with alum, or aluminum sulfate, said OEPA director Scott Nally. Treatment could happen as soon as April 1 to get a head start on the blooms, he added.

The chemical binds to phosphorous to prevents it from fueling the hazardous cyanobacteria outbreaks that have at times shut down recreation on the lake.

Nally appeared at a summit and briefing along with state and local officials held at the Wright State University Lake Campus to share updates on lake restoration plans.

In 2011, a partial treatment reduced phosphorous levels in the lake's center by a better-than-expected 56 percent.

A 50 percent reduction was the target for the treatment of the middle 4,000 acres of the 13,000-acre lake.

The goal for 2012 is to have no outbreaks that prompt health advisories, said Tom Knapke of the Grand Lake Restoration Commission, which organized the summit.

In another major undertaking, federal funding will pay for an 18-acre wetland being built this year on Prairie Creek, a major feeder to the lake.

The wetland should help naturally filter farm field manure runoff, which feeds to the algae blooms. Additional filtration projects are under way at the other creeks on the lake.

Plans are being developed with the U.S. Army Corps of Engineers to by 2014 build an additional 80 acres of wetlands in locations in the lake that used to support them, said Jared Ebbing, Mercer County's development director. The new wetland acreage could multiply within 20 years, he

Dayton Daily News

# The HAB Press Parade

SUNDAY, MARCH 25, 2012

## Commitment to Grand Lake St. Marys Continues with Spring Alum Treatment

*Author's Note: This latest update on the state DNR's efforts to solve the toxic algae problem at Grand Lake St. Marys is notable in that the state is leaving no stone unturned in what has become an immense and complex issue. Kudos to the Ohio DNR for its steadfastness in this regard, and here's hoping there will be some positive results this summer.*



In this July 2010 image from nso4i.com, the toxic algae problem at Grand Lake St. Marys is clearly evident.

COLUMBUS, OH – A step toward improving water quality at Grand Lake St. Marys will occur this spring when an alum treatment will be applied to cover the entire lake. This treatment is part of Gov. John Kasich's approach to improve Grand Lake St. Marys through rough fish removal, dredging, installation of a treatment train, wetland creation, watershed improvements and other water quality initiatives.

"We are committed to improving the water quality at Grand Lake St. Marys," said Ohio Department of Natural Resources (ODNR) Director James Zehring. "A healthy and thriving lake will not only benefit the residents of Mercer and Auglaize counties, but this improvement will benefit all Ohioans."

Ohio has offered steep discounts for campground reservations at Grand Lake Marys State Park, which obviously has seen a huge drop-off in campers since the lake problems first surfaced several years ago. One significant result was the findings of an outside company in determining the cause and solution of the toxic algae.

ODNR continues to work collaboratively with Ohio EPA to improve water quality in Grand Lake St. Marys. This is the second year an alum treatment has been applied to the lake.

[campers-support-lake-st-marys-00201.jpg](#) | treatment totals \$5 million and includes funding

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# Previous Studies and Work



- ⚡ Grand Lake St. Marys Restoration Commission – Strategic Plan (01/31/11)
- ⚡ Battelle – GLSM 2011 Aeration Testing (02/07/11)
- ⚡ Tetra Tech – GLSM Feasibility and Restoration (2010-2012) – 2011 Alum Application



# GLSMRC Strategic Plan 01/30/2011



- ⌘ Sequestration of Soluble Reactive Phosphorus (Chemical Treatment)
- ⌘ Dredge Sediment Depositions
- ⌘ Beneficial Use of Organic Waste
- ⌘ Treatment Train Establishment
- ⌘ Rough Fish Removal
- ⌘ HAB Prevention Through Micro Nutrient Modification
- ⌘ Aeration and Circulation
- ⌘ Water Level Management



# Battelle Aeration Testing 02/07/2011



- Study performed for GLSMRC
- Evaluated effectiveness of artificial circulation
  - DO, Chl, Secchi, Turbidity
  - Nutrient levels
  - Sediment Redox Potential Discontinuity (RPD)
- Improved DO levels at Airy-Gator site
- Allowed formation of RPD layer
- Recommended installation of aeration devices at strategic locations around S and E margins of lake
- Biomanipulation of fish stocks



# Tetra Tech 2011 Alum Application



- Aluminum sulfate (alum) application
- Treated ~40% of the lake area (~1,960 ha)
- Two barges to apply alum
- Over a period of 30 days
- Application began in June
- Algal bloom already underway
- Impacted effectiveness of 2011 application

# Tetra Tech 2011 Alum Application



Photos from Tetra Tech



# 2012 GLSM Alum Application



- ⚡ Team:
  - ⚡ Donahue IDEAS
  - ⚡ Tetra Tech
  - ⚡ HAB Aquatic Solutions
- ⚡ Turnkey project
- ⚡ Scheduled for April and May 2012
- ⚡ \$5M project including post-treatment evaluation



# 2012 GLSM Alum Application



- ⚡ Chemicals:
  - ⚡ Aluminum sulfate (alum)
  - ⚡ Liquid sodium aluminate (LSA)
  - ⚡ 2:1 ratio (alum:LSA)
- ⚡ Application area: same 40% as in 2011
- ⚡ Two barges
- ⚡ Two staging sites:
  - ⚡ West (near the ODNR boathouse)
  - ⚡ Public boat launch area

# 2012 GLSM Alum Application





# 2012 GLSM Alum Application



## ⚡ Schedule:

- ⚡ Contract was fast-tracked by ODNR
  - ⚡ Awarded - 03/06/2012
  - ⚡ Contract – 03/29/2012 (WOW)
- ⚡ Begin in early April; end by late May
- ⚡ Continuous operation through weekends during daylight hours
- ⚡ Beat the spring/early summer algal bloom



# 2012 GLSM Alum Application



## ⚡ Permits:

- ⚡ Notice of Intent (NOI) Pesticide application
  - ⚡ Submitted – 03/26/2012
  - ⚡ Received – 03/27/2012 (OMG)
  - ⚡ Application period: 04/01/12 - 05/16/12
  - ⚡ Work to be suspended if:
    - ⚡  $DO < 2.5$  mg/L
    - ⚡  $pH < 6.0$
- ⚡ SPCC Plan
  - ⚡ Dilution really is the solution



# 2012 GLSM Alum Application



## ⚡ Schedule:

- ⚡ Plan of Work submitted 03/23/2012
- ⚡ Began mobilizing 03/28/2012
- ⚡ Began application 04/02/2012
- ⚡ Worked extended days (many over 14 hours)
- ⚡ Longest days (16.8 and 16.5 hours)
- ⚡ Worked all weekends except Easter Sunday
- ⚡ Limited by weather conditions (high winds)
- ⚡ Complete by 04/30/2012

# 2012 GLSM Alum Application

⚡ Schedule:

File | The Journal Gazette

Last updated: May 9, 2012 11:45 a.m.

## Grand Lake St. Marys has early case of toxic algae

Associated Press

+ 5 0 0

Recommend Tweet 8+1

E-mail Printer friendly

COLUMBUS, Ohio - Tests indicate the blue-green algae growth that has hampered tourism near a western Ohio lake appeared about two months earlier this year than last, possibly because of unseasonably warm weather.

The algae blooms, which produce a nerve toxin that can sicken humans, have led to previous closures of Grand Lake St. Marys and swimming advisories.

The algae didn't show up last year until late May, but tests show it may have started growing in early March this year, The Columbus Dispatch (<http://bit.ly/LJD8i>) reported Wednesday.

Milt Miller, a co-founder of the Grand Lake St. Marys Restoration Commission, blames the unusually warm weather.

Daily high temperatures reported by the National Weather Service were at least 11 degrees above normal from March 12-25 and exceeded 80 degrees on March 20-22.

"Typically we don't see those warm temperatures until May or June," Miller said.



# 2012 GLSM Alum Application



- ⚡ Field staff – tracking parameters:
  - ⚡ pH
  - ⚡ Temperature
  - ⚡ Conductivity
  - ⚡ Transparency (Secchi disk)
  - ⚡ Number of barges (field check for daily reports from contractor)
  - ⚡ Field conditions (fish kills, etc.)
  - ⚡ Media (refer to ODNR)

# 2012 GLSM Alum Application



West End Staging Site

# 2012 GLSM Alum Application



East End Staging Site

# 2012 GLSM Alum Application



HAB Chemical Application Barge

# 2012 GLSM Alum Application



HAB Chemical Application Barge in Operation



# 2012 GLSM Alum Application



## Results:

- 2012 dose to the middle 40% of the lake:
  - Higher than in 2011 (23.6 mg Al/L in 2012; 21.5 mg Al/L in 2011)
  - Still less than recommended dose due to funding constraints (86 mg Al/L)
  - Over 232 barges of chemicals applied
  - Total of 1,808,888 gallons of alum and 904,344 gallons of LSA applied



# 2012 GLSM Alum Application



## Water Quality Results:

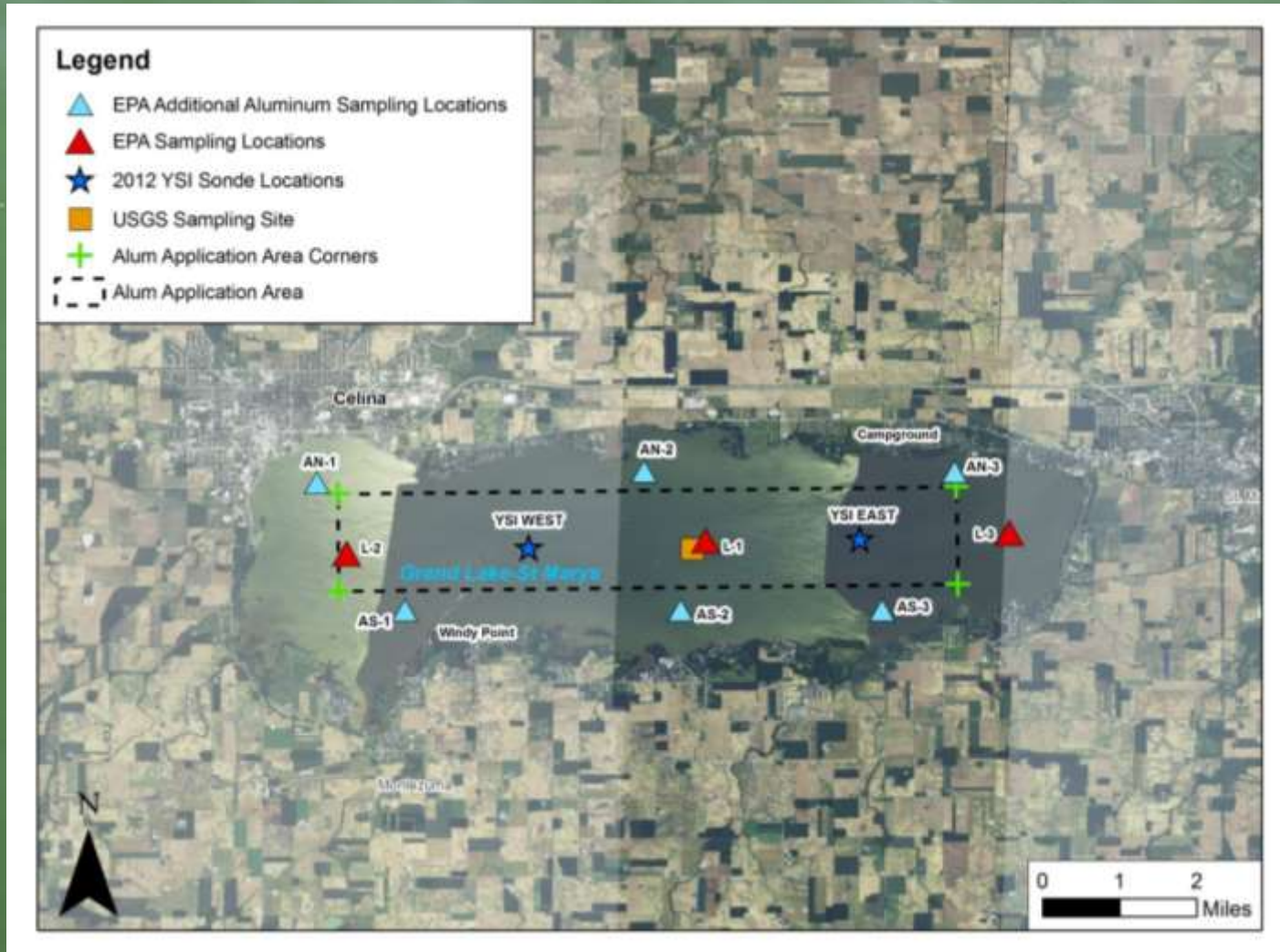
### During and post-application monitoring:

- Water Quality Results:
  - During and post-application monitoring:
    - Three water column monitoring sites (same as OEPA)
    - Two OEPA YSI sonde buoys
    - One USGS YSI sonde buoy (not useable)
    - Six aluminum sample sites (OEPA)

### Post-application sampling:

- Post-application sampling:
  - Five lake sites at 0.5 m below and 1.0 m above
  - TP, SRP
  - Alkalinity
  - Chl and phytoplankton

# 2012 GLSM Alum Application



# 2012 GLSM Alum Application

## Water Quality Results:

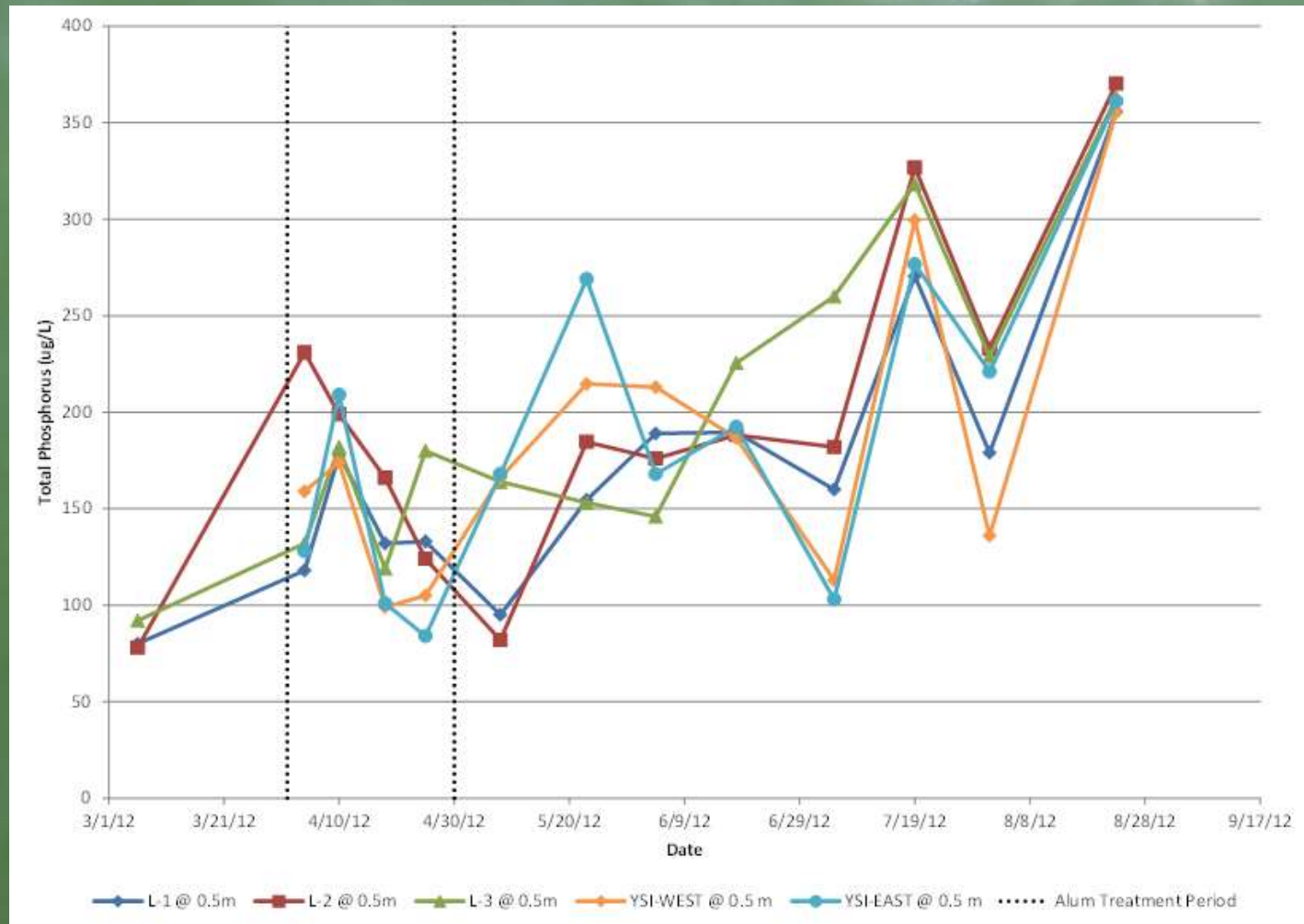
- Phosphorus increased and remained high possibly due to wind mixing, lower lake levels, and early algal bloom

Mean ( $\pm$  SD) 2012 TP and Chl Concentrations

	TP ( $\mu\text{g/L}$ )	Chl ( $\mu\text{g/L}$ )	Chl/ TP
Before (3/6)	83 $\pm$ 8	43 $\pm$ 1.2	0.52
During (4/4 -4/25)	148 $\pm$ 20	107 $\pm$ 5.5	0.82
After (5/8-8/23)	216 $\pm$ 12	109 $\pm$ 5.1	0.54

\*Before treatment, data were available from the three main lake sites (L-1, L-2, L-3) only.  
Chl results from OEPA were corrected downward; OEPA chl x 0.47

# 2012 GLSM Alum Application



Total Phosphorus Concentrations, Before, During and After Alum Treatment

# 2012 GLSM Alum Application

## Water Quality Results:

- Low residual aluminum in water column

**Mean and Range of Total and Dissolved Aluminum Concentrations during 2012 Alum Treatment**

<b>Location</b>	<b>Mean Total Al (mg/L)</b>	<b>Min Total Al (mg/L)</b>	<b>Max Total Al (mg/L)</b>
Whole Lake	1.83	1.00	2.95
Inside Treatment Area	2.08	1.00	2.95
Outside Treatment Area	1.69	1.18	2.60

<b>Location</b>	<b>Mean Dissolved Al (mg/L)</b>	<b>Min Dissolved Al (mg/L)</b>	<b>Max Dissolved Al (mg/L)</b>
Whole Lake	1.29	0.20	2.71
Inside Treatment Area	1.68	0.74	2.71
Outside Treatment Area	1.07	0.20	2.45



# 2012 GLSM Alum Application



- Water Quality Results:
  - Chlorophyll (algal biomass):
    - Increased in early April
    - Declined dramatically in late April to early June
    - Appear to be associated with the TP decline
    - Decline observed at all sites

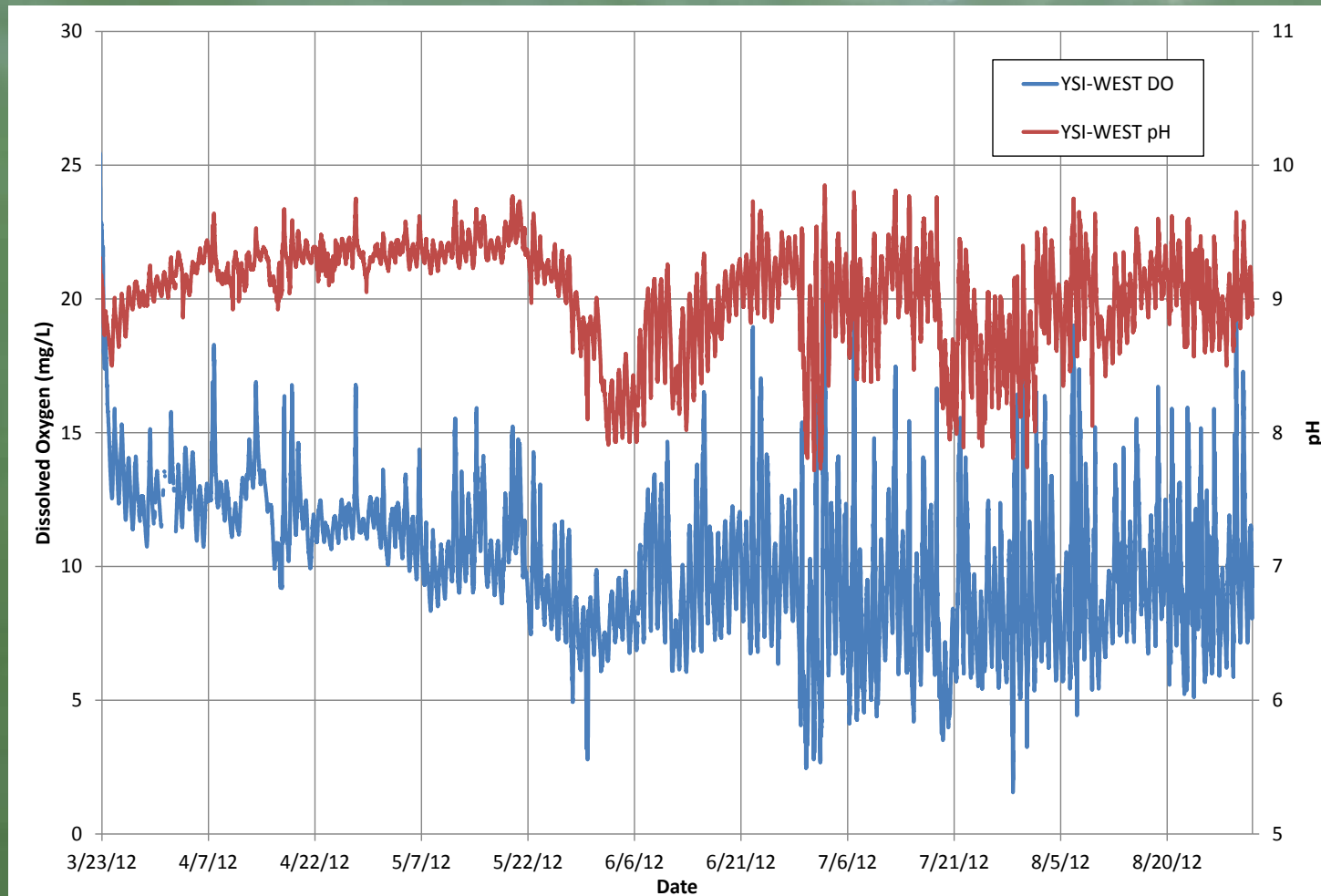
# 2012 GLSM Alum Application



**Chlorophyll a Concentrations, Before, During and After Alum Treatment**

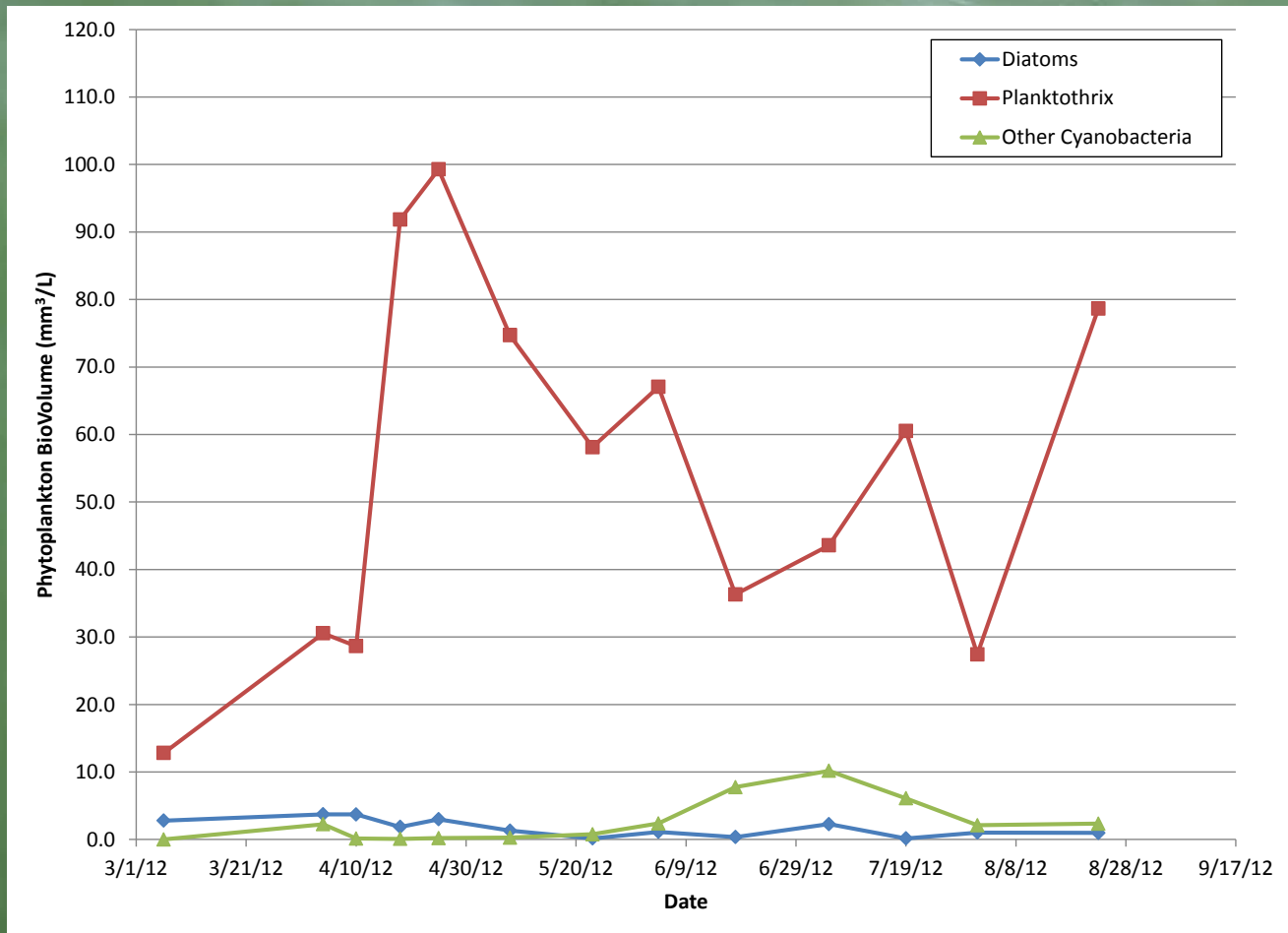
(Data collected by Ohio EPA (before and during treatment) has been corrected by a factor of 0.47.)

# 2012 GLSM Alum Application



Continuous Surface DO and pH at YSI WEST in GLSM

# 2012 GLSM Alum Application



Diatom and Cyanobacteria Biovolume at Station L-1 in GLSM

# The HAB Press Parade

## Grand Lake St. Marys had algae in March, tests show

Warnings won't be posted till late May



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### RELATED ITEMS

- ▶ Permanent algae signs will go in 14 state parks
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- ▶ In algae war at Grand Lake St. Marys, alum to affect more of lake, start earlier

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- ▶ More time

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By [Spencer Hunt](#)

The Columbus Dispatch • Wednesday May 9, 2012 5:19 AM

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Tests show toxic blue-green algae were growing in Grand Lake St. Marys as early as March this year.

The most-recent test, on April 18, detected the liver toxin produced by the algae at a concentration seven times higher than what the state uses to advise older visitors, young children and people with weakened immune systems not to wade or swim.

State officials said warning signs won't go up at the 13,000-acre western Ohio lake and state park until Memorial Day weekend, the start of the state's swimming season.

"At this point, there may be some boating on Grand Lake," said Carlo LoParo, spokesman for the Ohio Department of Natural Resources. "However, there is no water-skiing or full-body contact with the water because of lake temperatures."

Blue-green algae, also called cyanobacteria, are common in most Ohio lakes. They grow thick by feeding on phosphorus from manure, fertilizers and sewage that rain washes from farm fields into nearby streams.

As many as 19 public lakes, including Erie, have been tainted in recent years by toxic algae.

Algae grew so thick in Grand Lake in 2010 that the state warned people not to touch the water. Officials say it likely caused seven people to get sick that year. The algae can produce as many as four toxins.

The concentration of toxins was reduced in 2011 after state officials treated the central 5,000 acres of the lake with alum, a chemical that



# 2012 GLSM Alum Application



- ⌘ Water Quality Results Summary:
  - ⌘ Algal bloom began early
  - ⌘ Impact of treatment hard to visually observe
  - ⌘ Sampling and monitoring results show in-lake TP concentrations decreased but only temporarily likely due to the lower lake volume (23% less)
  - ⌘ Tetra Tech continued evaluation of results through contract with USEPA
    - ⌘ Sediment Al and Al-P concentrations showed the alum treatments inactivated P
    - ⌘ Lake TP was less in 2012 than in 2011



# 2012 GLSM Alum Application



## ⚡ Conclusions/Recommendations:

- ⚡ 2012 GLSM Alum Application is estimated to have removed over approximately 40,300 lb P (to as much as 183,100 lb) from bioavailability
- ⚡ Continued holistic approach to lake management:
  - ⚡ Reduction in external (watershed) P loading
  - ⚡ Reduction in internal (in-lake) P loading
    - ⚡ Removal of lake sediment
    - ⚡ Management to avoid re-suspension



# Other Recent Work



- ⚡ Dredging
- ⚡ Rough fish removal
- ⚡ Constructed wetlands
- ⚡ Watershed management

# GLSM Dredging

- ⌘ Through ODNR:
  - ⌘ Now have 4 dredges
  - ⌘ Sediment removal is significant:
    - ⌘ 2011 - 272,000 cubic yards
    - ⌘ 2012 – 289,000 cubic yards
    - ⌘ 2013 – 302,226 cubic yards!
  - ⌘ Disposal of spoils – biggest challenge
  - ⌘ Phosphorus harvesting?



# Rough Fish Removal (aka Carp Derby)

- Annual competition (Get the Carp Outta Here):
  - Fish removal is significant:
    - 2011 – 8,142 lbs
    - 2012 – 12,831 lbs
    - 2013 – 15,541 lbs in 44 hours!
  - 2013 winner:
    - Doug Moran (20.5 + 15.7)



Photos: Grand Lake St. Marys Lake Improvement Association



# Constructed Wetlands



- Prairie Creek artificial wetland
  - Managed through GLRC
  - Design by KCI Engineering
  - 200-acre wetland; \$1.9M
  - Construction began spring 2012
  - Operation began June 2013
  - ~1.3 MGD
  - Includes:
    - alum dosing station
    - settlement ponds
    - treatment wetlands

# Constructed Wetlands

- Prairie Creek artificial wetland
  - Performance in 2013:
    - ~41% nitrogen reduction
    - ~75% Total P reduction
    - ~65% DRP reduction
  - Alum needed seasonally
- Additional wetlands:
  - 40-acre wetland adjacent to Prairie Creek; construction almost complete
  - \$2.1M funding for Coldwater Creek
  - 319 Grant for Beaver Creek



Photo: Milt Miller, GLSMRC



# Watershed Management



- ⌘ Lake Facilities Authority
  - ⌘ Authorized June 30, 2013
  - ⌘ Provide funding source for improvements
    - ⌘ Property tax
    - ⌘ Excise/lodging tax
  - ⌘ Authority to apply for grants and loans
  - ⌘ Authority to sell bonds
  - ⌘ Own and operate facilities for algae mitigation
  - ⌘ Developed by State Senator Keith Faber and Representative Jim Buchy

# The HAB Press Parade

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The Daily Standard

Stories Archive    Entire Day Archive  
Wednesday, September 18th, 2013  
By Nancy Allen

## Algae toxins remain high in Grand Lake

State officials say water quality in Grand Lake is improving. Data show the opposite.

Average monthly algae toxin levels between Memorial Day and Labor Day in 2011, 2012 and 2013 show an increase every month except July, when the level fell slightly.

Despite the readings, a state official said the lake is getting better. "I talked to a lot of folks and they said the fishing has been the best it has been in a long time and a lot of folks in our department said fishing has been good and people around the lake said it looks better than it has in years past," said Mark Bruce of the Ohio Department of Natural Resources. "We continue to do testing and while there was an advisory posted, we feel things are improving up there."

This is the fifth consecutive year the state has placed a water advisory on Grand Lake due to unsafe levels of toxins produced by blue-green algae, also known as cyanobacteria. The advisory is posted when microcystin toxins exceed 6 parts per billion. The elderly, very young and people with compromised immune systems are told not to swim or wade in the water.

Between 2011 and 2013, average toxin levels ranged from a low of 11 ppb in May 2011 to a high of 90.3 ppb in May 2013. The only month the average monthly toxin level dropped was in July 2012 and July 2013 when it went from 36.2 ppb to 29.1 ppb.

Bruce said tests done on water leaving a treatment train on Praine Creek showed significant reductions in nitrogen and phosphorous nutrients that feed the blue-green algae. The treatment train diverts a small amount of water from the creek, funnels it through a series of manmade wetlands and treats it with alum, a chemical that deactivates phosphorous - the algae's favorite food source - before emptying into the lake.

He could not point to any other data showing the 13,500-acre lake is improving. He added that the lake's health is not based solely on toxin levels. Nutrient loading reductions at the treatment train site is a "positive step in the right direction," he said.

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2%    2%  
Tonight 43°    Tonorrow Night 43°    Thursday Night 45°  
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## Action Called In Ohio And Other States With Toxic Algae

[Listen to the Story](#)



Algae-saturated water at Grand Lake St. Marys in 2010 (Photo: Sam Hendren / WOSU)

9:59 AM  
September 26, 2013

AP by The Associated Press

Contact the Author:



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An environmental group is calling for national policymakers to take action after a report shows significant increase in toxic algae. Ohio is on the list of states experiencing problems.

The nation is experiencing a massive outbreak of toxic algae on its lakes, rivers and

WOSU public media

# The HAB Press Parade



The screenshot shows the NBC4i.com website with a news article titled "Toxic Algae Again Plaguing Grand Lake St. Marys". The article is dated May 22, 2014, and updated on Aug 14, 2014. It is attributed to the Associated Press. The article text describes the resurgence of toxic blue-green algae in Grand Lake St. Marys, Ohio, which is making swimming hazardous. It mentions that state officials have been testing near lake beaches and that the city of Celina draws water into its treatment plant. The article also notes that blue-green algae are common in most Ohio lakes, fed by phosphorus from manure, fertilizers, and sewage. It states that algae grew so thick in Grand Lake in 2010 that the state warned people not to touch the water. The city of Celina spends about \$450,000 a year to control algae, and the state has spent more than \$10 million trying to treat it. Finally, it mentions that the phosphorus runoff from area farms is such a summertime problem that nearby farmers now face state-mandated limits on the manure they spread on fields.

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## Toxic Algae Again Plaguing Grand Lake St. Marys

Posted: May 22, 2014 2:11 PM EST  
Updated: Aug 14, 2014 2:11 PM EST  
By: Associated Press

CELINA, Ohio - Signs were going up on the beaches of Ohio's largest inland lake Thursday warning visitors that toxic algae blooms are back.



Toxic blue-green algae is again making swimming hazardous at Grand Lake St. Marys in western Ohio. It's been a recurring problem at the 20-square-mile lake between Dayton and Toledo.

State officials have been testing near lake beaches this week after measurements of a liver toxin associated with the algae began to increase last month near where the city of Celina draws water into its treatment plant, according to The Columbus Dispatch. By the end of April, readings of microcystin measured four times higher than the state's safety threshold.

Ohio Department of Natural Resources spokesman Matt Eiselstein said exact measurements are still being calculated, but the readings are "definitely over the safety level."

Blue-green algae are common in most Ohio lakes, fed by phosphorus from manure, fertilizers and sewage that rain washes from farm fields into nearby streams. As many as 19 public lakes, including Erie, have been tainted in recent years by toxic algae.

Algae grew so thick in Grand Lake in 2010 that the state warned people not to touch the water. Officials say it likely caused seven people to get sick that year.

The city of Celina spends about \$450,000 a year to control algae at Grand Lake, and the state has spent more than \$10 million trying to treat it. The Ohio Environmental Protection Agency says it could take years to reverse the situation.

The phosphorus runoff from area farms is such a summertime problem at Grand Lake St. Marys that nearby farmers now face state-mandated limits on the manure they spread on fields.

# The HAB Press Parade

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Posted: 1:51 p.m. Monday, Sept. 29, 2014

### Man drowns near Grand Lake St. Marys

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By [Breaking News Staff](#)

**GRAND LAKE ST. MARYS** — A Miami County man is dead after an apparent drowning near Grand Lake St. Marys over the weekend.

The Mercer County Sheriff's Office said Kevin Miller, 54, of near Bradford died on Sunday.

Deputies said on Saturday, Miller had been swimming with family members at a campground near Grand Lake St. Marys when he suddenly went under water.

Miller was located about 15 minutes later, according to officials.

The Ohio Department of Natural Resources is also looking into this incident.

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# Thanks to:



- ⚡ Tetra Tech
  - ⚡ Harry Gibbons, PhD
  - ⚡ Shannon Brattebo
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- ⚡ HAB Aquatic Solutions
  - ⚡ John Holz, PhD
  - ⚡ Tadd Barrow
- ⚡ All Donahue IDEAS staff



# Thanks to:



- ⚡ Ohio Department of Natural Resources
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  - ⚡ Dave Mohr
- ⚡ Ohio Environmental Protection Agency
  - ⚡ Russ Gibson
- ⚡ Grand Lake St. Marys Restoration Commission
  - ⚡ Milton Miller
- ⚡ The Ohio State University
  - ⚡ Dave Culver, PhD (Limnology professor)

# Questions?

