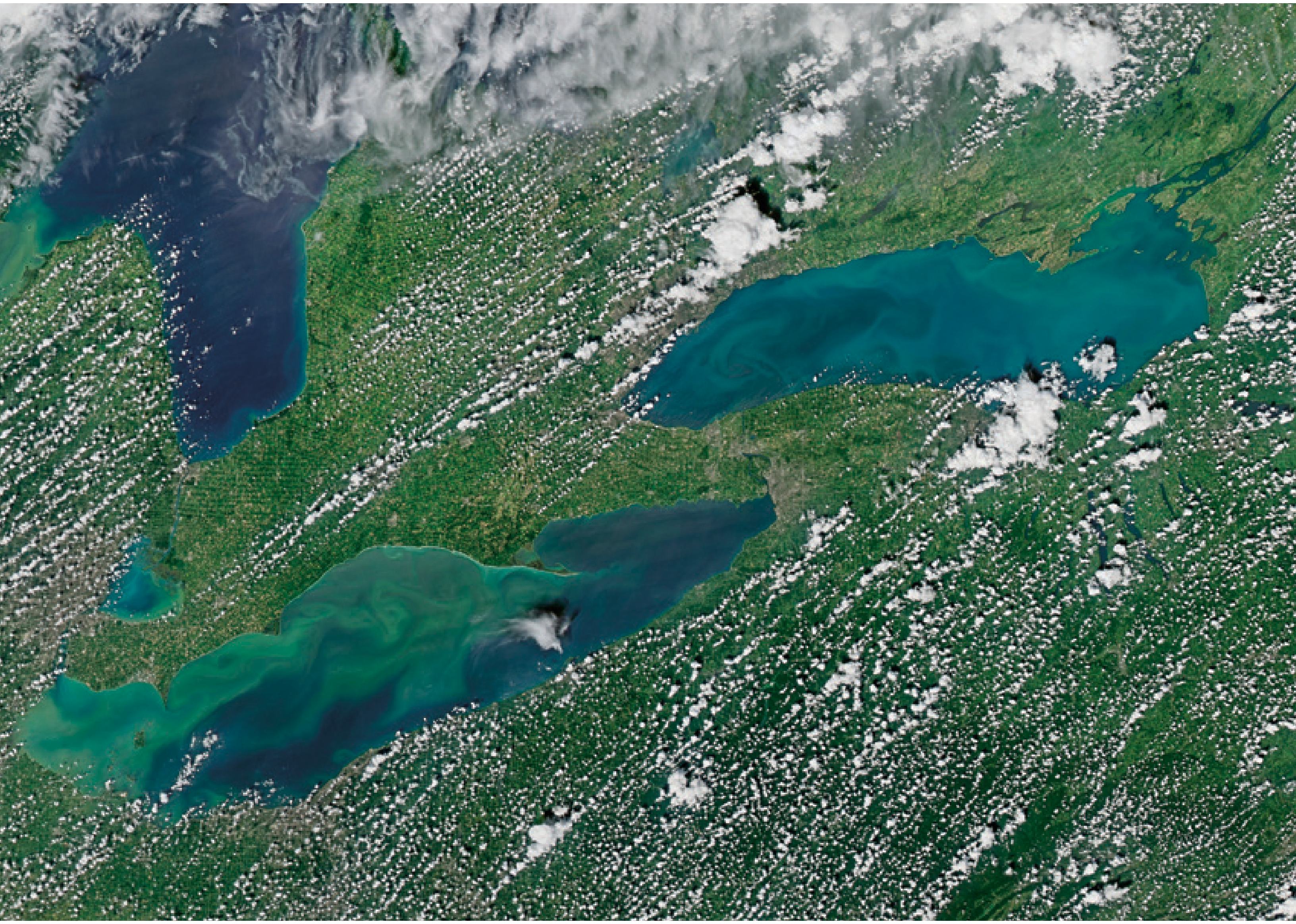
2025

HARMFUL ALGAL BLOOM

RESEARCH INITIATIVE

PROJECT UPDATE

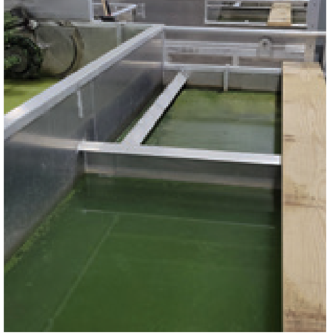


Track Blooms From the Source

Produce Safe Drinking Water

Protect Public Health

Engage Stakeholders



HARMFUL ALGAL BLOOM

RESEARCH INITIATIVE

PROJECT UPDATE | DECEMBER 2025

Toledo's drinking water ban in August 2014 was a wake-up call to the state and the nation. Harmful algal blooms (HABs), which result from spring storms, summer temperatures and nutrient-rich water flowing into bodies such as Lake Erie, are a persistent and increasing issue that impacts communities all over the world. The challenge is, we still don't know exactly what kind of risks the blooms might present, how to fully prevent them and the best ways to protect people and watersheds. So Ohio's HABRI science teams are on the case: working with front-line health, environmental and agricultural agencies to bring them the answers they need to get the state — and region — out ahead of HABs.

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Ohio Lake Erie Commission

Joy Mulinex, Executive Director

Sandra Kosek-Sills, Environmental Specialist

Introduction

Ohio's Harmful Algal Bloom Research Initiative (HABRI) is a statewide response to the threat of harmful algal blooms. The initiative arose out of the 2014 Toledo drinking water crisis, where elevated levels of the algal toxin microcystin in Lake Erie threatened drinking water for more than 500,000 people in northwest Ohio. To better position the state to prevent and manage future algal water quality issues, the chancellor of Ohio's Department of Higher Education (ODHE) worked with representatives from Ohio's universities to solicit research projects that address critical needs and knowledge gaps identified by state agencies at the front lines of water quality crises.

ODHE, since 2015, has funded applied research at numerous Ohio universities to put answers in the hands of those who need them ahead of future harmful algal blooms. The initiative has launched a new round of agency-directed research each year, with the first round of projects completed in spring 2017. The Ohio Department of Higher Education has funded all the research, with matching funds contributed by participating universities.

TIME SPAN	NUMBER OF PROJECTS	STATUS	RESULTS	FUNDING AMOUNT (before 1:1 match by universities)	FUNDING SOURCE
2015-2017 (FY15)	19	Complete	2017 Report	$2 Million	ODHE
2016-2018 (FY16)	14	Complete	2019 Report	$2 Million	ODHE
2018-2020 (FY17&18)	21	Complete	2021 Report	$4.5 Million	ODHE and OEPA
2019-2021 (FY19)	12	Complete	2024 Report	$2 Million	ODHE
2021-2024 (FY20&21)	19	Complete	2024 Report	$4 Million	ODHE
2022-2024 (FY22&23)	12	Complete	2025 Report	$5 Million	ODHE
2024-2026 (FY24&25)	17	In Progress	2025 Report	$5 Million	ODHE

We're All Over the Map

Science teams are made up of faculty and students from 15 Ohio universities, spanning the state with water monitoring networks, shared sample analysis and collaborative testing of drinking water treatment options. The teams are also all over the map in terms of expertise — from engineering to medicine to economics — and that's by design. Harmful algal blooms (HABs) have many causes, many impacts and many avenues for smart prevention and management.

HABRI Universities

The initiative arose out of the 2014

TOLEDO DRINKING WATER CRISIS

when elevated levels of the algal toxin microcystin in Lake Erie **threatened drinking water for over**

500,000

people in northwest Ohio.

"HABRI research projects continue to inform us about the effectiveness of actions included in Ohio's Domestic Action Plan and to help the state improve our understanding of nutrient reductions from the H2Ohio work being implemented."

— **Joy Mulinex**, Executive Director, Ohio Lake Erie Commission on behalf of Ohio Department of Natural Resources, Ohio Environmental Protection Agency and Ohio Department of Agriculture

Breaking It Down

High-quality research — even driven by urgent needs — takes time. So HABRI divided the major research questions into bite-sized chunks for science teams to turn around in two years or less. Keeping in mind the four focus areas, the first group of projects, launched in 2015, tackled the entire range of open questions — from upstream nutrient movement in tributaries and algal bloom dynamics to water treatment and public health risks. A fifth and sixth cohort of teams is reporting their results this year, and a seventh cohort just got started on more projects, building on what we've learned and continuing to drive toward solutions that will better prepare Ohio for the next crisis.

Contributing to the National and Global HABs Dialogue

With HABRI, Ohio has created a research and outreach framework that other states can use to help solve statewide environmental issues. As part of that effort, Ohio's university research teams are also capturing their work in the form of publications for peer review, conference and public presentations, patents and policy briefs. These products, which contribute to efforts such as the World Health Organization developing health guidelines for algal toxins, help to position Ohio as an emerging leader in providing actionable data and systems solutions to this globally relevant threat.

Are We Better Prepared Now?

Unfortunately, harmful algal blooms arise every summer in Lake Erie and in many other lakes, rivers and reservoirs. ODHE launched HABRI to get Ohio ahead of the problem and to prevent another drinking water advisory. HABRI efforts have already yielded results:

- The Ohio EPA, with HABRI support and researchers, are working directly with water treatment plant operators to optimize removal of cyanotoxins.
- Several HABRI projects have helped Ohio EPA understand the nature of how nutrients move from the working landscape to streams and, ultimately, Lake Erie. This allows us to better plan for and support nutrient reduction implementation actions.
- Researchers at Bowling Green State University and The Ohio State University are collaborating with Ohio EPA and local farmers to evaluate the beneficial use of dredge materials to amend agricultural soils. This research is providing information for stakeholders on the impact of dredge sediment on soil properties and economic feasibility of beneficial use for agriculture.
- HABRI research has demonstrated that Drinking Water Treatment Material (DWTM) effectively binds phosphorus. Based on the results of the research, Ohio EPA is working with stakeholders to explore new and innovative reuse opportunities to utilize the materials to improve water quality.
- A HABRI-supported review of human health data repositories by researchers has enhanced the Ohio Department of Health's understanding of HAB susceptibility by identifying several potential risk factors, including respiratory illness, smoking, and diabetes, that may influence future health recommendations.
- New information regarding nutrient loss pathways, as well as losses from nutrient application activities and losses from residual soil phosphorus, is helping the Ohio Department of Agriculture adjust program practices and specifications to better address nutrient loss from row crop agriculture. Additionally, recent projects studying farmland water management practices are providing valuable insight into their nutrient capture potential.
- Working directly with the academic research community, through the ODHE HABRI, the Ohio Department of Natural Resources is able to more deeply explore the mechanisms that are driving the water quality impacts of its wetland restoration program. The program now has a sharper understanding of the results of its work and better tools to use as it strengthens the effect of natural infrastructure restoration in the battle against harmful algae blooms in Ohio's waterways.
- In partnership with the Ohio Department of Health, with support from HABRI, researchers are working to improve the dissemination of health education on HABs to current and future physicians. More evidence-based HAB education will aid physicians in swiftly diagnosing, treating, and reporting HAB-related illnesses, improving overall state response to HAB events.

HABRI: What We Do

So far, 62 scientists leading 114 research projects around the state of Ohio are hard at work getting answers about harmful algal blooms that will directly help state agencies prevent and manage future HABs-related issues and will position Ohio as a leader in understanding this emerging global threat. HABRI teams work under four basic mandates:

FOCUS AREA	CHALLENGE	CRITICAL NEEDS OR KNOWLEDGE GAPS IDENTIFIED BY AGENCIES*
Track Blooms From the Source	Algal blooms are not necessarily "harmful" unless they contain certain algae species and have the right mix of conditions to make toxins such as microcystin. With standard detection methods, public health officials may have to wait for hours or even days to confirm whether blooms are toxic and how they are growing and moving in the water body.	• Rapid determination of whether blooms are toxic and where toxins are moving (even apart from the main algae mass) • Prediction capability for the location and severity of blooms, even months ahead of time • The ability to track nutrients and stormwater upstream and correlate them with particular sources, storm events and algal bloom characteristics • Assessment of bloom and toxin locations within the vertical water column
Produce Safe Drinking Water	When pollutants end up in the water source for a city, water treatment officials need to know what they're dealing with and how best to clear them out of the water. But toxins from harmful algal blooms present a relatively new challenge globally, and the detection and treatment protocols are not mature.	• Laboratory testing of water treatment methods that give treatment facilities effective and cost-efficient options for clearing out algal toxins using their current infrastructure • Development of new, innovative techniques for producing safe drinking water
Protect Public Health	Algal toxins such as microcystin are known to have risks for humans and animals under certain circumstances. But the laboratory studies needed to make public health guidelines have not yet been updated and tailored for the more severe, persistent algal blooms we're seeing in Lake Erie and other freshwater sources around the world.	• New laboratory methods to detect the presence of algal toxins and their byproducts in living tissue such as blood • Laboratory studies on the effects of algal toxins at the cellular level and beyond • Testing of fish from affected water bodies to aid officials in advising anglers
Engage Stakeholders	Effective crisis prevention and management involves many different types of people who need to be connected — ahead of time. The Toledo water quality crisis provided a galvanizing event that revealed the need for closer ties among scientists, agencies, municipalities and landowners.	• Establishment of connections between various land management practices upstream and nutrient flows downstream

**A full list of agency priorities is available at go.osu.edu/habri*

2025

HARMFUL ALGAL BLOOM FOCUS AREAS

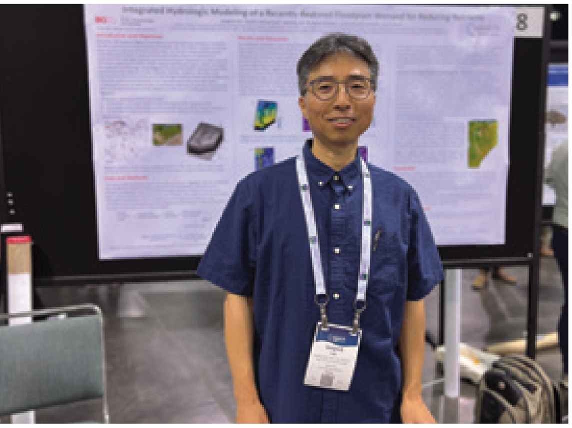
PROJECT UPDATE

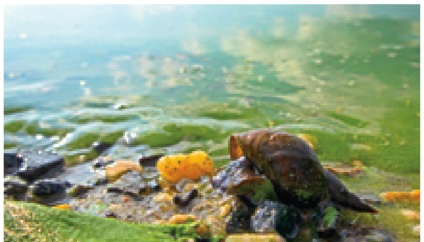
Track Blooms From the Source

Produce Safe Drinking Water

Protect Public Health

Engage Stakeholders





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 ensure drinking water is safe and the environment is healthy for lakeshore residents by 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, to what makes them produce toxins in the first place.

Monitoring tributaries for nutrients that cause algal blooms

Early warning systems for bloom activity

Understanding blooms better for smarter management

Projects in this Focus Area

Evaluating the effect of colloidal-phosphorus on phosphorus exports, bioavailability and transformations from the edge-of-field to Lake Erie
James Hood, The Ohio State University

Translating wetland monitoring to better restoration and management: development of a novel simulation-optimization tool for nutrient reduction wetlands
Ganming Liu, Bowling Green State University

Tracking reductions in nutrient loads from Lake Erie tributaries
Nathan Manning, Heidelberg University

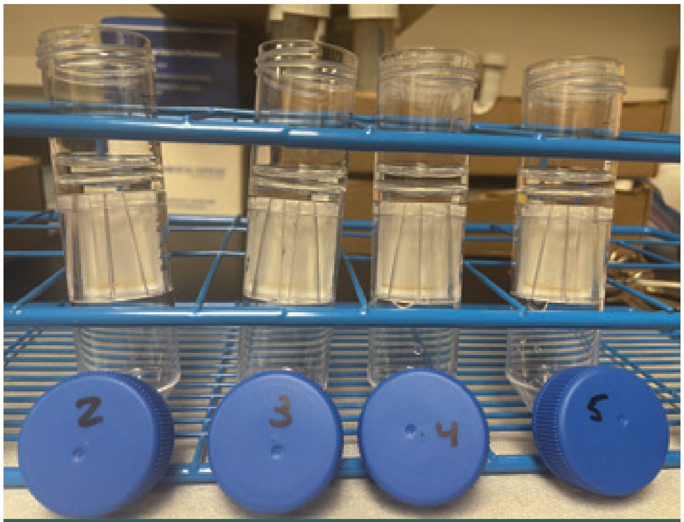
Evaluating the dynamics of legacy fields: nutrients and effectiveness of conservation practices under future climate at field to watershed scales in the Maumee River watershed
Asmita Murumkar and Jay Martin,
The Ohio State University

Do Natural Colloid Particles Disrupt Harmful Algal Bloom Management?

Scientists know that phosphorus flowing into Lake Erie in its dissolved form, which is available to be taken up by organisms, drives harmful algal blooms. However, a 2019 study found that phosphorus bound to small, natural particles called colloids could make up half of “dissolved” reactive phosphorus, or DRP. Colloids are extremely small — 1 to 450 nanometers, which are a billionth of a meter — and differ widely in their chemical composition. Notably, compared to dissolved phosphorus, colloidal phosphorus often has lower bioavailability, meaning it may not be as readily available to support algal growth. If colloidal phosphorus accounts for a large fraction of dissolved phosphorus being measured by scientists, then this lack of understanding likely impedes how they monitor phosphorus loading and manage harmful blooms on Lake Erie.

In response, a team of researchers led by Dr. James Hood of The Ohio State University aimed to find out how much colloidal phosphorus contributes to dissolved phosphorus loads and how bioavailable it is. Their project sought to better understand the source, composition, and chemical and ecological reactions involving colloidal phosphorus in waters ranging from agricultural edge-of-field sites to wetlands and rivers to Lake Erie. Specifically, the team measured the concentration of colloidal phosphorus and planned to determine how rapidly it was being created or lost within the streams and rivers flowing into Lake Erie. They also planned to use algal assays to determine the bioavailability of colloidal-DRP in Lake Erie.

After the first year of sampling, however, researchers found that colloidal-DRP concentrations were much lower than expected, so the team switched gears and focused mostly on 1) determining whether colloidal phosphorus was ever a large portion of DRP in the Lake Erie watershed, 2) the bioavailability of colloidal phosphorus, and 3) why previous studies had found high concentrations of colloidal phosphorus. Researchers conducted a survey of Lake Erie tributaries focusing on high flow events, which have been shown to carry the highest colloidal phosphorus concentrations. They also conducted several experiments focusing on understanding how freezing, a technique used to preserve samples in previous studies, influenced colloidal-DRP concentrations.

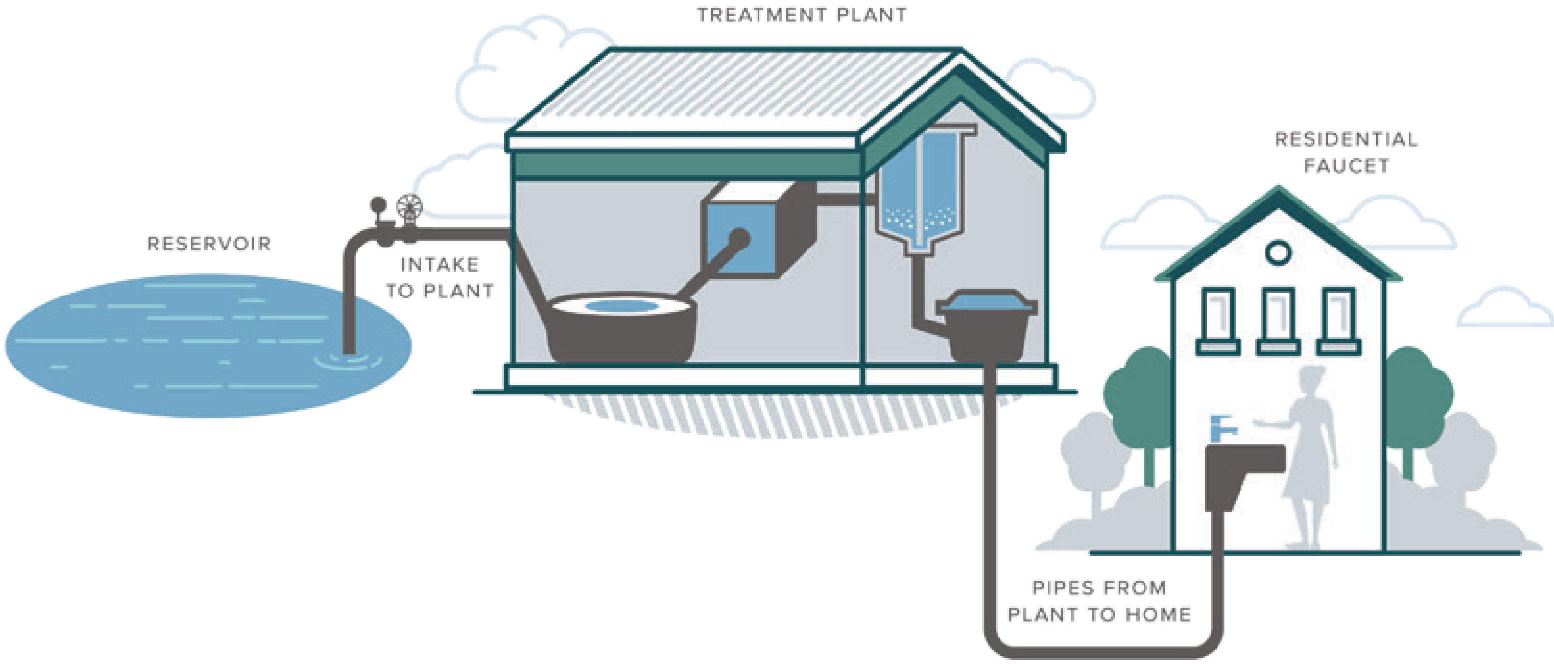


A water sample that researchers collected from Blue Creek in northwest Ohio during a high flow event to study colloidal phosphorus concentrations. Colloids are tiny, natural particles that differ widely in chemical composition.

Ultimately, the study showed that colloidal-DRP concentrations and loading to Lake Erie were relatively low. Lake Erie managers currently operate on the understanding that loading of DRP, which is nearly 100% bioavailable, into the Maumee River is the main cause of harmful algal blooms. If results had shown that most of the DRP loading was associated with colloids, which are likely not as bioavailable, then the way scientists monitor, forecast, and manage Lake Erie HABs might have needed to be modified, causing an expensive disruption to management efforts. Instead, based on the study’s findings, the team recommends that colloidal phosphorus does not need to be monitored or managed. Researchers also found that freezing alters colloidal phosphorus concentrations and are preparing a paper that would recommend against freezing colloidal-DRP samples.

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 algal drinking water crises like this one, 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.



Projects in this Focus Area

Impacts of low UV wavelengths on cyanobacteria and cyanotoxins in drinking and natural water treatment
Natalie Hull, The Ohio State University

Can UV Light Exposure Treat Harmful Algal Blooms?

Toxin-producing harmful algal blooms or cyanobacteria present a human health concern for Great Lakes communities due to potential impacts on drinking water. Scientists have studied how to improve water treatment strategies to account for these cyanotoxins, yet each method presents tradeoffs. In search of a treatment tool without tradeoffs, researchers are studying a new technique: exposing harmful algal blooms to UV light. Previous studies have shown that harmful bacteria and toxins can absorb certain wavelengths of UV light, and such exposure can potentially "photolyze," or degrade them. However, further investigation of the method's effectiveness was needed.

A team of researchers led by Dr. Natalie Hull of The Ohio State University hypothesized that exposure to UV light near wavelengths of 222 nanometers showed greater promise in treating and degrading algal toxins compared to wavelengths near 254 nanometers, used in previous studies. This method could potentially improve both treatment effectiveness and energy efficiency. Researchers aimed to understand if UV light would cause toxins to degrade and whether such light exposure would cause cells to produce or release more or fewer toxins. These factors are important considerations in water treatment to ensure communities are provided with safe drinking water.

For the UV experiments, researchers collected samples of several different algal toxins found in bodies of Ohio freshwater: microcystin, anatoxin, cylindrospermopsin, and saxitoxin. Here, samples were taken from Grand Lake St. Marys in northwest Ohio.

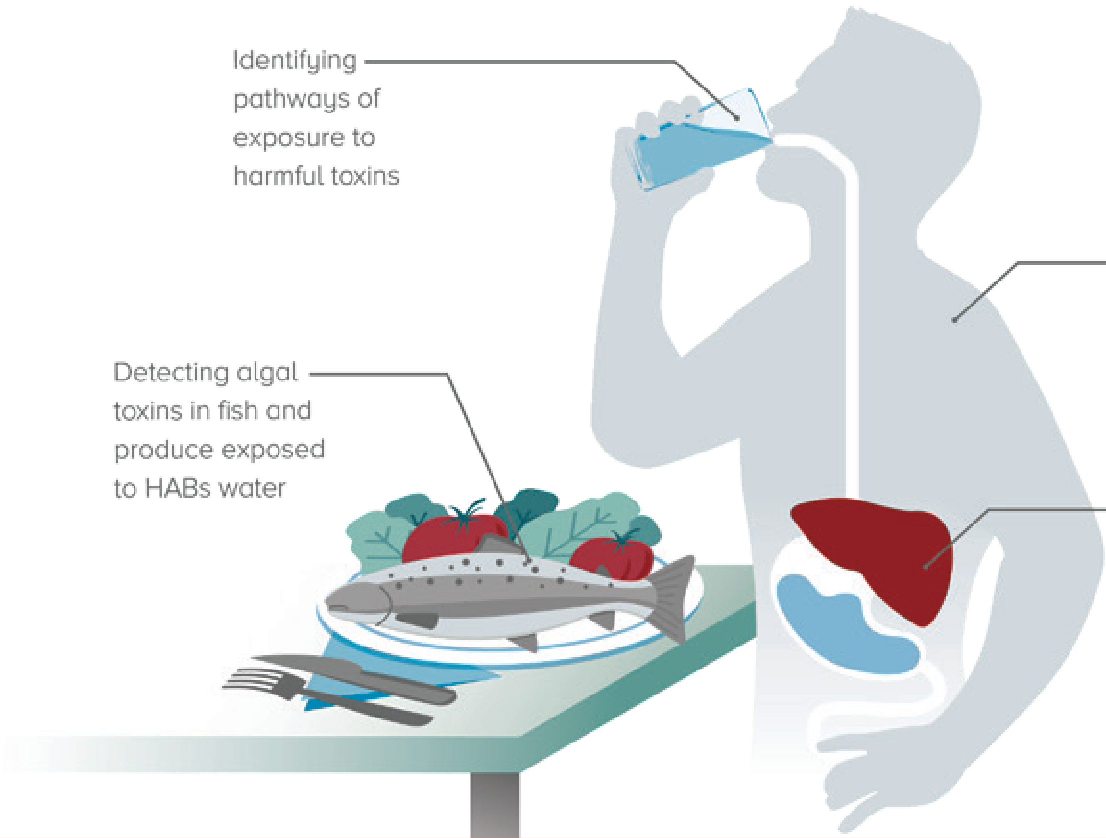
Through the project, the team exposed four different toxins and four different cyanobacteria to two lamps emitting either 222- or 254-nanometer wavelength UV light. Toxins included common varieties found in bodies of Ohio freshwater: microcystin, anatoxin, cylindrospermopsin, and saxitoxin. After light exposure, all four toxins were measured using a fairly standard lab test (enzyme-linked immunosorbent assay, or ELISA), and all four cyanobacteria were measured for specific parameters. For the potent toxin microcystin, researchers took additional, high-resolution measurements (chromatography and spectroscopy) to make further predictions about degradation.

This work found that microcystin was more effectively broken down by UV than the other three toxins. Further, results showed that the impact of UV on cyanobacteria is dependent on bacteria strain, UV wavelength, and dose — or the amount of energy absorbed. The 222-nanometer lamp was observed to be 2.4 to 4.2 times more effective at degrading microcystin and resulted in lower toxic activity than exposure to the 254-nanometer lamp. Some microcystin molecules were found to further degrade at a higher UV dose — measured in millijoules per square centimeter — under exposure, especially to 222-nanometer wavelength light, while others persisted. The impact of UV on cyanobacteria was measured to be dependent on the wavelength and dose the cells were exposed to.

These insights will help inform water treatment plants that UV treatment is beneficial to implement when microcystin is present, but additional consideration may need to be made for other toxins and different cyanobacteria. One such consideration is the use of an advanced oxidation process which can increase the degradation of toxins such as anatoxin, researchers suggested. The project also allowed for collaboration with the U.S. Geological Survey to measure toxin concentrations.

Protect Public Health

While safe drinking water is a major focus for public health officials and researchers, scientists are also working to determine other ways that harmful algal blooms and the associated toxins — in particular microcystin — may impact human health. In this focus area, science teams develop techniques to better detect toxins in biological samples, study the effects of algal toxins on various types of cells and determine the significance of the different ways that people might be exposed to algal toxins — physical contact, eating fish, etc. These studies aim to assist agencies as they develop guidelines for handling harmful algal blooms in coming years.



Projects in this Focus Area

Development of evidence-based strategies to improve harmful algal bloom health education and outcomes
David Kennedy and Steven Haller, The University of Toledo

Helping People Understand the Health Risks of Harmful Algal Blooms

Harmful algal blooms (HABs) in Lake Erie and other water bodies have the ability to produce toxins that could contaminate air, via aerosolized water droplets, and drinking water, posing a growing public health risk. Prior to this project, many healthcare providers and community members were unfamiliar with the potential health implications of HAB exposure. In response, a team of researchers led by Drs. David Kennedy and Steven Haller of The University of Toledo aimed to bridge this gap by generating evidence-based insights and translating their findings into practical education for healthcare professionals and the public. Their goal was to learn who might get sick from HAB toxins, why it happens, and how to prevent or treat it – then share this knowledge widely to health professionals wanting this information.

To tackle these questions, the team combined data analysis with on-the-ground clinical insights and educational outreach. Researchers leveraged large-scale health datasets, including a database of U.S. emergency room visits and global biomedical gene expression databases, to identify patterns in HAB-related illnesses.

The research yielded several important findings about HAB-related health risks. Large-scale analysis confirmed that respiratory exposure to algal toxins is a real concern — many patients reported breathing problems after bloom exposure, and a striking number were smokers. Together with the gene database analysis, this suggests that people with lung conditions are at a greater risk of elevated effects from algal toxins. The team also identified other potential susceptibility factors, such as diabetes for liver effects, that had not been well recognized before. Furthermore, researchers uncovered a biological explanation for these risk factors: chronic lung inflammation may increase the expression of toxin transporter proteins in the lungs, essentially creating a bigger "welcome mat" for microcystin toxins.

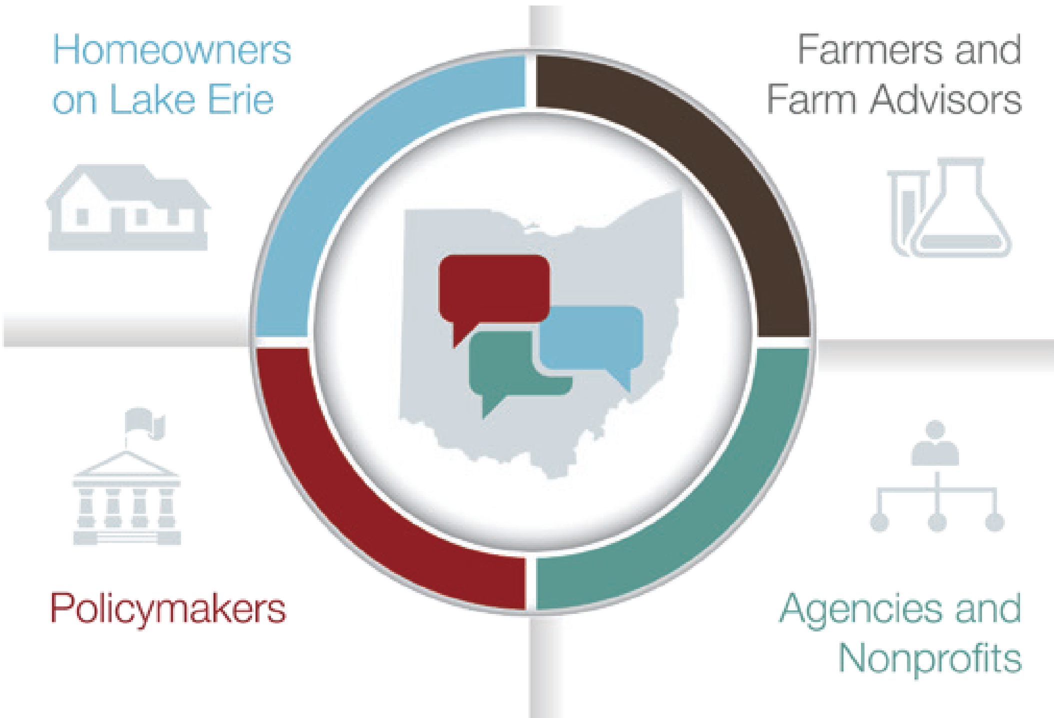
In gathering real-world clinical evidence, Kennedy and Haller compiled a series of challenging patient cases involving suspected HAB toxin illnesses in northwest Ohio. The team documented how these patients presented and were diagnosed and managed, then shared these lessons with the broader medical community. This resulted in a peer-reviewed publication that is one of the largest case studies on human HAB exposures to date. By documenting clinical cases and publishing them, these researchers have been able to disseminate evidence-based guidelines on HAB illness. For example, the case study gives other doctors reference points on what toxin exposure looks like in children, how to differentiate it from more common illnesses, and what steps to take. This is a building block for future official guidelines on HAB exposure management.

These findings not only advanced scientific knowledge but also informed the educational materials and interventions the team produced for the project. Researchers used surveys and focus group discussions with medical students, residents, and practicing doctors to fully understand that many providers lack awareness of HAB health risks or feel ill-equipped to address them. Additionally, they also discovered that HAB exposure incidents that are reported at urgent cares may be underreported. To help overcome these barriers, the team developed a suite of educational tools and programs tailored to healthcare providers' needs as well as resources for the public. Materials included educational videos, a podcast, medical curriculum modules, health policy templates, and public health briefings. These solutions were designed to be accessible, engaging, and directly relevant to clinical practice.

Using surveys and focus group discussions with medical students, residents, and practicing doctors, the team worked to better understand people's awareness of harmful algal bloom health risks.

Engage Stakeholders

Complex issues like harmful algal blooms have many causes and many impacts, which means many different people have perspectives and roles to play in finding solutions. Researchers in this focus area are figuring out how information moves through existing networks of people and how to best use those networks — such as OSU Extension and farmer partnerships — to create effective collaborations to tackle harmful algal blooms.



Projects in this Focus Area

Beneficial use of byproducts to reduce phosphorus loss from agricultural land
Nicholas Basta, The Ohio State University

Innovations in geospatial technologies to identify agricultural and roadside buffers for enhanced nutrient trapping
Kevin Czajkowski, The University of Toledo

Understanding the performance of cascading waterways in Ohio agricultural landscapes
Steve Lyon, The Ohio State University

A decision support tool to optimize engineered drain design for rural on-site wastewater and urban stormwater treatment systems
Vinayak Shedekar, The Ohio State University

Assessing dissolved reactive phosphorus sequestration onto farm soils amended with Lake Erie dredged sediments: implications on hydrological budgets and HAB occurrences
Angelica Vazquez-Ortega, Bowling Green State University

Do conservation channel designs deliver an effective last-ditch defense against downstream phosphorus impairment?
Jon Witter, The Ohio State University

Can Dredged Sediments Benefit Crops and Mitigate Algal Blooms?

Each year, the state of Ohio dredges approximately 1.5 million tons of sediments from its Lake Erie ports to keep federal navigation channels clear for ships. This dredged material is made up of loose sand, clay, silt, and gravel from the bottom of water bodies. The majority of dredging on the lake occurs at the Port of Toledo, which has particularly high sedimentation. In past decades, harbors would dispose of their dredged material by dumping it in the open lake. In 2020, however, Ohio banned open water disposal of dredged sediments in an effort to improve water quality and reduce annual algal blooms. Currently, dredged sediments from Toledo Harbor are stored in a confined facility — with a limited capacity of 10 years — and the state is looking for beneficial uses for this material.

In response to this need, a team of researchers led by Dr. Angelica Vazquez-Ortega of Bowling Green State University investigated the viability of using dredged material as an agricultural farm soil amendment. Researchers reasoned that applying sediment to farm fields would return nutrients that were exported from the Maumee River watershed into Lake Erie. They also proposed that such soil amendments could help replace eroded topsoil, benefit crop yields, reduce phosphorus export, and potentially reduce harmful algal bloom severity. Further, proving that dredged materials are beneficial for soil health and crop yields might motivate farmers to adopt this resource and practice.

Through the project, the team developed a demonstration farm to test soil health, agronomic productivity, and the potential environmental effects of this beneficial use. On the farm, one area received dredged materials while another did not, serving as a control. During the experiment, researchers also took into consideration compaction exerted by heavy machinery used to spread the dredged material. To track success, researchers also installed a system to monitor the export of nutrients in both surface and subsurface runoff from field edges.

Results showed that amending farm soil with dredged materials improved the soil's chemical health — such as an increase in soil organic matter and available phosphate to help plants grow. In comparing areas with and without compaction, researchers found no difference in soybean yield but lower corn yield in fields that had no dredged material applied. However, in fields with soil amendment, yields were the same regardless of compaction. From this, researchers concluded that adding dredged material doesn't affect the yield of cash crops negatively. Notably, the study found no preferential accumulation of heavy metals in corn crops applied with dredged sediment when compared to 100% farm soil. Analysis of data from the edge-of-field monitoring system is still ongoing, with more results to come.

Researchers developed a demonstration farm to test soil health, agronomic productivity, and the potential environmental effects of applying dredged sediment to farm fields. The study found that amending farm soil with dredged materials from Lake Erie improved the soil's chemical health with no preferential accumulation of heavy metals.

2025

PROJECT UPDATE

HARMFUL ALGAL BLOOM RESEARCH PROJECTS

Track Blooms From the Source

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RESEARCH PROJECTS TABLE OF CONTENTS

Research Project Summaries

Ongoing Research Project Briefs

Do Natural Colloid Particles Disrupt Harmful Algal Bloom Management?

RESEARCH PROJECT TITLE:

Evaluating the effect of colloidal-phosphorus on phosphorus exports, bioavailability and transformations from the edge-of-field to Lake Erie

Principal Investigator: James Hood, The Ohio State University

PROJECT SUMMARY

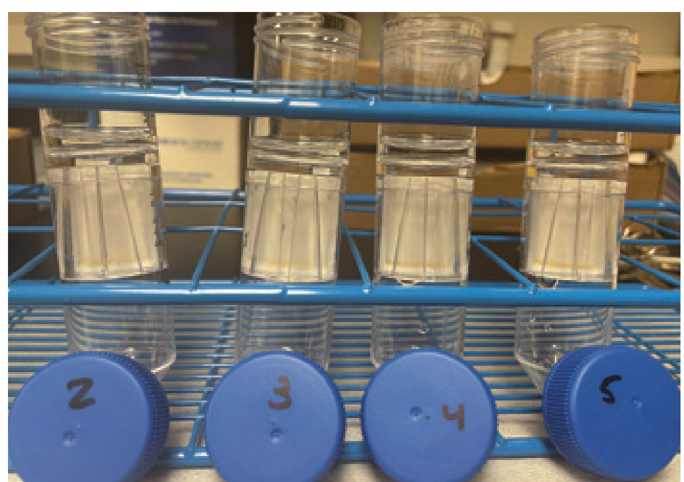
Scientists know that phosphorus flowing into Lake Erie in its dissolved form, which is available to be taken up by organisms, drives harmful algal blooms. However, a 2019 study found that phosphorus bound to small, natural particles called colloids could make up half of "dissolved" reactive phosphorus, or DRP. Notably, compared to dissolved phosphorus, colloidal phosphorus often has lower bioavailability, meaning it may not be as readily available to support algal growth. If colloidal phosphorus accounts for a large fraction of dissolved phosphorus being measured by scientists, then this lack of understanding likely impedes algal bloom monitoring and management on Lake Erie.

In response, researchers aimed to find out how much colloidal phosphorus contributes to dissolved phosphorus loads and how bioavailable it is. Their project sought to better understand the source, composition, and chemical and ecological reactions involving colloidal phosphorus in waters ranging from agricultural edge-of-field sites to wetlands and rivers to Lake Erie.

After the first year of sampling, however, researchers found that colloidal-DRP concentrations were much lower than expected, so the team switched gears and focused mostly on 1) determining whether colloidal phosphorus was ever a large portion of DRP in the Lake Erie watershed, 2) the bioavailability of colloidal phosphorus, and 3) why previous studies had found high concentrations of colloidal phosphorus. Researchers conducted a survey of Lake Erie tributaries focusing on high flow events as well as several experiments focusing on understanding the influence of freezing as a preservation technique.

Ultimately, the study showed that colloidal-DRP concentrations and loading to Lake Erie were relatively low. Lake Erie managers currently operate on the understanding that loading of DRP, which is nearly 100% bioavailable, into the Maumee River is the main cause of harmful algal blooms. If results had shown that most of the DRP loading was associated with colloids, which are likely not as bioavailable, then the way scientists monitor, forecast, and manage Lake Erie HABs might have needed to be modified, causing an expensive disruption to management efforts. Instead, based on the study's findings, the team recommends that colloidal phosphorus does not need to be monitored or managed.

THE BOTTOM LINE: In response to a study, scientists confirmed that concentrations of colloidal phosphorus are relatively low, and the tiny particles do not need to be monitored or managed.



Filtered water samples collected from the Auglaize River in northwest Ohio. Through analyzing these samples, researchers found that colloidal phosphorus concentrations and loading to Lake Erie were relatively low.

Optimizing Wetlands to Reduce Nutrient Runoff

RESEARCH PROJECT TITLE:

Translating wetland monitoring to better restoration and management: development of a novel simulation-optimization tool for nutrient reduction wetlands

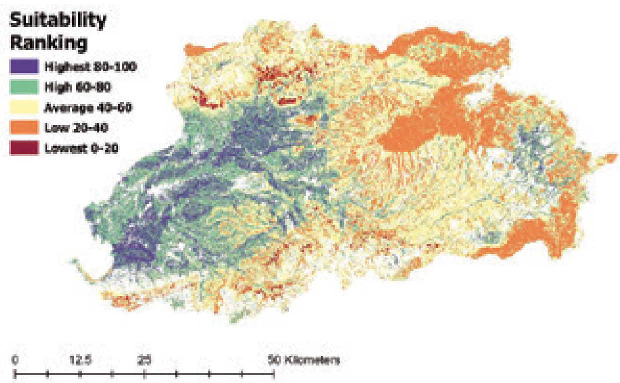
Principal Investigator: Ganming Liu, Bowling Green State University

PROJECT SUMMARY

Wetlands have the potential to improve water quality and prevent nutrients from entering downstream and potentially vulnerable surface-water bodies — such as lakes, rivers, and estuaries. In the context of the Western Basin of Lake Erie, specifically the Maumee River Basin, wetlands could prevent nutrients like phosphorus and nitrogen from contributing to the formation of harmful algal blooms. However, wetland ecosystems are inherently heterogeneous, and their nutrient-reduction ability varies broadly across wetland types, designs, hydrological regimes, site locations, soil characteristics, and plant communities. While interest in applying modeling approaches to optimize wetland restoration has increased in recent years, knowledge is still limited. Scientists need more information about which wetland designs and hydrologic management would yield better nutrient-reduction efficiency.

The goal of this project was to explore optimal nutrient-reduction in wetlands using an innovative approach that integrates 3D modeling and on-site monitoring. Specifically, researchers created 3D hydrologic models to simulate flow and nutrient transport in two representative H2Ohio wetland project sites in northwest Ohio: the Forder Bridge Floodplain Reconnection Wetland in Paulding County and Oakwoods Nature Preserve in Findlay.

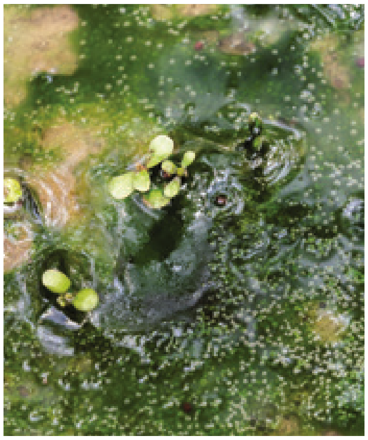
The 3D model was driven by weather data, topography, and other conditions that often impact the flow of water into and through wetlands. This model then simulated surface water flows, groundwater flows, and nutrient transport within the wetlands. The team enhanced the model to simulate various hydrologic scenarios and settings. They also developed a multi-criteria evaluation approach to quickly assess and identify lands that are suitable for restoration projects, and the approach was successfully tested in a northwest Ohio watershed.



Researchers created 3D hydrologic models to simulate flow and nutrient transport in two representative H2Ohio wetland project sites in northwest Ohio. Here, they mapped and ranked the suitability of watersheds for future restoration projects.

Researchers were able to use the model to provide managers with valuable suggestions and insights for better wetland management and restoration. Results from model simulations suggest that wetlands' nutrient-reduction efficiency can be improved by applying some economical but effective strategies, such as enhancing hydrologic connectivity among wetland pools, diverting more nutrient-rich water to "idle" depressional pools, and increasing residence time (the duration that water stays in a wetland) by preventing short-term backflow from the water source. Notably, the project's products could save agencies time and money through more effective wetland design.

THE BOTTOM LINE: Researchers used 3D modeling and on-site monitoring to study which wetland restoration approaches are better at reducing nutrients. Results yielded valuable insights that will be able to inform future wetland design and management.



Improving Nutrient Monitoring in the Lake Erie Watershed

RESEARCH PROJECT TITLE:

Tracking reductions in nutrient loads from Lake Erie tributaries

Principal Investigator: Nathan Manning, Heidelberg University

PROJECT SUMMARY

Water quality can be extremely dynamic and difficult to measure, particularly in large river systems that are likely influenced by many pollution types and sources, such as the watersheds of the western basin of Lake Erie. This watershed, thankfully, has a uniquely long-running, high-frequency, and dense network of stream and river monitoring equipment and sensors compared to anywhere else around the globe. Unfortunately, because this monitoring is conducted across multiple agencies, organizations, and laboratories across different time intervals, it can be challenging to collate this information in a useful manner to provide an up-to-date status on tributary water chemistry trends.

To better understand the different sampling regimes deployed by these partners and to show a more comprehensive picture of the state of water quality monitoring in the region, researchers aimed to develop new methods to compare data collected by these different groups. Using data from the National Center for Water Quality Research and the U.S. Geological Survey, researchers created various sampling scenarios that can be applied broadly to other sampling regimes across the region. The scenarios mimicked common sampling frequencies as well as gaps in the sampling record due to weather or funding issues.

The team compared and tested a number of different load estimator applications that are widely used and discovered that some are better under certain sampling conditions than others. Load estimators are tools that help estimate loads and inputs of various chemicals into streams and rivers. Results can be used to advise others which estimator tool to use based on their sampling model and suggest the best times to sample to yield the most accurate results. This gives scientists a better understanding of the amount of nutrients being added into the lake and allows sampling to be more efficient and cost effective.

The team is developing a new data dashboard that will be available online to explore and compare data between and within rivers that contribute to the Lake Erie Western Basin. Researchers are also sharing Maumee River trends with the Ohio Environmental Protection Agency, and they partnered with the Cleveland Water Alliance to implement several sensor networks.

THE BOTTOM LINE: Researchers studied water quality monitoring regimes used across different groups and timeframes in the Lake Erie watershed to help provide more reliable information on nutrient loading.

Where Can Conservation Practices Limit Runoff from 'Legacy' Phosphorus?

RESEARCH PROJECT TITLE:

Evaluating the dynamics of legacy fields: nutrients and effectiveness of conservation practices under future climate at field to watershed scales in the Maumee River watershed

Principal Investigators: Asmita Murumkar and Jay Martin, The Ohio State University

PROJECT SUMMARY

The Western Lake Erie Basin is experiencing elevated nutrient inputs, primarily associated with agricultural runoff, which results in harmful algal blooms, potential health risks associated with recreational exposure to algal toxins (e.g., beaches and watersports activities), and economic losses. Previous findings have shown that fields with elevated levels of phosphorus in the soil, built up from historical or "legacy" nutrient applications, are disproportionately large phosphorus polluters. Notably, at least 13% of agricultural fields in the Maumee River watershed have at least one legacy phosphorus zone. Researchers aimed to address this nutrient overload by identifying suitable locations for implementing structural best management practices (BMPs), such as drainage water management (DWM), phosphorus filters (P-filters), and wetlands. Previous research demonstrated that these conservation practices show promise, yet it's unknown how implementing this approach at a watershed scale would reduce nutrient inputs to Lake Erie.

Through the project, the team focused on fields with legacy phosphorus — phosphorus that has unintentionally built up over time. The team collaborated with the U.S. Department of Food and Agriculture (USDA) Agricultural Research Service and The University of Toledo to gain access to edge-of-field and remote sensing data. Then, using a multi-criteria decision-making approach, they evaluated locations based on soil characteristics, water flow, and phosphorus levels to determine where conservation practices would be most effective.

From the results, researchers developed a manuscript that identifies priority locations for structural best management practices, DWM, P-filters and wetland, which were suitable for 9.7%, 13.3%, and 11.6% of legacy fields, respectively. The framework directly supports state agencies, conservation planners, watershed managers, and farmers by providing a cost-effective roadmap for finding sites that maximize nutrient reduction benefits. The project demonstrated that targeting legacy phosphorus fields for BMP deployment can yield a strong return on investment in terms of phosphorus reduction.

The team studied agricultural fields with legacy phosphorus — phosphorus that was unintentionally built up over time and contributes disproportionately to phosphorus pollution.

THE BOTTOM LINE: Farm fields with "legacy" phosphorus accumulated over time disproportionally contribute nutrients to Lake Erie. Researchers developed an approach to identify priority locations for conservation practices to limit runoff.

Can UV Light Exposure Treat Harmful Algal Blooms?

RESEARCH PROJECT TITLE:

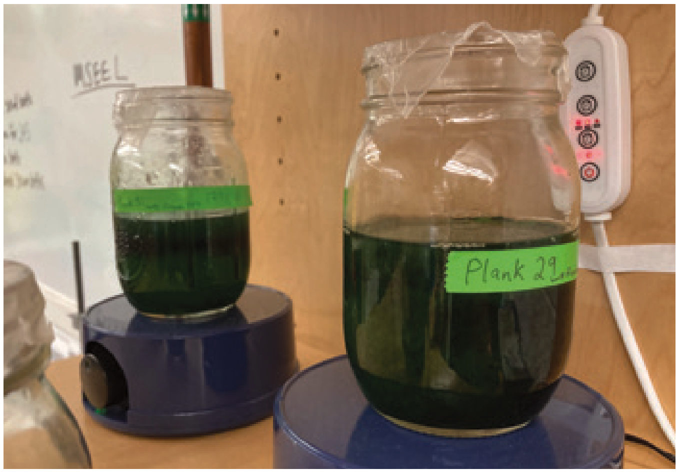
Impacts of low UV wavelengths on cyanobacteria and cyanotoxins in drinking and natural water treatment

Principal Investigator: Natalie Hull, The Ohio State University

PROJECT SUMMARY

Toxin-producing harmful algal blooms or cyanobacteria present a human health concern for Great Lakes communities due to potential impacts on drinking water. Scientists have studied how to improve water treatment strategies to account for these cyanotoxins, yet each method presents tradeoffs. In search of a treatment tool without tradeoffs, researchers are studying a new technique: exposing harmful algal blooms to UV light.

A team of researchers led by Dr. Natalie Hull of The Ohio State University hypothesized that exposure to UV light near wavelengths of 222 nanometers showed greater promise in treating and degrading algal toxins compared to wavelengths near 254 nanometers, used in previous studies. Researchers aimed to understand if UV light would cause toxins to degrade and whether such light exposure would cause cells to produce or release more or fewer toxins. These factors are important considerations in water treatment to ensure communities are provided with safe drinking water.

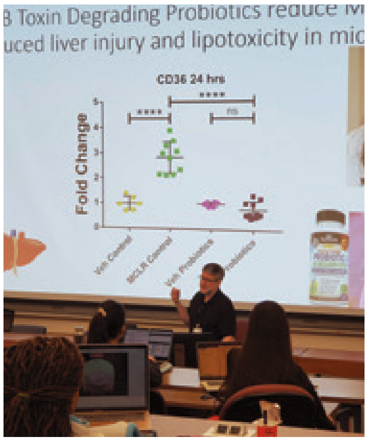


For the UV experiments, researchers collected samples of several different algal toxins found in bodies of Ohio freshwater: microcystin, anatoxin, cylindrospermopsin, and saxitoxin. Here, samples were taken from Grand Lake St. Marys in northwest Ohio.

Through the project, the team exposed four different toxins and four different cyanobacteria to two lamps emitting either 222- or 254-nanometer wavelength UV light. Toxins included common varieties found in bodies of Ohio freshwater: microcystin, anatoxin, cylindrospermopsin, and saxitoxin. After light exposure, all four toxins were measured using a fairly standard lab test (enzyme-linked immunosorbent assay, or ELISA), and all four cyanobacteria were measured for specific parameters.

This work found that microcystin was more effectively broken down by UV than the other three toxins. Further, results showed that the impact of UV on cyanobacteria is dependent on bacteria strain, UV wavelength, and dose — or the amount of energy absorbed. The 222-nanometer lamp was observed to be 2.4 to 4.2 times more effective at degrading microcystin and resulted in lower toxic activity than exposure to the 254-nanometer lamp. The impact of UV on cyanobacteria was measured to be dependent on the wavelength and dose the cells were exposed to. These insights will help inform water treatment plants that UV treatment is beneficial to implement when microcystin is present, but additional considerations may need to be made for other toxins and different cyanobacteria.

THE BOTTOM LINE: Researchers found success degrading harmful algal blooms and cyanotoxins with exposure to UV light, particularly with the potent toxin microcystin. Results are informing water treatment plants.



Helping People Understand the Health Risks of Harmful Algal Blooms

RESEARCH PROJECT TITLE:

Development of evidence-based strategies to improve harmful algal bloom health education and outcomes

Principal Investigators: Steven Haller and David Kennedy, The University of Toledo

PROJECT SUMMARY

Harmful algal blooms (HABs) in Lake Erie and other water bodies have the ability to produce toxins that could contaminate air and drinking water, posing a growing public health risk. Prior to this project, many healthcare providers and community members were unfamiliar with the potential health implications of HAB exposure. In response, researchers aimed to bridge this gap by generating evidence-based insights and translating their findings into practical education for healthcare professionals and the public.

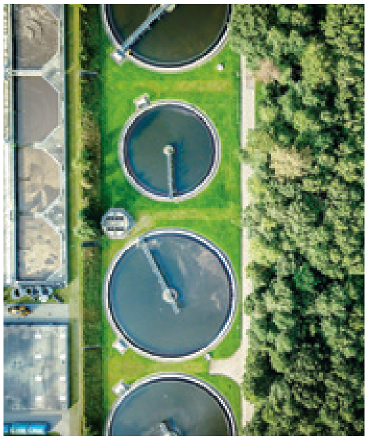
The team's goal was to learn who might get sick from HAB toxins, why it happens, and how to prevent or treat it. To tackle these questions, the team combined data analysis with on-the-ground clinical insights and educational outreach. Researchers leveraged large-scale health datasets, including a database of U.S. emergency room visits and global biomedical gene expression databases, to identify patterns in HAB-related illnesses.

The research yielded several important findings about HAB-related health risks. Analysis confirmed that respiratory exposure to algal toxins is a real concern, and people with lung conditions may be at a greater risk of elevated effects from algal toxins. The team also identified other potential susceptibility factors, such as diabetes for liver effects, that had not been well recognized before. Furthermore, researchers uncovered a biological explanation for these risk factors: chronic lung inflammation may increase the expression of toxin transporter proteins in the lungs, creating a bigger "welcome mat" for microcystin toxins.

In gathering real-world clinical evidence, the team compiled a series of challenging patient cases involving suspected HAB toxin illnesses in northwest Ohio. By documenting these cases and publishing them, researchers have been able to disseminate evidence-based guidelines on HAB illness. Their findings not only advanced scientific knowledge but also directly informed the educational materials and interventions the team produced for the project. Materials included educational videos, a podcast, medical curriculum modules, health policy templates, and public health briefings. These solutions were designed to be accessible, engaging, and directly relevant to clinical practice.

THE BOTTOM LINE: Researchers studied who might get sick from toxins, why it happens, and how to prevent or treat it — then shared that information with healthcare professionals.

By documenting clinical cases and publishing them, researchers have been able to disseminate evidence-based guidelines on illness from harmful algal blooms.



Using Water Treatment Byproducts to Reduce Nutrient Runoffs

RESEARCH PROJECT TITLE:

Beneficial use of byproducts to reduce phosphorus loss from agricultural land

Principal Investigator: Nicholas Basta, The Ohio State University

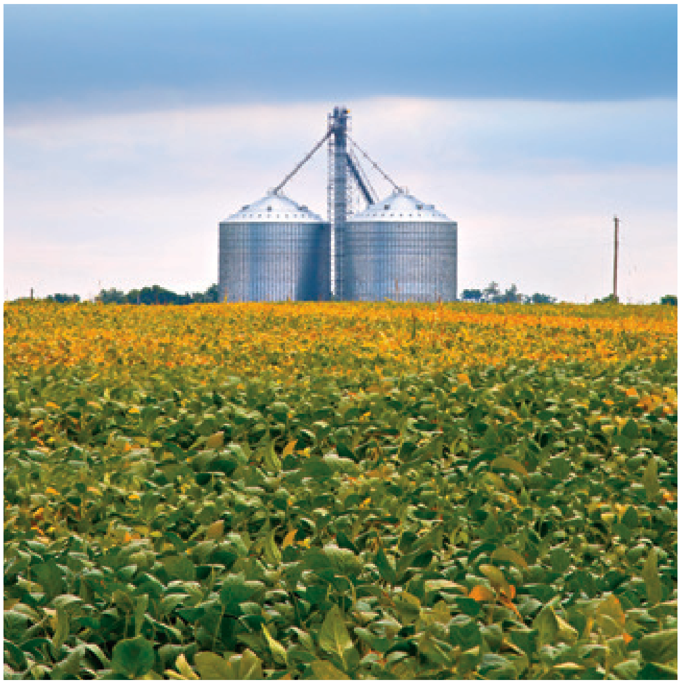
PROJECT SUMMARY

Scientists understand that Ohio farm fields, when exposed to wet spring conditions, can produce runoff of phosphorus (an agricultural fertilizer) that will ultimately contribute to harmful algal blooms in Lake Erie. Different best management practices (BMPs) have been shown to successfully control phosphorus loss associated with water movement and soil erosion. However, these water management and erosion-based BMPs are often unable to control all dissolved reactive phosphorus, or DRP, from leaving fields and fueling harmful algal blooms. Thankfully, sorbent materials have been shown to augment BMPs, increasing our ability to effectively remove DRP from surface water runoff and tile drainage by adsorbing phosphorus and reducing loss from agricultural land. Researchers previously established that waste material from drinking water treatment — known as water treatment residual — is an inexpensive and effective sorbent.

To put these byproducts to the test, the team studied the potential use of water treatment residuals and other waste material sorbents in novel technology targeted at reducing DRP in agricultural fields. First, they tested blending byproducts with poultry manure and biosolids (treated waste from humans) to reduce water soluble phosphorus. Next, they incorporated byproducts into two-stage agricultural drainage ditches, and, finally, they used sorbents in controlled phosphorus removal structures that treat tile drainage.

Results to date are very promising and may provide a mechanism to successfully trap DRP before it leaves Ohio farm fields. Notably, blending 10 to 20% of water treatment residuals with poultry manure or biosolids reduced DRP loss by 80 to 90%, respectively. This is a benefit to water quality and to municipalities that pay millions of dollars to move waste byproducts or residuals to landfills. Results from the study will be used to help apply byproducts from Ohio drinking water treatment plants to agricultural land to control phosphorus loss.

THE BOTTOM LINE: Researchers tested the ability of drinking water treatment byproducts to reduce the loss of dissolved reactive phosphorus from farm fields.



How Well Do Farm Field Filter Strips Trap Nutrients?

RESEARCH PROJECT TITLE:

Innovations in geospatial technologies to identify agricultural and roadside buffers for enhanced nutrient trapping

Principal Investigator: Kevin Czajkowski, The University of Toledo

PROJECT SUMMARY

Filter strips, also known as vegetative buffer zones, are often placed along the edges of agricultural fields to slow runoff, absorb nutrients, and improve water quality. However, prior projects and discussions with state agencies in Ohio suggest that these strips aren't always efficient throughout the Maumee River watershed, resulting in a greater risk of nutrient loss or runoff from fields than assumed. Water movement off of a field after a rain event doesn't flow equally through all filter strips, but rather forms channels of concentrated water flow that can bypass the filtering process. This concentrated flow, often called preferential flow, needs to be evaluated because filter strips are one of the best management practices promoted by the state's H2Ohio program and are a tool farmers are comfortable utilizing as a nutrient reduction strategy.

Based on this concern, agencies and researchers in Ohio set out to evaluate the nutrient trapping capacity of these filter strips within the watershed. The goal was to identify locations where nutrient trapping can be improved on agricultural fields, and to explore opportunities to install new filtering practices to intercept agricultural runoff as it travels downstream.

Through the project, the team used remote sensing data from multiple sources, including lidar and high-resolution imagery, to map and study filter strips. They also collected field data to confirm imagery and build a model that estimates how Ohio filter strips are being utilized. Researchers were able to successfully create a dataset identifying drainage networks, vegetative buffer zones, points of concentrated flow, and other features across the entire Maumee watershed. Combining the results with prior research, they were able to map priority areas with strong potential to reduce nutrient losses, identifying sites that have the best "bang for the buck" in reducing runoff.

An observed channelized drain flows through a vegetated buffer zone on a farm field. Researchers studied the nutrient trapping capacity of these zones, also called filter strips, within the Maumee River watershed.

Data from this project is supporting the refinement of hydrological models that track water and phosphorus movements at a higher resolution and are improving nutrient pollution monitoring and control. This work is also providing farmers with insight into nutrient runoff, helping them take steps to enhance best management practices. Additionally, results will be able to help inform management decisions by local agencies, focusing on reducing nutrient release from less efficient nutrient-trapping buffer zones and developing more impactful filtration techniques. Several promising sites were found on land managed by the Ohio Department of Transportation where filtration systems could substantially lower nutrient release.

THE BOTTOM LINE: Researchers studied the efficiency of vegetative buffer zones to trap nutrients in the Maumee River watershed, identifying locations where improvements can be made.

Can Cascading Waterways Limit Nutrient Flow in Northwest Ohio?

RESEARCH PROJECT TITLE:

Understanding the performance of cascading waterways in Ohio agricultural landscapes

Principal Investigator: Steve Lyon, The Ohio State University

PROJECT SUMMARY

Ongoing research within the Western Lake Erie Basin watershed indicates that harmful algal blooms are tightly correlated with precipitation events that cause surface and subsurface runoff, delivering nutrients throughout the watershed. Farmers can implement conservation practices to limit the flow of nutrients, and researchers have worked to study which practices are most effective in the watershed. One new practice, informed by this research effort, is starting to show promise: cascading waterways. These cascading systems — series of retention basins within grassed waterways — are designed to simultaneously prevent erosion and temporarily store water. However, little is known about how they function and their ability to retain nutrients and sediments associated with precipitation and runoff events.

To address this knowledge gap, researchers monitored water flows across several cascading waterways in Ohio.

A cascading waterway in Seneca County, Ohio, where researchers measured water and nutrients coming into and going out of these cascading systems over growing seasons. Based on field observations, the team found that cascading waterways store water for most storm events and allow for increased water infiltration into the ground.

They measured the water and nutrients coming into and going out of these cascading systems over a few growing seasons. From these measurements, researchers were able to estimate the amount of nutrients retained in each cascading waterway being monitored. From here, the team could estimate the cost effectiveness of the practice relative to other more established conservation practices, such as wetlands and edge-of-field phosphorus filters.

Based on observations, the water retention basins in the cascading waterways store water for most storm events and allow for increased water infiltration into the ground. This reduction in runoff results in reduced nutrient and sediment loading at the cascading waterway outlet. The team found this method to have similar cost effectiveness to other conservation practices currently being used in the Lake Erie watershed. On average, across the cascading waterways being monitored, approximately 83% and 94% of dissolved reactive phosphorus load and nitrate load was reduced, respectively.

Researchers are working with state agencies to continue to develop standards around design and maintenance of cascading waterways. The team will work with partners to establish cascading waterways as an interim conservation practice eligible for cost-share support. This project also allowed the researchers to establish a monitoring platform that can be maintained to extend data on performance under different weather conditions and as the system ages.

THE BOTTOM LINE: Cascading waterways are a management practice that can retain nutrients on agricultural land. Researchers measured the effectiveness of several cascading waterways in Ohio and found promising results.

Developing a Tool to Improve Rural Wastewater Treatment Infrastructure

RESEARCH PROJECT TITLE:

A decision support tool to optimize engineered drain design for rural on-site wastewater and urban stormwater treatment systems

Principal Investigator: Vinayak Shedekar, The Ohio State University

PROJECT SUMMARY

Ohio is home to over six million acres of poorly or somewhat poorly drained soils, creating challenges for designing and implementing wastewater and stormwater systems. On-site wastewater treatment systems, commonly known as septic treatment systems (STS), are used in rural areas to collect, treat, and dispose of wastewater, where it is often difficult or cost-prohibitive to connect to central wastewater plants. Ohio Administrative Code mandates that a certain minimum vertical separation distance (VSD) must exist between the bottom of leach trenches and underground limiting conditions such as bedrock or the seasonal water table. This allows the flow of sewage to receive adequate treatment. Without adequate VSD, there is greater risk of leaking untreated water into nearby water bodies, potentially causing contamination or eutrophication (i.e., movement of excess nutrients). A 2012 survey by the Ohio Department of Health showed that about 31% of septic treatment systems in Ohio are failing, increasing the risk of groundwater interaction and contamination.

Engineered drainage systems are often used to lower high water tables in STS leach fields, and similar drainage features are also incorporated into stormwater management practices, such as bioretention cells and permeable pavements. To address these concerns, researchers are developing a state-wide decision tool aimed at assisting engineers and designers in optimizing rural on-site wastewater and urban stormwater systems across the state.

The tool evaluates the overall performance of on-site STS (or stormwater systems) based on various inputs, such as location-specific soil properties, long-term weather, sewage application rate, and the layout of the proposed system. Researchers have completed backend coding and extensive testing of the tool, but further work is needed to release the tool to the public over the next two years. Once fully developed, the tool will inform decision makers about the suitability of any proposed on-site STS as per the Ohio Administrative Code and provide recommendations for the optimal spacing and depth of engineered drains.

The team conducted a field day for Lima City Schools, presenting an overview of the project and water quality benefits of drainage water recycling to about 50 students.

A trial version of the decision support tool will be available to users soon. It will play a key role in both designing new systems and in the repair or replacement of existing systems. By empowering local designers with data-driven insights, the tool will help ensure Ohio's wastewater and stormwater systems are more efficient, sustainable, and better equipped to protect water quality for future generations.

THE BOTTOM LINE: This project is developing an online tool to help designers optimize rural wastewater and urban stormwater treatment systems in Ohio, ensuring better performance, compliance with state regulations, and reduced environmental risks.

Can Dredged Sediments Benefit Crops and Mitigate Algal Blooms?

RESEARCH PROJECT TITLE:

Assessing dissolved reactive phosphorus sequestration onto farm soils amended with Lake Erie dredged sediments: implications on hydrological budgets and HAB occurrences

Principal Investigator: Angelica Vazquez-Ortega, Bowling Green State University

PROJECT SUMMARY

Each year, the state of Ohio dredges approximately 1.5 million tons of sediments from its Lake Erie ports to keep federal navigation channels clear for ships. In past decades, harbors would dispose of their dredged material by dumping it in the open lake. In 2020, however, Ohio banned open water disposal of dredged sediments in an effort to improve water quality and reduce annual algal blooms. Currently, dredged sediments from Toledo Harbor are stored in a confined facility — with a limited capacity of 10 years — and the state is looking for beneficial uses for this material.

In response to this need, the team investigated the viability of using dredged material as an agricultural farm soil amendment. Researchers reasoned that applying sediment to farm fields would return nutrients that were exported from the Maumee River watershed into Lake Erie. They also proposed that such soil amendments could help replace eroded topsoil, benefit crop yields, reduce phosphorus export, and potentially reduce harmful algal bloom severity. Through the project, the team developed a demonstration farm to test soil health, agronomic productivity, and the potential environmental effects of this beneficial use. During the experiment, researchers took into consideration compaction exerted by heavy machinery used to spread the dredged material. To track success, researchers also installed a system to monitor the export of nutrients in both surface and subsurface runoff from field edges.

Results showed that amending farm soil with dredged materials improved the soil's chemical health — such as an increase in soil organic matter and available phosphate to help plants grow. In comparing areas with and without compaction, researchers found no difference in soybean yield but lower corn yield in fields that had no dredged material applied. However, in fields with soil amendment, yields were the same regardless of compaction. From this, researchers concluded that adding dredged material doesn't affect the yield of cash crops negatively. Analysis of data from the edge-of-field monitoring system is still ongoing, with more results to come.

THE BOTTOM LINE: The state of Ohio is seeking beneficial uses for sediments dredged from Lake Erie. Scientists found promising results using dredged sediment as a farm soil amendment to benefit crops.

Researchers developed a demonstration farm to test soil health, agronomic productivity, and the potential environmental effects of applying dredged sediment to farm fields.

Do Conservation Ditches Limit Nutrient Flow from Farm Fields?

RESEARCH PROJECT TITLE:

Do conservation channel designs deliver an effective last-ditch defense against downstream phosphorus impairment?

Principal Investigator: Jon Witter, The Ohio State Universit

PROJECT SUMMARY

In northwest Ohio, drainage systems (tiled fields) allow farmers to remove excess water from surface soil helping crops grow. These systems are essential for the cultivation of fertile yet poorly drained soils so that crop production is economically viable. However, the increased flow of water from tile drained fields can contribute to excess runoff of nutrients — primarily phosphorus and nitrogen — downstream, fueling harmful algal blooms on Lake Erie.

To address this concern, researchers are studying the potential of conservation channel designs, which can disrupt the increased flow of sediment and nutrients associated with tile drainage, capturing them before they reach downstream waterbodies. Two promising best management practices are two-stage and self-forming ditch designs. Two-stage ditches include an inset channel with vegetated floodplain "benches" on either side, while self-forming ditches are the result of widening the existing channel bed to allow ecological processes to mimic natural stream systems. Currently, there is a lack of research data on phosphorus dynamics within these conservation channels in agricultural fields — information that conservationists, policymakers, and landowners need to effectively implement the practices.

Researchers dissect the floodplain in a conservation ditch. Through the project, they established baseline geomorphology monitoring in conservation ditches to assess changes in shape through time.

Throughout the project, researchers surveyed drainage engineers to assess the extent of current drainage work and identified outreach and education needs to promote the adoption of conservation ditch designs. They established baseline geomorphology monitoring in conservation ditches implemented through the program to assess changes in shape through time. Additionally, the team set up an experiment to quantify the water quality impacts of conservation ditch designs. Finally, they conducted an analysis to assess the costs and benefits of implementing conservation ditches on water quality and crop production.

While delays in construction of conservation channels and drought conditions in the second year of the project hindered full completion of all objectives, the project yielded significant outcomes. Researchers were able to assess the current extent of channel maintenance occurring in numerous Ohio counties, and results suggest that maintenance is active throughout the state. They successfully used grant funding to develop educational materials and deliver training throughout the Western Lake Erie Basin. Research completed through this project continues to inform policy and programs for the Ohio Department of Agriculture and the state's H2Ohio program.

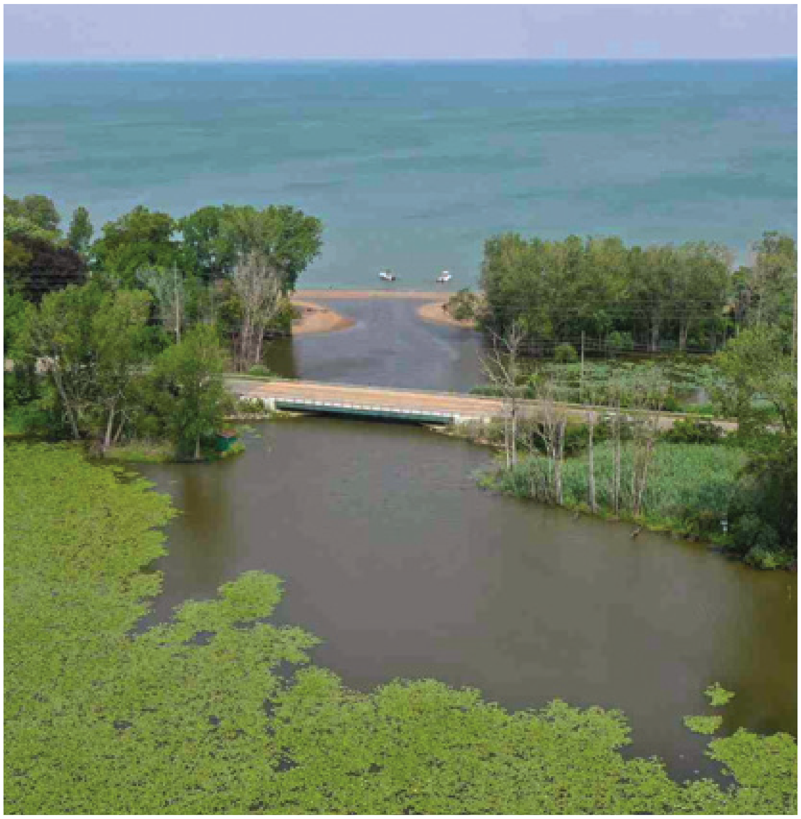
THE BOTTOM LINE: To address nutrient runoff from farm fields, researchers explored the potential of conservation ditch designs, informing decision-makers and statewide initiatives.

TRACK BLOOMS FROM THE SOURCE

Geophysical Mapping of Sub-Bottom Sediments, Groundwater Discharge Zones, and Bathymetry of Inundated Coastal Wetlands and Shallow Lakes

Kennedy Doro, The University of Toledo

How much groundwater discharges directly into the western basin of Lake Erie versus coastal wetlands? How do sediment properties and water depth vary at the bottom of these coastal wetlands? This project focused on answering these questions to improve scientists' understanding of how nutrients are retained within coastal wetlands. Further, the goal was to enhance wetland management to reduce nutrient release into Lake Erie. Researchers adapted the use of electrical alexwhere groundwater may be discharging directly. They also adapted modern geophysical approaches including ground penetrating radar (GPR) and electromagnetic imaging (EMI) to assess different sediment properties in coastal wetlands without having to collect many samples, a costly practice. Imagery from Old Woman's Creek and Lake Erie show weak zones in the bedrock that may allow groundwater to discharge directly. The team will be taking more measurements at sections of Lake Erie, Sandusky Bay, and Grand Lake St. Marys to assess this further.



TRACK BLOOMS FROM THE SOURCE

Show Me the Data: Visualizing Water Quality Trends in the Lake Erie Watershed

Nate Manning, Heidelberg University

In this project, researchers aimed to continue daily monitoring of West, Wolf, and South Turkeyfoot Creeks, where they are seeing lower values of dissolved reactive phosphorus than expected, in an attempt to determine why. They are combining sensor data from a variety of sources to create comparisons and trend analyses across the Lake Erie Watershed. The team also plans to make its long-standing data more available and functional to anyone who is interested in it. Daily monitoring of West, Wolf, and South Turkeyfoot Creeks is ongoing, and the team has deployed sensor suites at these sites and are beginning trend analyses on these data. Researchers created an online dashboard that allows users to explore and download the team's data and create their own figures. This dashboard is entering its beta stage, and researchers will soon meet with potential end users to discuss what functionality is needed to make the data and analyses accessible to a wide variety of users.

TRACK BLOOMS FROM THE SOURCE

Tracking Stream Channel Migration and Extent of Stream Bank Erosion in Ohio's Watersheds

Asmita Murumkar, The Ohio State University

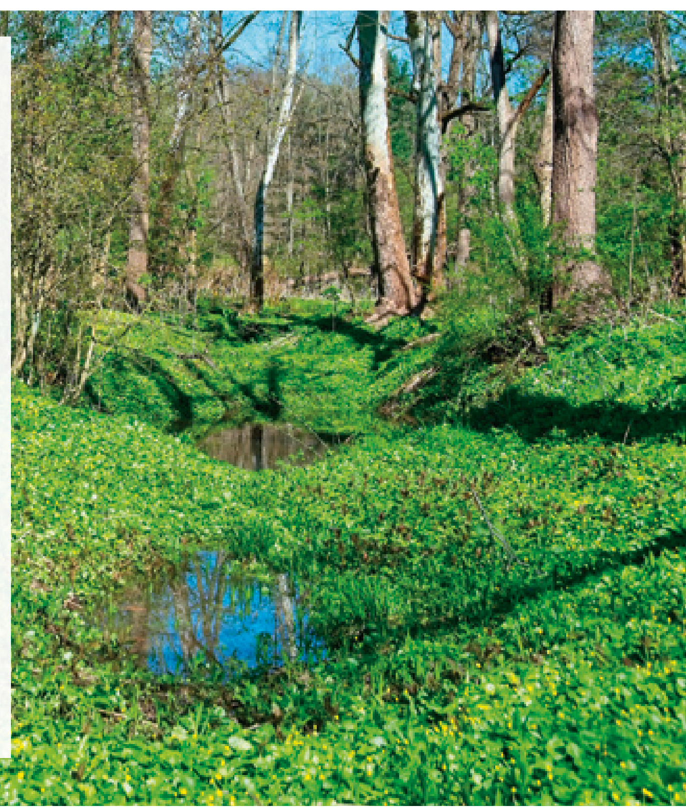
Understanding phosphorus export from agricultural fields is key to planning and implementing agricultural land-use and conservation practices in Ohio watersheds. Streambank erosion is a major pathway for sediment and phosphorus loadings into streams and is associated with land management practices. Here, researchers aim to track stream channel migration and associated streambank erosion with a special emphasis on identifying areas for conservation practice implementation that can help improve stream health. The team is mapping different types of streams, estimating channel migration rates, identifying factors causing migration, and assessing the effectiveness of stream restoration management practices. To do so, they are integrating remote sensing, on-site stream characteristic data, hydro-climatic data, water quality data, and modeling approaches. The outcomes of the project will support watershed planning and streambank stabilization, ultimately promoting improved water quality in downstream water bodies. So far, the required datasets for the assessment are ready, and researchers have developed stream power index maps and an algorithm to track channel migration using remote sensing data.

TRACK BLOOMS FROM THE SOURCE

Assessing Ohio Wetland Plants for Nutrient Capture to Guide Construction and Management

Helen Michaels, Bowling Green State University

Wetlands are essential tools for reducing nutrients that stimulate algae, yet scientists have a limited understanding of how to choose plant species used in restoration and management to maximize nutrient filtration. The team aimed to understand how key plant traits influence nutrient uptake, storage in tissues, soil chemistry that affects nutrient cycling, and trapping of nutrient-laden sediment. Researchers are tackling this problem with field sampling of plant biomass — above and below ground — to measure traits likely to affect nutrients in 12 common wetland species across seasons. They are also using litter bags to study decomposition rates, sediment traps, and iron rods to estimate soil oxygen conditions. To complement field sampling, researchers are conducting a mesocosm experiment that allows for comparing growth, traits, and effects on soil chemistry of the 12 species under common conditions and different water depths. Both field sampling and the mesocosm study are nearly completed with lab assays planned.



Ongoing Research Project Briefs

Summarized results for ongoing projects that are in the first of their two-year funding cycle

TRACK BLOOMS FROM THE SOURCE

Enhancing Ecosystem Models to Guide Selection and Placement of Wetlands in the Western Lake Erie Basin

Joel Paulson, University of Wisconsin

Lorrayne Miralha, The Ohio State University

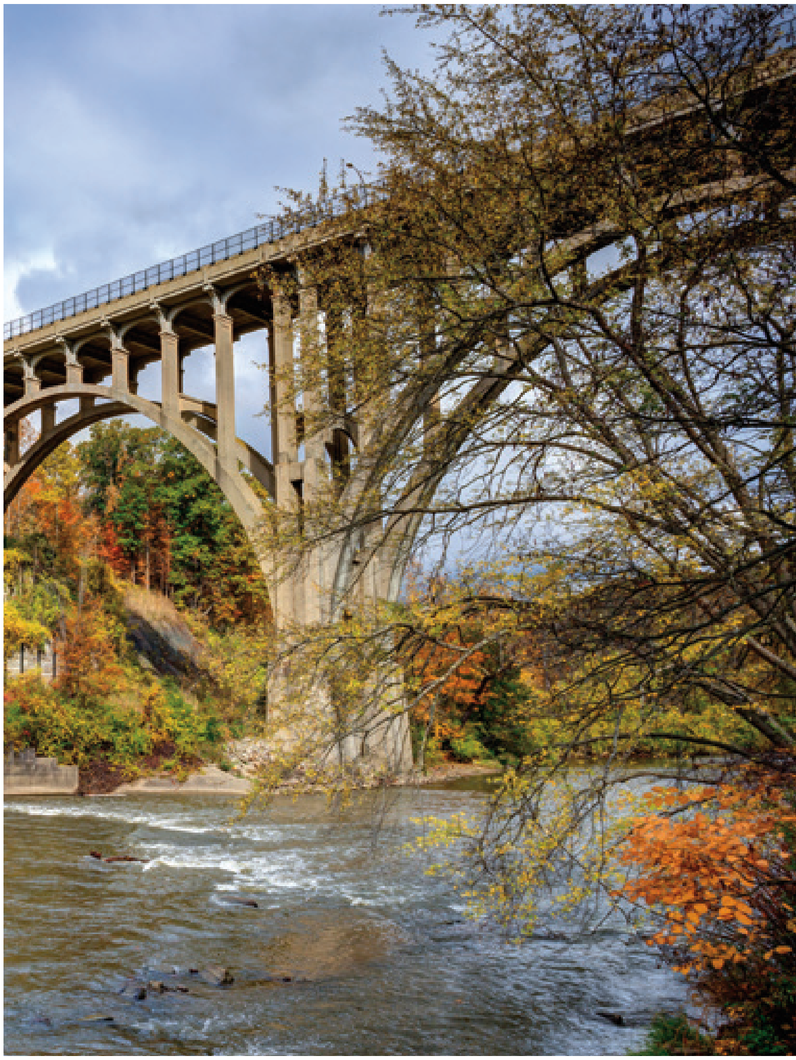
This project tackles harmful algal blooms (HABs) in Lake Erie by helping the state of Ohio make smarter choices about where and how to build wetlands. While wetlands can greatly reduce the phosphorus and nitrogen that fuel HABs, their effectiveness depends on many factors such as location, design, vegetation, and hydrology. Researchers are using satellite imagery, field data, and upgraded ecosystem models to map wetlands, monitor seasonal changes, and simulate nutrient reduction under different designs and climate scenarios. To support faster and more informed decision-making, the team has also developed new optimization methods, guided by machine learning, that can greatly accelerate model calibration and analysis in high-dimensional settings. So far, researchers have completed wetland mapping across the Western Lake Erie Basin and are actively upgrading the modeling framework to better capture wetland processes. This system is starting to be used to explore design and placement strategies that maximize water-quality benefits, laying the groundwork for future collaboration with state agencies and other stakeholders.

TRACK BLOOMS FROM THE SOURCE

Utilizing Data-Driven Predictive Models for Assessing Climate Change Effects on Nutrient Runoff in Ohio's Inland Lakes

Huichun Zhang, Case Western Reserve University

This project examines how climate variability shapes nutrient loading and contaminant risks in Ohio's major inland lakes — an urgent challenge for water quality and ecosystem health. The team integrated eight rounds of field sampling across 20 lakes with analysis of 14 water-quality parameters and nearly 40,000 legacy observations from Ohio EPA monitoring (1999 to 2024) to build a comprehensive, data-driven understanding of nutrient dynamics. Preliminary findings indicate that lakes with higher agricultural land use and smaller surface areas — for example, Clarence J. Brown Reservoir and Caesar Creek Lake — are especially vulnerable to elevated nutrient inputs. Atrazine, a widely used herbicide for controlling broadleaf and grassy weeds in crops, and zinc emerged as major pollutants of concern. To support rapid decision-making, the team developed a low-cost screening approach that couples machine learning with association-rule mining to infer hard-to-measure contaminants (e.g., heavy metals and pesticides) from readily monitored indicators (e.g., turbidity). Ongoing work is developing predictive models to quantify the influence of environmental variability on nutrient runoff and to identify lakes most at risk under future scenarios, providing actionable insights for targeted monitoring, mitigation, and adaptive watershed management.



▸ **TRACK BLOOMS FROM THE SOURCE**

Quantifying Nutrient Reduction in a Constructed Wetland Complex Treating Storm Flows from East Fork Little Miami River

Ryan Winston, The Ohio State University

In collaboration with the Clermont Soil and Water Conservation District, researchers are monitoring the function of a large floodplain wetland complex treating storm overflows from the East Fork Little Miami River, located upstream of a lake impacted by harmful algal blooms. This wetland system uses an abandoned drinking water reservoir as initial storage for runoff, with this water eventually flowing out of the reservoir through a 7-acre treatment wetland before re-entering the river. Researchers have continuously monitored the wetland for 31 months at five locations, assessing water flow, water characteristics (e.g., nutrient levels), and soil and vegetation characteristics. Results will inform state agencies and design engineers on what parts of the wetland complex are functioning best for nutrient removal. In 2024, 30.6 million cubic feet of water — about 350 Olympic-size swimming pools — entered the wetland complex during eight rainfall events. During these events, 665 tons of sediment, 1,700 pounds of phosphorus, and 3,400 pounds of nitrogen were captured by the wetland, representing highly effective treatment of the target pollutants. The project has demonstrated that low-lying areas near streams offer great potential as locations to retrofit off-channel storage to mitigate nutrient transport to waters like the Western Lake Erie Basin.

30 million cubic feet of water

entered the wetland complex during eight rainfall events in 2024

Summarized results for ongoing projects that are in the first of their two-year funding cycle

TRACK BLOOMS FROM THE SOURCE

Watershed Monitoring to Determine Nutrient Load Allocations from Urban Areas to Inform Recommendations for Nutrient Control through Strategic Best Management Practice Implementation

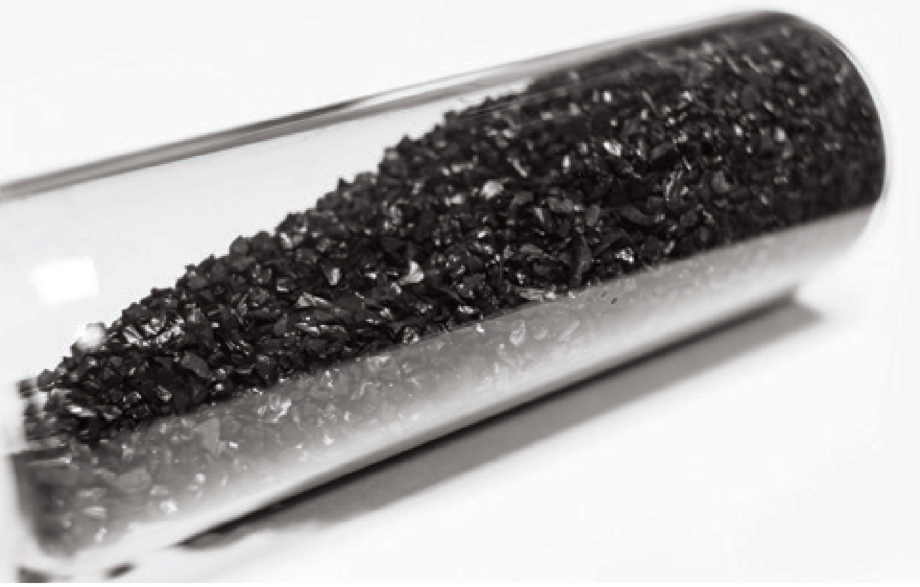
Ryan Winston, The Ohio State University

In collaboration with Summit Soil and Water Conservation District and Chagrin River Watershed Partners, researchers are monitoring stormwater from six urban watersheds in central and northern Ohio. Their aim is to study nutrient loads — that is, the mass of nutrients — in stormwater as a function of land use, across a variety of commercial and residential developments. This will show "hot spots" of nutrient loading from urban regions and help state agencies better account for the urban nutrient load in their basin-wide estimates. Further, data from this project may reveal locations that would provide greater return on investment if cities retrofitted stormwater controls into existing urban development. In the project, stormwater is continuously monitored using sensors and automated samplers, which allow for collection of runoff hydrographs and representative water condition samples. This information will be combined with data from approximately 30 previous watershed monitoring research projects in the Dayton, Cincinnati, Columbus, and Cleveland regions to inform watershed managers on nutrient loading from urban land uses.

PRODUCE SAFE DRINKING WATER

A Multi-Scale Assessment of Cyanotoxin Treatment by Granular Activated Carbon to Enhance Removal in Systems with Co-Occurring Emerging Contaminants

John Lenhart, The Ohio State University



In Ohio, water treatment utilities face an array of emerging contaminants in their source waters that they must remove or reduce to safe levels, with algal toxins often being most prevalent. To address this concern, utilities are increasingly adopting treatment using granular activated carbon (GAC). However, increased incidence of per- and polyfluorinated alkyl substances (PFAS) and microplastics requires evaluating activated carbon for the simultaneous removal of all of these contaminants. To address this knowledge gap, researchers have designed, constructed, and begun testing pilot-scale and rapid small-scale column systems to evaluate the use of GAC to simultaneously remove multiple contaminants. Based on their design, these systems can provide data that will scale up to the activated carbon reactors at Greater Cincinnati Water Works. The team recently began experiments using these systems to evaluate their removal of algal bloom toxins and PFAS using GAC for a range of system conditions, and they plan to start experiments with microplastics soon.

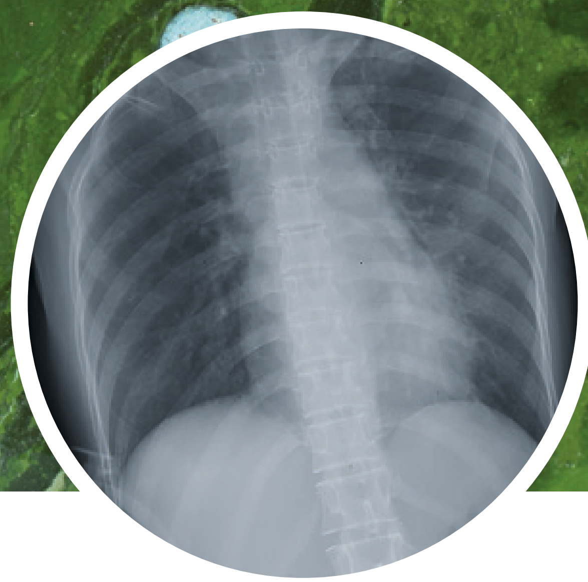
PROTECT PUBLIC HEALTH

Aging as a Primary Risk Factor for Increased Susceptibility to Aerosolized Harmful Algal Bloom Toxins and Toxic Microplastics

Steven Haller, The University of Toledo

Toxins from harmful algal blooms (HABs) and tiny plastic particles (microplastics and nanoplastics) can become airborne and breathed in, posing health risks, especially for older adults, who are more likely to suffer from chronic conditions. The team's prior research showed that even short-term exposure to these airborne toxins can trigger inflammation in the lungs, liver, and kidneys. To study this further, researchers exposed older rats (similar in age to elderly humans) to airborne microcystin, a toxin from HABs, for one hour a day over five days. The team found increased inflammation, stress responses, and genes linked to lung scarring. Lung tissues showed damage similar to emphysema, and nasal and heart tissues also showed scarring. These findings suggest that breathing in microcystin can potentially cause injury, especially in aging individuals. This research helps explain why aerosol from HAB toxins and plastics may pose a greater risk than previously realized, especially for vulnerable populations.

The team found increased inflammation, stress responses, and genes linked to lung scarring.



PROTECT PUBLIC HEALTH

Characterization and Screening of Aerosolized Anatoxin-a, Guanitoxin, Cylindrospermopsins, and Saxitoxins in Vulnerable Populations

Steven Haller, The University of Toledo

Harmful algal blooms (HABs) in the Great Lakes release toxins like microcystin into the air, which nearby communities can unknowingly breathe in. While swallowing these toxins through water is well studied, scientists know far less about the health risks of breathing them in, especially for people with asthma. To better understand this, researchers are using advanced air sampling tools, lab-grown airway models, and asthma-focused model systems to see how inhaling these toxins affects the body. Early results from human airway cells show that breathing in microcystin causes inflammation, and this reaction is much stronger in people with asthma. The team's goal is to uncover how asthma increases vulnerability, identify how cells are damaged, and find treatments using large-scale drug testing. This research will help shape public health advice, improve diagnosis and treatment options, and protect high-risk groups in Ohio and other areas affected by HABs.

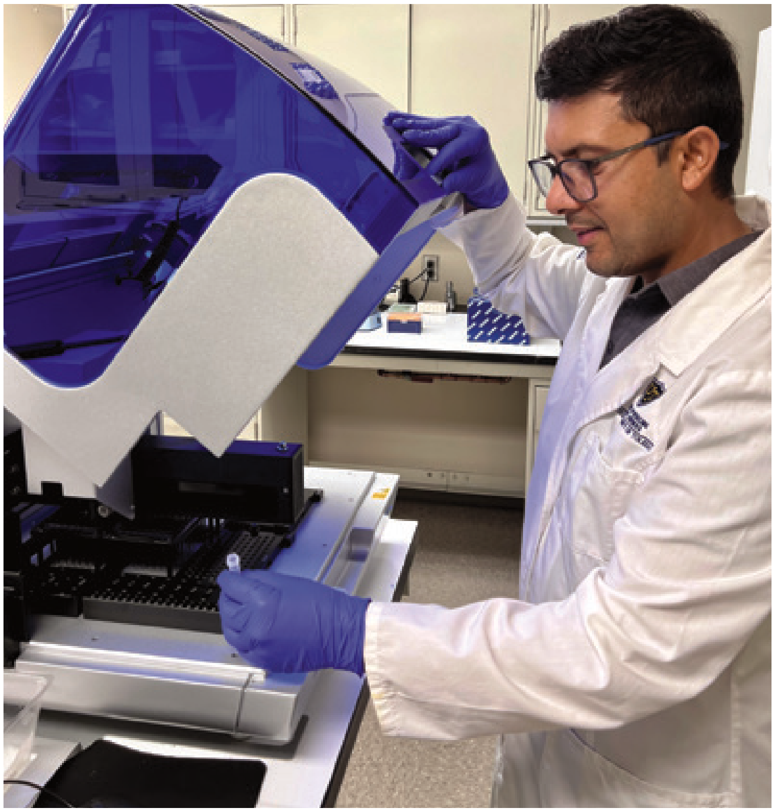
Summarized results for ongoing projects that are in the first of their two-year funding cycle

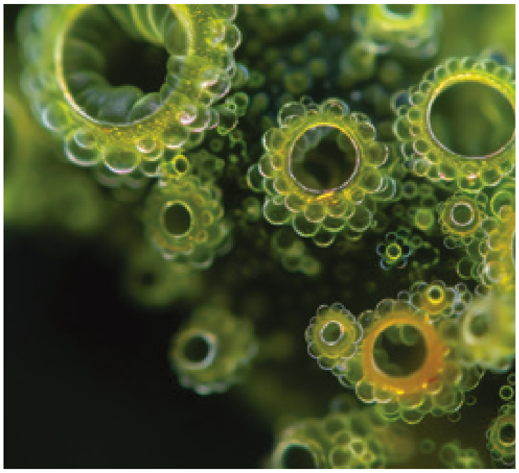
PROTECT PUBLIC HEALTH

Diagnostic Test Development for Detection and Monitoring of Cyanotoxins in Human and Veterinary Applications

David Kennedy, The University of Toledo

Harmful algal blooms (HABs) release toxic chemicals called cyanotoxins that has the potential to harm people, pets, livestock, and wildlife. One of the most abundant toxins, microcystin, can damage the liver, but right now, doctors and veterinarians often have to guess if this toxin is responsible based on symptoms, since there is no reliable test for exposure. To fix this, researchers are studying liver cells from different species (including humans, dogs, cows, and fish) to find unique biological "signatures" that show clear signs of microcystin exposure. These signatures could help develop accurate diagnostic tests. So far, the team has found two compounds that protect liver cells from microcystin damage and can even reverse the effects after exposure. Their strategy combines three tools: measuring toxins directly in blood and urine, detecting immune responses with antibody tests, and identifying exposure-related changes in liver cells. Together, these tools will improve diagnosis, guide treatment, and help protect both public health and the environment.





PROTECT PUBLIC HEALTH

Direct and Indirect Impacts of Cyanotoxins on Human Health: A Review

Stuart Ludsin and Kathryn Campbell, The Ohio State University

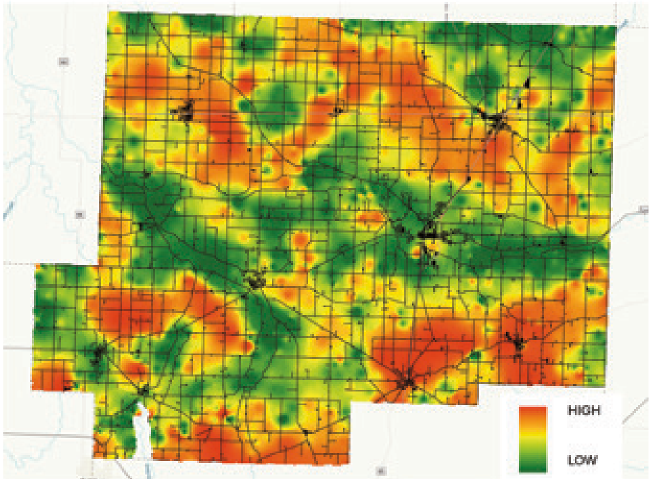
Harmful algal blooms (HABs) are a persistent freshwater disturbance that is increasing in frequency globally. Much research exists on the potential impacts of HABs on different organisms within freshwater food webs, as well as the impact they can have on human health. However, this body of research is quite dispersed and typically limited to organisms in the lower food web. This research team is currently synthesizing and summarizing studies identified in a systematic review of the peer-reviewed literature on HAB impacts in freshwater ecosystems of the world, with a focus on the U.S. Midwest. One goal of this review is to identify the major impacts of HABs on freshwater food webs, as well as critical information gaps that hamper understanding and management. A second goal is to better understand how HABs have affected human health and well-being through toxin exposure and loss of ecosystem services. The team is currently writing the manuscript associated with the first goal.

ENGAGE STAKEHOLDERS

Use of High-Resolution Data Sets to Locate Sites for Restoration and Installation of Nutrient Interceptors in the Maumee Watershed

Kevin Czajkowski, The University of Toledo

Researchers are using high-spatial resolution imagery and GIS data layers to improve the Parcel-based Ecological Restoration Model (PERM), a project to identify priority locations for nutrient-reducing installations, such as wetlands, in alignment with the state's H2Ohio program. Using high-resolution data on field boundaries and agricultural practices, such as tillage practice, crop rotation, cover crops, and catchment area, the team developed maps of nutrient loading data for the Western Lake Erie Basin that have been integrated into a new version of PERM. Cost-benefit analysis is being employed to prioritize locations where wetlands should be located to maximize nutrient reduction for the cost. As a pilot, researchers are working with the Putnam County Soil and Water Conservation District to identify locations within Ohio Department of Transportation (ODOT) rights-of-way for installations that would reduce nutrients.



Here, researchers mapped the Nutrient Runoff Potential Index, in which high values represent a greater potential for dissolved reactive phosphorus outflow from agricultural fields.

Ongoing Research Project Briefs

Summarized results for ongoing projects that are in the first of their two-year funding cycle

ENGAGE STAKEHOLDERS

Quantifying Cropland Water-Carbon-Nutrient Coupling under Drainage Water Management for Climate-Resilient Production

Yanlan Liu, The Ohio State University

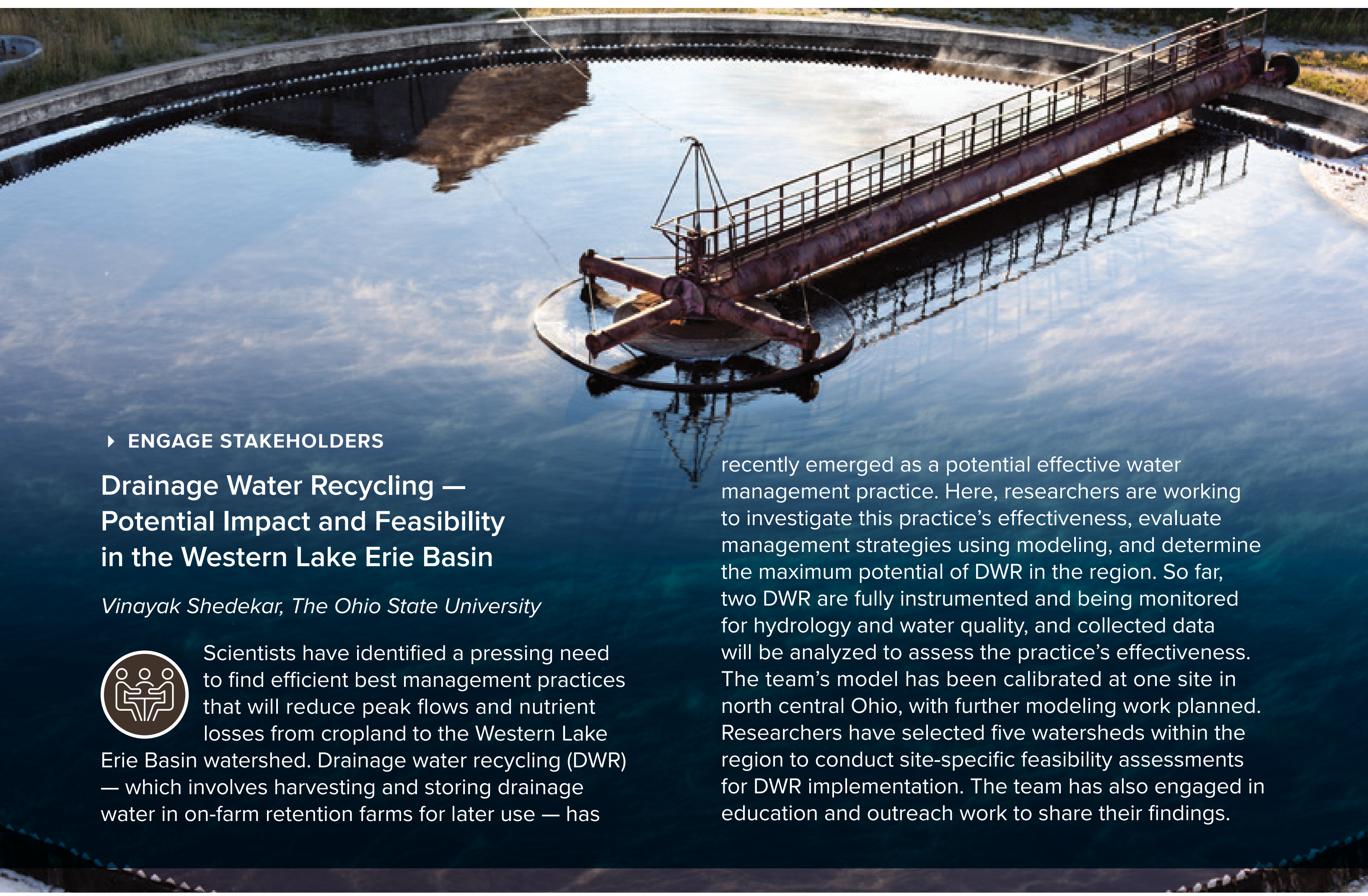
Automated drainage water management can help farmers grow healthier crops while protecting the environment. This project combines field data and computer modeling to understand how different drainage strategies affect crop yields, water quality, and greenhouse gas emissions. At sites in northwestern Ohio, researchers have measured soil moisture, crop performance, and nutrient runoff over two growing seasons. These data feed into a model that estimates how drainage choices impact plant stress and water movement. By the end of the 2025 season, the team will refine the model to identify strategies that balance farm productivity with environmental benefits. Their findings have been shared at several conferences, including the 2025 Conservation Drainage Network Annual Meeting in Illinois and the Water Management Association of Ohio Annual Meeting. This research supports smarter water management that benefits agricultural resilience.

ENGAGE STAKEHOLDERS

Monitoring and Modeling of Tappan Lake for Harmful Algal Bloom Reduction Initiatives

Suresh Sharma, Youngstown State University

Researchers have developed a robust watershed coupled hydrodynamic and water quality model (both three-dimensional and one-dimensional) to simulate flow regime and detect potential causes of algal blooms in Tappan Lake in Harrison County, Ohio. Researchers collected high-frequency sensor data twice a month during the summer and once a month in other seasons, excluding freezing months. These data include temperature, dissolved oxygen, chlorophyll a, turbidity, and pH. They also collected data from an acoustic doppler current profiler and are working to interpret the results. The team presented their preliminary research at various internal conferences and are currently analyzing the results for the final project completion report.



ENGAGE STAKEHOLDERS

Drainage Water Recycling — Potential Impact and Feasibility in the Western Lake Erie Basin

Vinayak Shedekar, The Ohio State University

Scientists have identified a pressing need to find efficient best management practices that will reduce peak flows and nutrient losses from cropland to the Western Lake Erie Basin watershed. Drainage water recycling (DWR) — which involves harvesting and storing drainage water in on-farm retention farms for later use — has recently emerged as a potential effective water management practice. Here, researchers are working to investigate this practice's effectiveness, evaluate management strategies using modeling, and determine the maximum potential of DWR in the region. So far, two DWR are fully instrumented and being monitored for hydrology and water quality, and collected data will be analyzed to assess the practice's effectiveness. The team's model has been calibrated at one site in north central Ohio, with further modeling work planned. Researchers have selected five watersheds within the region to conduct site-specific feasibility assessments for DWR implementation. The team has also engaged in education and outreach work to share their findings.

HARMFUL ALGAL BLOOM RESEARCH INITIATIVE

2025 Project Update to the
Ohio Department of Higher Education

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