HARMFUL ALGAL BLOOM RESEARCH INITIATIVE

2015 Report to the Ohio Department of Higher Education

Track Blooms From the Source

Produce Safe Drinking Water

Protect Public Health

Engage Stakeholders

Chancellor John Carey
Ohio Department of Higher Education

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On behalf of the current consortium of Ohio universities engaged in the Ohio Department of Higher Education Harmful Algal Bloom Research Initiative (HABRI), we are pleased to submit the initial progress report for the research activities funded in Round 1, covering year one of these two-year projects.

As shown in the report, the 18 Round 1 projects are already providing needed answers that help water treatment operators, regulators, farmers and legislators deal with harmful algal blooms in the present, better predict the situation for the coming years, and lay the foundation for longer-term mitigation and prevention activities.

Whereas Round 1 requirements were primarily driven by OEPA inputs, we are pleased to note the current HABRI advisory board has active representation from OEPA, ODNR, ODH, ODA and the Lake Erie Commission and that they played a key role in setting research priorities and selecting the 13 new projects just funded in Round 2 in February 2016.

We anticipate sharing even more actionable research solutions from the combined efforts of both research cohorts in our next annual report as well as in periodic updates to ODHE. At present, ten Ohio research universities are engaged in HABRI.

We would like to recognize the Ohio Sea Grant team for their management of HABRI projects from start to finish and for preparing this report on behalf of the HABRI university consortium.

And finally, it is fitting that we submit this report to the Ohio Department of Higher Education during the week of World Water Day in light of ODHE's visionary support for creating a sustainable water future for the state through university research, education and outreach/engagement. Thank you.

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Introduction

After the Toledo water crisis in August 2014, the Ohio Department of Higher Education (then the Ohio Board of Regents) allocated $2 million to Ohio universities for research to solve the harmful algal bloom problem in Lake Erie. The funding was matched by participating universities for a total of more than $4 million.

Led by representatives from The Ohio State University and the University of Toledo, and managed by Ohio Sea Grant, the first round of the Harmful Algal Bloom Research Initiative (HABRI) includes 18 projects involving researchers from seven Ohio universities and partners as far-flung as South Dakota and Japan.

The initiative also provides invaluable training for Ohio students, from undergraduate to doctoral candidates, which distinguishes university research from other scientific institutions and gives taxpayers a double return on their investment.

Input from partners such as the Ohio Environmental Protection Agency, Ohio Department of Natural Resources and the Lake Erie Commission (Appendix I) ensures that projects complement state agency efforts to protect Ohio's fresh water and that results address known management needs to ensure sustainable water for future generations.

HABRI used Ohio Sea Grant's proposal development system to streamline project proposals, project management and public engagement, capitalizing on Sea Grant's strong reputation among various stakeholder groups including the research community.

This report describes the process of HABRI's first cohort of 18 funded two-year projects and offers an overview of the goals of the initiative in the year to come as researchers seek innovative solutions for harmful algal blooms.

Background Information

A harmful algal bloom (HAB) is any large increased density of algae that is capable of producing toxins. In freshwater, such as Lake Erie, those algae tend to be cyanobacteria — more commonly known as blue-green algae — which grow excessively in warm water with a high phosphorus concentration.

Phosphorus enters the water from agriculture, suburban and urban sources, and likelihood of runoff is strongly affected by climatic factors including drought, severe weather and average temperatures.

Many HABRI projects seek to understand both how phosphorus and other elements like nitrogen affect algal blooms, and how runoff can be reduced without negative impacts on farmers and other industries. Other projects focus on the public health impacts of toxic algal blooms, ranging from drinking water issues to food contamination.

Category Definitions

Track Blooms From the Source
Projects aim to improve existing technologies and develop new methods to track algal blooms as they develop and move, giving lakeshore residents and state agencies quicker and more effective tools to understand whether algal blooms might cause a hazard.

Produce Safe Drinking Water
In addition to monitoring bloom locations, researchers are developing new treatment methods for drinking water to remove algal particles and toxins.

Protect Public Health
Projects in this focus area examine the effects of the algal toxin microcystin on people and animals and study whether microcystin is found in produce irrigated with algal-contaminated water.

Engage Stakeholders
Research in this focus area analyzes the decisions that stakeholders have to make—from nutrient management to dealing with algal blooms—and develops tools to make these decisions more clear, systematic, and supported by the latest science.

Track Blooms From the Source

Projects in this focus area aim to improve use of existing technologies as well as develop new methods to detect, prevent and mitigate harmful algal blooms and their impacts. This will help to ensure drinking water safety and a healthy environment for lakeshore residents by scientifically connecting many of the potential causes and effects of harmful algal blooms, from the runoff that fuels them to the toxins that contaminate water supplies.

Early-Warning Systems for Lake Erie Algal Blooms

Two complementary projects in this focus area are developing warning networks for Lake Erie's western basin, where harmful algal blooms are most common. Tailored specifically for Maumee Bay and Sandusky Bay, the networks provide basin-wide data coverage of bloom-affected areas by streaming data from water quality buoys and sensors positioned near water treatment plant intakes to an online database.

The early warning system in Sandusky Bay already demonstrated its potential during the 2015 season. A rapid increase in chlorophyll, a green plant pigment, was detected on July 17, 2015, indicating that algae were present at the primary water intake for Sandusky's Big Island Water Works. While the rise in algae happened too quickly to keep the water from entering the treatment plant, operators had enough warning to adjust treatment to prevent a temporary water shutdown for more than 100,000 residents.

A related project focuses upstream of Lake Erie, monitoring both nutrient amounts and their sources (fertilizer, manure, human or wild animal waste) in the rivers and streams flowing to Lake Erie. This project integrates and augments an existing array of river monitoring stations maintained by a combination of federal, state and university partners.

Combining data from river sensors, lake buoys and existing climate models will refine predictive tools that will give water managers more time to react to developing bloom events in the near future, and ultimately will lead to a better understanding of how to prevent harmful algal blooms altogether.

Projects in this Focus Area

HAB Detection, Mapping and Warning Network: Maumee Bay Area
Lead: University of Toledo

HAB Detection, Mapping and Warning Network: Sandusky Bay
Lead: Bowling Green State University

Identifying the Best Strategy to Reduce Phosphorus Loads to Lake Erie From Agricultural Watersheds
Lead: Heidelberg University

A new early warning system for

ALGAL BLOOMS

in Sandusky Bay protected the water supply for

100,000

residents from algal toxins in July 2015.

Produce Safe Drinking Water

One of the most direct public impacts of algal blooms was seen in August 2014, when a harmful algal bloom in Toledo caused a “Do Not Drink” order to be issued for more than two days, an impact felt by residents and businesses alike. With direct guidance from state agencies at the front lines of Toledo and related algal drinking water crises, HABRI researchers are developing new treatment methods that will give public health and water treatment professionals the tools they need to make informed decisions when water supplies are threatened by algal blooms.

Treating Drinking Water to Remove Toxins

Researchers are developing new methods to remove the algal toxin microcystin from drinking water, using various filtration methods as well as ozone gas. The laboratory models can eventually be scaled up for use at water treatment plants that deal with harmful algal blooms in their water supply so they can better ensure their customers’ drinking water is safe to use.

Lab results so far have shown that bubbling ozone into a microcystin solution can lead to 100% destruction of the toxin. Further experiments are in process to achieve similar results at ozone concentrations and treatment times that work with treatment plant procedures. A range of filter membranes are also showing promising results, removing up to 96.9% of microcystin from tested solutions in the lab experiments.

Once these separate experiments are completed, combinations of ozone and filter membranes will be examined to determine the best pairing for toxin removal and cost effectiveness. The ultimate goal is to provide water treatment plant managers with a series of strategies to remove toxins.

Projects in this Focus Area

Treatment of Cyanotoxins by Advanced Oxidation Techniques
Lead: University of Cincinnati

Development of Microcystin Detoxifying Water Biofilters
Lead: University of Toledo

Investigation of ELISA and Interferences for the Detection of Cyanotoxins
Lead: University of Toledo

Guidance for Powdered Activated Carbon Use to Remove Cyanotoxins
Lead: The Ohio State University

Prevention of Cyanobacterial Bloom Formation Using Cyanophages
Lead: The Ohio State University

Identifying Bacterial Isolates for Bioremediation of Microcystin-Contaminated Waters
Lead: Kent State University

Investigation of Water Treatment Alternatives in the Removal of Microcystin-LR
Lead: University of Toledo

Transport and Fate of Cyanotoxins in Drinking Water Distribution Systems
Lead: University of Toledo

Preliminary results have shown

100%

destruction of microcystin when contaminated water is treated with high ozone gas concentrations.

Protect Public Health

While safe drinking water is a major focus for public health officials and researchers, scientists are also working on other health impacts of harmful algal blooms and the associated toxins. The algal toxin microcystin affects the liver, nervous system and skin, and potentially causes cancer in humans. Projects in this focus area examine those effects, develop techniques to detect the toxin in biological samples, and study whether microcystin is found in fish or produce grown in algae-contaminated water.

What's On Your Lettuce?

Water affected by harmful algal blooms doesn't just end up in residential sinks, it also travels through agricultural irrigation systems that water fields of lettuce, carrots and other vegetables. The recent increase in harmful algal blooms in the region means there is a need to determine whether this produce is a possible source of human exposure to microcystin, how that contamination occurs, and how it could best be prevented.

So far, researchers at The Ohio State University have examined microcystin concentrations in lettuce, tomatoes and carrots watered both above- and below-ground. Preliminary results show that all three vegetables had low levels of microcystin in their tissues, but that concentrations varied depending on irrigation method and type of vegetable: some crops watered from above contained more microcystin than the same crops watered near the roots, while others showed the opposite pattern. Adjusting watering methods based on this data may help reduce the occurrence of microcystin in crops destined for human consumption.

Microcystin in the water used for irrigation also slowed crop growth of all vegetables when compared to water not containing the toxin. This was especially significant in the tomato plants, and adds yet another checkmark to the long list of economic impacts stemming from harmful algal blooms.

Projects in this Focus Area

Method Development for Detecting Toxins in Biological Samples
Lead: University of Toledo

Fish Flesh and Fresh Produce as Sources of Microcystin Exposure to Humans
Lead: The Ohio State University

Evaluation of Cyanobacteria and Their Toxins in a Two-Staged Model of Hepatocarcinogenesis
Lead: The Ohio State University

Water containing microcystin

SLOWS CROP GROWTH

compared to toxin-free water.

Engage Stakeholders

All the research in the world won't be able to solve the harmful algal bloom problem if results and recommendations aren't passed on to the people who need them. Researchers in this focus area are developing ways to disseminate information more effectively, by establishing how information moves through existing networks of people and using those networks – such as Extension and farmer partnerships – to distribute new information about harmful algal blooms.

Sampling Networks Involve Farmers Right From the Start

Fifty-six farmers in the western Lake Erie basin are working with HABRI researchers to collect data about their own fields and the effects that their cropping, irrigation, and soil management practices have on downstream factors like nutrient runoff. Led by Ohio State Extension, these farmers collected information about conditions in 80 fields throughout the 2015 field season with more expected to join in 2016.

While the farmers' data will be used to better understand the effects of variables such as farm practices, climate, and soil type on the development of downstream harmful algal blooms, the farmers' participation allows for tight feedback loops that can inform their choices directly as they make business and land stewardship decisions.

Ultimately, the information can be used to test model predictions, ensuring that watershed managers, state agencies and legislators to have the most current information when making decisions about how best to deal with freshwater harmful algal blooms without negatively impacting other economic sectors such as agriculture.

Projects in this Focus Area

Maumee Basin Lake Erie HABs Nutrient Management Options Comparative Analysis
Lead: The Ohio State University

Farmer/Farm Advisor Water Quality Sampling Network
Lead: The Ohio State University

Maumee Basin Lake Erie HABs Stakeholder Informed Decision-Making Support System
Lead: University of Toledo

Social Network Analysis of Lake Erie HABs Stakeholder Groups
Lead: Kent State University

56 farmers

in western Lake Erie are providing **nutrient and weather data from 80 fields** to researchers studying Lake Erie algal blooms.

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