# TWINELINE

2016 FALL EDITION VOL.38/NO.2

## OHIO SEA GRANT RESEARCH

# KEEPS TAP WATER SAFER

from harmful algal blooms

NOAA

The Ohio State University

Sea Grant
Ohio Sea Grant College Program

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2016 FALL EDITION






## New Stone Lab Designs Added to Merchandise Options

It's once again time to expand your collection of Stone Lab gear, perfectly timed for the holiday season! Whether it's a vintage design like the Stone Lab Microscope, or something modern like a bumper sticker-inspired Gibraltar Island design, Stone Lab merchandise is a perfect gift for science students and Stone Lab alumni alike. Remember, the holidays are almost here – you should get a head start on that list.

Merchandise is available from the Stone Lab office, and can be ordered online, by phone, or in person. Visit ***ohioseagrant.osu.edu/giving/merch*** for the full catalog, as well as ordering instructions.

***Twine Line*** (ISSN 1064-6418) is published four times a year by the Ohio Sea Grant College Program at The Ohio State University, 1314 Kinnear Rd., Columbus, OH 43212-1156. Subscription price is $10.00 per year (four issues). The opinions expressed are those of the authors only. Please contact the office to obtain permission before reprinting articles or graphics. Ohio Sea Grant is a statewide program that supports greater knowledge and stewardship of Lake Erie and the Great Lakes. It is part of the NOAA Sea Grant College Program (NOAA grant NA16RG2252, project M/P-2), which includes 33 state programs. Support of Ohio Sea Grant is provided by National Sea Grant, the State of Ohio, The Ohio State University, Ohio State University Extension, and participating universities, agencies, and businesses.

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# Ohio Sea Grant Research Keeps Tap Water Safer from Harmful Algal Blooms

*by Christina Dierkes, Ohio Sea Grant Communications*

In the aftermath of the 2014 harmful algal bloom (HAB) in Lake Erie, which left residents in the city of Toledo without drinking water, there's been a lot of activity around making sure something similar doesn't happen again. Water treatment plants have added additional testing for the algal toxin microcystin that caused Toledo's water shutdown, scientists are monitoring HABs as they develop, and backup intakes let larger plants avoid pulling in potentially contaminated water altogether.

But remembering the news reports of people stuck without water for days, some concerned citizens may still wonder "what if?"

Dr. Glenn Lipscomb at the University of Toledo will address just that question. As a chemical engineer, one of his focus areas is membrane separation, where thin filter membranes are used to separate very small particles or even molecules – oxygen from the nitrogen and gases that make up the air we breathe, for example.

"When this incident we had two years ago occurred, it was a natural fit," Lipscomb said. "It was obvious that a reverse osmosis membrane would take out the microcystin in the water, and it was just a question of coming up with a way to provide some certainty to the fact that it'll do that."

Reverse osmosis (RO) occurs when water is pushed through a semipermeable membrane with "holes" that are too small for anything but the water molecules themselves. The process is commonly used in drinking water purification, as it removes minerals and particles that can cause undesirable flavors.

Partnering with NSF International (formerly the National Sanitation Foundation), Lipscomb's research focuses on the reverse osmosis systems commonly sold at home improvement stores and installed under kitchen sinks in a number of homes. The goal is to develop a certification process for these home membrane systems that shows that they remove microcystin from drinking water.

RO membranes are essentially sheets of very thin plastic, and include a layer

with pores so small that contaminants like mineral salts, organic contaminants and viruses can't pass through them. Microcystin is a peptide – essentially a very small protein molecule – that is much larger than a water molecule, so it should be filtered out quite effectively.

With the project just getting underway after receiving funding from the Ohio Department of Education's Harmful Algal Bloom Research Initiative (HABRI), the final certification protocol should be complete in early 2018. Before assessing the full systems, the researchers will work with Dow Water & Process Solutions, a division of the Dow Chemical Company, to characterize different system components straight from the manufacturer.

"One of the things that we're really concerned about is how effective the systems retain their ability to filter out microcystin over time," Lipscomb explained. "So we'll be developing some accelerated aging protocols for testing. Chlorine is added to water to help protect us, and it turns out that for the membranes that are used in these home systems, the chlorine can attack the membrane and reduce the ability to filter out toxin. So we're going to be accelerating that effect and look at how the system responds."

Reverse osmosis membranes are made up of three distinct layers: a

coarse fibrous mat comparable to a furnace air filter that provides the primary strength and support for the membrane, a second thinner layer that acts as a secondary support structure, and the membrane itself, which is the thinnest layer and has the very smallest pores that would filter out microcystin.

"When chlorine attacks that very top layer, it basically eats it up," Lipscomb explains. "It degrades the material into smaller particles that lift right off the surface and reveal the larger-pored support underneath. And that larger-pore support is not capable of filtering out the microcystin."

This process takes a long time at the chlorine levels found in drinking water, but it does occur and needs to be addressed. Studies have shown that increasing chlorine concentration above normal drinking water levels is an effective way of demonstrating chlorine's effect on membranes over time in a much shorter timeframe. Applying those findings to actual membrane systems will be an important data point for the certification Lipscomb and his partners plan to develop.

"Our goal is to demonstrate how a manufacturer would go through this process, and then NSF International would ultimately be responsible for doing the certification or identifying third parties that would do it," Lipscomb said. "But what this would show is how to certify a system, and then everybody can compete on price and quality, on how often you have to change the units out, and so on, under the same set of guidelines."

While the home membrane systems Lipscomb is testing are relatively affordable at $250-300, some people may not be able to install an under-sink water filter system – they may rent an apartment, or the upfront cost of the system may strain their budget too far. For them, the natural next question is "will my Brita pitcher filter out microcystin?"

It's a question Stone Lab research coordinator Dr. Justin Chaffin hears a lot at outreach events. "I didn't know how to answer that question at first," Chaffin said. "So we wrote a proposal to the Lake Erie Protection Fund and got funded, and now I know the answer."

"Basically what these tests say is that once microcystin is attached to the filter, it's not going to come off."

That answer, as with so many things in science, is "maybe."

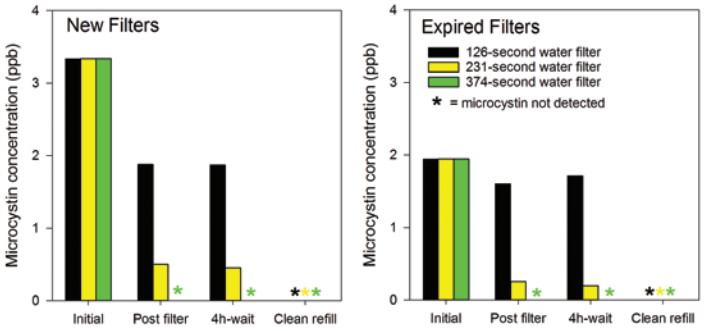
It turns out that the biggest predictor of whether a pitcher filter will remove microcystin from water is how long it takes that water to percolate through the filter. Chaffin and his team tested three different water filters – Brita®, Pur® and ZeroWater®, all available at most grocery stores or online. Each brand is built just a little differently, so that selection also gave the researchers a good idea of what other basic features make a water filter more likely to remove microcystin.

The cartridges in most water filters contain activated carbon, which does the heavy lifting in removing contaminants from water. Molecules like chlorine and microcystin stick to the carbon particles, while water molecules travel through the filter and into the pitcher. That adsorption process relies on the carbon's surface area, and "activating" carbon opens up pores on the particle's surface, which gives it a larger surface area for molecules to stick to.

"There are several types of activated carbon, for example coconut, coal, wood and peat moss," Chaffin said. "The filter that removed the least amount of microcystin had coconut-based activated carbon, whereas the other ones that removed more microcystin had a blend of different types."

Based on previous research, Chaffin explained that the pores on coconut-based activated carbon tend to be very small, just 1 nanometer across,

## Do pitcher filters remove microcystin from tap water?




Both new and expired filters in this Ohio Sea Grant study removed microcystin from water. The filter that retained water the longest (green bars) had the lowest microcystin concentration; it was also the filter with the most filter stages. The coconut-based activated carbon filter (black bars) removed the least microcystin. The researchers took samples right after filtration, after the filter sat on the lab bench for four hours, and after the pitcher had been refilled with clean water. Results showed that once the microcystin is attached to the filters, it will stay there and not leach back into the pitcher.

Stone Lab field station assistants take samples from a range of water filter pitchers and analyze them for microcystin, the major toxin in harmful algal blooms (HABs). The study showed that the longer a filter retained water before releasing it into the pitcher, the more microcystin it removed.

while the microcystin molecule itself is about 2-3 nanometers in size. This means the toxin doesn't fit into the pores and only attaches to the very edge of the carbon particle. The pores on activated carbon made of wood are larger, up to 50 nanometers, allowing microcystin to bind to a much larger overall surface area.

The researchers used water drawn directly from Lake Erie during two different algal blooms for the tests, to make sure that any other natural compounds present in normal drinking water were also present in their experiments. After determining the initial toxin concentration, a liter of water was poured through each filter and the time it took for the whole liter to pass into the pitcher was recorded.

Microcystin concentrations were consistently lowest in the filter that retained water the longest, at six minutes and 14 seconds (this was also the filter with the most filter stages, including a coarse filter and an activated carbon stage), and highest in the coconut-based activated carbon filter that only retained water for two minutes and six seconds. Results for all three brands were similar in both new filters and filters that needed to be replaced according to manufacturers' instructions.

To more accurately model how people use these water pitchers in real life, the team also tested microcystin concentrations in the pitchers after they had been sitting on a shelf for four hours – no microcystin leached out of the filter and back into the water. In addition, they ran a liter of clear water through the filter that had previously been used on the contaminated water, and found similarly encouraging results.

"Basically what these tests say is that once microcystin is attached to the filter, it's not going to come off," Chaffin said.

While all of this information will be helpful to people who are concerned about problems with their drinking water supply, Chaffin emphasizes that microcystin reaching a kitchen faucet is a highly unusual event.

"But for those people that do worry about it, these pitchers may be a more economical and less wasteful option than buying tons of bottled water on a regular basis. Of course, if microcystin is confirmed in the tap water, as happened in Toledo two years ago, then I would still recommend switching to bottled water for that time." **TL**

For more information about these projects, contact Dr. Lipscomb at ***glenn.lipscomb@utoledo.edu*** or Dr. Chaffin at ***chaffin.46@osu.edu***.

The Maumee River, downstream of Providence Dam
*Credit: The Nature Conservancy*

# *Western Lake Erie Basin Conservation Effects Assessment Project (CEAP) Wildlife Assessment Develops Models to Improve Stream Health with Agricultural Conservation Practices*

The Conservation Effects Assessment Project (CEAP) is an effort sponsored by the Natural Resources Conservation Service (NRCS) to assess the effectiveness of agricultural conservation practices at reducing the impacts of agriculture on surrounding ecosystems.

In 2016, work was completed on a 4-year CEAP-Wildlife project focused on nutrient and sediment impacts on fishes in streams throughout the western Lake Erie basin (WLEB). This project convened partners from The Nature Conservancy, the USDA's Agricultural Research Service and NRCS, Ohio Sea Grant, The Ohio State University and Texas A&M University to develop a computer model that can assess in-stream ecological impacts of agriculture at spatial scales ranging from the entire western basin down to small watersheds. The analysis also focuses on the costs and benefits of conservation practices that reduce those ecological impacts.

The research team focused on western Lake Erie in part because of the region's connections to the harmful algal blooms (HABs) that have plagued the lake in late summer and early fall. Phosphorus and sediment inputs from the western Lake Erie watershed fuel those algal blooms, and improvements to stream health, even high up in the watershed, may well help reduce algal blooms in the lake. Of course, the streams themselves also offer important services like drinking water and recreational opportunities, and are home to a number of fish species that have declined dramatically over the past century.

The research uses two indicators of environmental health:

- Top predators in a stream are fish (often sportfish like bass) that consume other fishes, but do not have predators themselves. Because these species are sensitive to environmental damage, their presence can be used to determine how healthy an ecosystem is overall.
- Index of Biotic Integrity (IBI) uses fish community structure to gauge stream conditions. It connects human disturbance on streams and watersheds to fish diversity, and gives managers a standard tool to use when targeting improvements to a damaged watershed.

"Until our study, nobody has taken a hard look at how agricultural conservation practices aimed at protecting Lake Erie could influence the health of streams in the watershed. We're asking what happens to water quality and fish communities if we implement conservation measures," said Stuart Ludsin, co-director of Ohio State's Aquatic Ecology Laboratory.

The research shows that many streams in the western Lake Erie basin have high levels of sediment and nutrients (such as phosphorus and nitrogen), and that this is negatively affecting stream health. To manage agricultural water quality impacts, a suite of practices is needed to achieve measurable improvements to fish communities.

While the current model is focused on the western Lake Erie basin, the same approach can be adapted for use in other areas as well.

Figure 1, an example map from the research model, shows how just a 20% reduction in nutrient and sediment

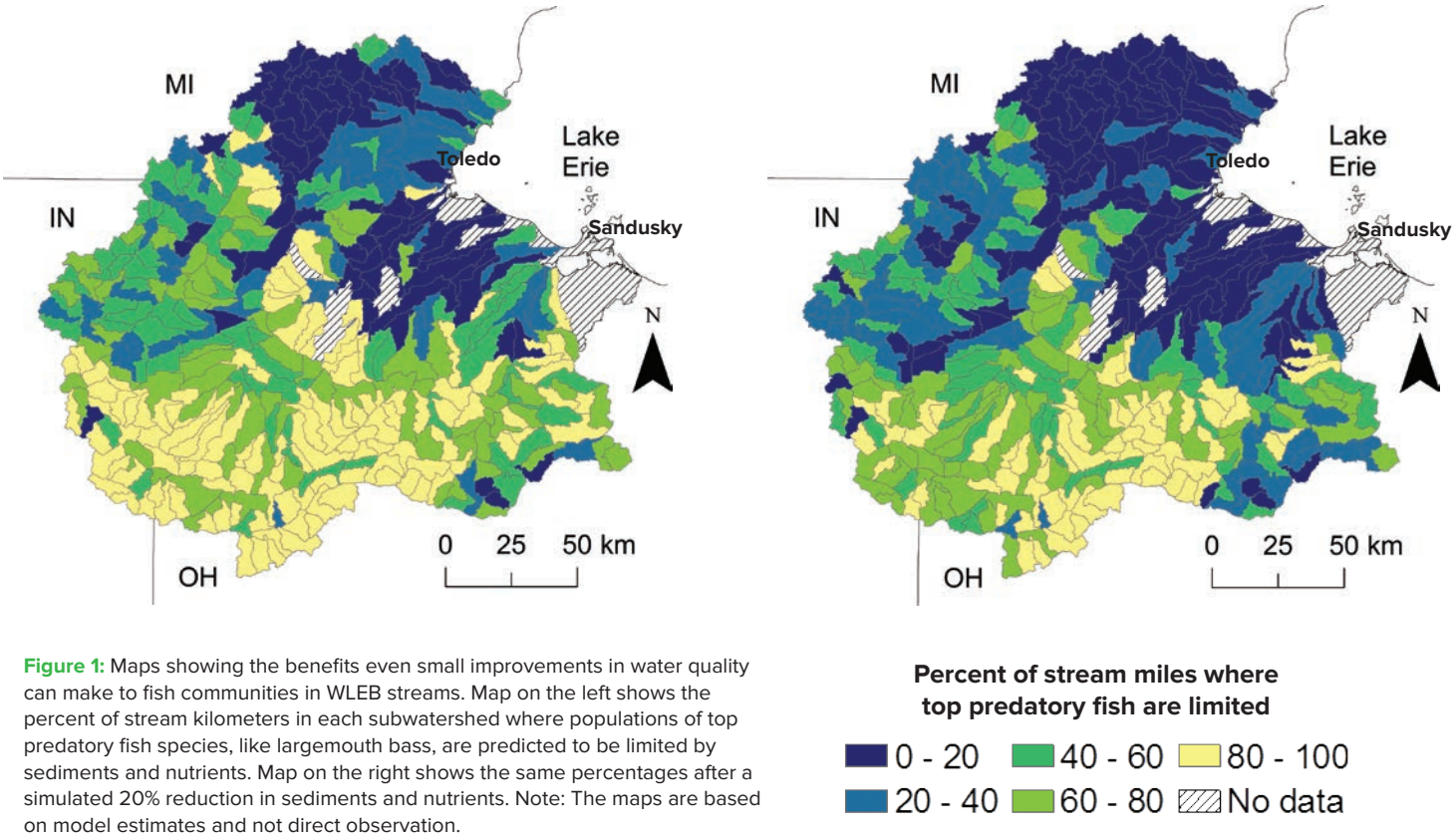



**Figure 1:** Maps showing the benefits even small improvements in water quality can make to fish communities in WLEB streams. Map on the left shows the percent of stream kilometers in each subwatershed where populations of top predatory fish species, like largemouth bass, are predicted to be limited by sediments and nutrients. Map on the right shows the same percentages after a simulated 20% reduction in sediments and nutrients. Note: The maps are based on model estimates and not direct observation.

inputs to streams can increase the health of top predator fishes. The more blue the map becomes, the healthier the watershed is considered to be, which in turn means water from that watershed is less likely to contribute to harmful algal blooms and other problems in Lake Erie.

Shifting colors in the maps can also help pinpoint the small watersheds where future changes in land use practices would have the biggest impact on stream fish communities. While some spots don't change color at all, suggesting little if any improvement, others transition into healthier conditions. This is particularly evident in the northwestern map region, which shifts from regions of mostly 40-80% water quality impact to areas of 0-40% impact with a 20% reduction in nutrient and sediment inputs.

That 20% reduction can be achieved through a combination of best management practices on and around farm fields. On the field, proper timing of fertilizer use, such as not applying to frozen ground or before rainstorms, as well as incorporating fertilizer into the soil, significantly reduces nutrient loss to streams and saves farmers money in fertilizer cost. Managing the water that drains from fields via buffer strips of vegetation between fields and streams, as well as managing drainage water in tile systems, can help keep nutrients and sediment on the field instead of running into streams. Such practices are an integral component of comprehensive watershed management.

While efforts to reduce agriculture-related water quality impacts have increased in recent years, additional expenditures are likely needed to make a difference in stream fish communities. In addition, it is important to note that: efforts should not focus solely on phosphorus, but must also address nitrogen and sediments, we must include a combination of structural practices and nutrient management, and that a high percentage of agricultural lands, up to 100% in a given watershed, should be treated to see measurable in-stream benefits. While it will take a whole suite of practices to achieve those measurable improvements, change is definitely possible.

"Results of our project clearly show that we can achieve significant improvements in both the streams and the lake, but it is going to take a lot of work," said Scott Sowa, director of science at The Nature Conservancy in Michigan, adding: "It also shows that we can't just focus on a single problem or stressor, like phosphorous. We are dealing with a multifaceted problem that will require a variety of practices and innovative collaborative solutions." **TL**

Additional model scenarios are available in the full WLEB CEAP report, which can be found online at ***lakeerieceap.com***.

For more information about the Western Lake Erie Basin CEAP-Wildlife, contact Amy Brennan at ***abrennan@tnc.org*** or use the contact form at ***lakeerieceap.com***.

# Lake Erie Fishery Managers Ask Anglers to Scan Yellow Perch

*by Lisa Aurand Rice, Ohio Sea Grant Communications*

Lake Erie was as smooth and flat as glass on a May morning when researchers from the Ohio Department of Natural Resources Division of Wildlife (ODNR-DOW) and the U.S. Geological Survey (USGS) set out from Fairport Harbor.

Their mission: catch, tag and release as many yellow perch as possible. The project – a collaboration among ODNR-DOW, USGS, Ohio Sea Grant and the Ontario Ministry of Natural Resources and Forestry – aims to study fish behavior, migration, population size and rate of death by natural causes.

Along for the ride that day were Ohio Sea Grant Extension Program Leader Tory Gabriel and two members of the Ohio Sea Grant communications staff, there to produce a video about the project asking anglers for their help to scan any yellow perch they catch for microchips.

The microchips, called PIT tags, are about the size of a grain of rice – 12 millimeters – and work similarly to a pet microchip, explained Carey Knight, a fisheries biologist with the ODNR Division of Wildlife.

Because of their small size, it is impossible to tell if a fish is tagged without scanning it. The part of the fish containing the tag, just under the skin in the fish's throat, is removed as a part of normal cleaning, so tagged fish are safe to eat.

ODNR Fish Biologist Carey Knight demonstrates the PIT tagging procedure on a yellow perch. More than 8,300 fish were tagged during the three-year project.

The team of biologists tagging perch worked methodically, measuring and recording the length and sex of each fish, inserting the microchip into any fish larger than 170 millimeters (6.7 inches), and throwing them back into the lake. A few were placed in a holding pen so the researchers could track what effect the tagging had on fish mortality.

"This research will help us better understand movement patterns of yellow perch in space and time, which in turn will assist management agencies to better manage the yellow perch fishery," said Patrick Kocovsky, a fishery biologist with the USGS Lake Erie Biological Station. "Differences in genetics and morphology of yellow perch throughout Lake Erie discovered through collaborative research was the impetus for the tagging study."

It took many meetings and discussions between USGS and DOW personnel to figure out the best approach to tag and scan the fish, since the organizations hadn't undertaken such a large-scale fish-tagging project before, Knight said.

"One of the best things about working on this project was the affiliation of working with the USGS folks in Sandusky and the Fairport office for the tagging and with the commercial trap netters, cleaning houses, recreational fishers and Sea Grant for the scanning part of the project," Knight said.

The study began in 2013, and ran through three springs. In total, more than 8,300 yellow perch were tagged during the 2013, 2014 and 2015 spawning seasons – all about a half mile west of Fairport Harbor in less than 30 feet of water.

Lake Erie sport fishing is a $1 billion industry, according to Tory Gabriel, fisheries educator for Ohio Sea Grant, which assisted with the project.

"Sport fishing on Lake Erie is hugely important to Ohio's coastal economies, and one of the most important species is yellow perch," Gabriel said. "With this project, anglers have a chance to provide data to the fisheries managers, and in the long term they actually help in keeping Lake Erie a world-class fishery for yellow perch."

It's an easy opportunity to participate in citizen science. All anglers have to do to help is take any yellow perch they catch to a scanning station. They don't even have to take the fish out of their cooler for scanning, Gabriel added.

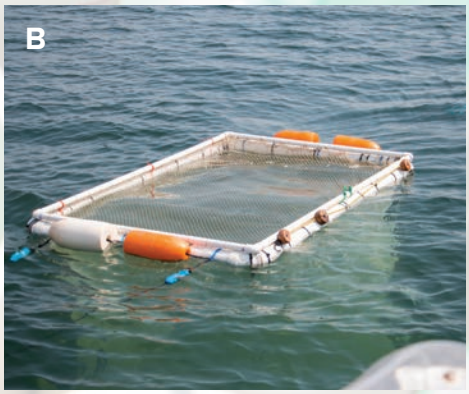
There are currently seven scanners along the Lake Erie coast, and a map of scanner locations is available at ***go.osu.edu/perchscan***.

Scanners – square shaped antennae that detect any of the tagged fish as they pass through – on commercial trap net boats and at cleaning houses have scanned more than 4 million fish so far.

Preliminary results of the study show that yellow perch tend to stick together in groups and stay within a limited area of Lake Erie, Knight said. There also was some evidence that the fish returned mostly to the same spawning area, but that some strays could travel over 200 kilometers.

"This is another case where the tagging of animals has provided valuable information and insight toward the understanding and management of species," Knight said, adding that partnerships with other organizations helped the study go smoothly. **TL**

Watch Ohio Sea Grant's video overview of the project at ***go.osu.edu/perchvideo***.



A) PIT tags are about the size of a grain of rice and work similarly to a pet microchip. B) Clearly marked access gates to the nets make it easier for ODNR to collect yellow perch, and for other boaters to avoid damaging the nets. C) Once fish are pulled into the boats, the researchers work fast to reduce stress on the animals. Prepared trays let them grab the microchip syringes more quickly while working in heavy gloves.

Stone Lab's Advanced Five-Week Courses Offer a

# DEEP IMMERSION INTO SCIENCE

*by Christina Dierkes & Lisa Aurand Rice, Ohio Sea Grant Communications*


Cleveland State student Brittany Dalton (center) worked with Stone Lab research coordinator Dr. Justin Chaffin (left) in the water quality lab during her five-week REU. Dalton now plans to pursue a master's degree in environmental science, focusing on water chemistry and quality.

Potential students at Stone Lab can choose from learning opportunities in all shapes and sizes, from one- to three-day workshops to intensive week-long college courses. But there's a special kind of atmosphere inherent in the lab's five-week courses, which immerse students not only in Lake Erie science, but in the daily life that's so unique to Ohio State's island campus.

Five-week courses meet every other day, either Monday, Wednesday and Friday or Tuesday, Thursday and Saturday. On days when they're not in class, some students study or work on class projects, while others take jobs on or off Gibraltar to help pay their way. And a select group are hard at work on scientific research as part of Stone Lab's Research Experience for Undergraduates Scholarship Program.

For some students, studying at Stone Lab wouldn't be possible without the chance to work on the days when they aren't in class. The lab hires about ten student workers each summer, with compensation for the positions covering room and board for the five-week term.

It was a great fit for Ella Weaver, who is majoring in environmental science at The Ohio State University and is hoping to apply for a job in environmental education after she graduates in December 2016.

"I like informing the public. It was a good place for me," Weaver said, describing how she would lead lighthouse tours or help children at the Aquatic Visitors Center bait their hooks to go fishing. "We worked in the kitchen quite a bit. We did lots of landscaping and cleaning, and we helped with some of the Gibraltar Island tours."

Students who want to squeeze every last bit of education out of their five weeks at Stone Lab can choose a different route. Because five-week classes meet every other

day, some careful planning means dedicated students can take two courses concurrently, with a day off on Sundays. That's what Ohio State senior Kyleigh Godsey did in 2015, pairing Field Zoology with Ecology.

"It was a little busy," but manageable, said Godsey, a zoology major. "It was really nice how they played off each other. We would learn something in Ecology and then in Field Zoology the professor would say, 'Here's what that's like for this species.'"

Or there's the Research Experience for Undergraduates (REU) Scholarship Program, which pairs high-achieving undergraduates with a working scientist for an independent research project during their non-class days. Previous REU students have contributed to research that helps protect Lake Erie fisheries and water quality and assisted in the management plan for the formerly endangered Lake Erie Watersnake. All participants present their research results to an audience of peers and visiting scientists during the last week of the five-week term, and often go on to present at academic conferences as well.

Cleveland State student Brittany Dalton decided to apply for grad school after completing an REU in limnology. During Dalton's time in the Water Quality Lab in the summer of 2016, working with Stone Lab Research Coordinator Dr. Justin Chaffin, she became intensely interested in environmental chemistry and plans to pursue a master's degree in environmental science with that focus.

"I realized how important the work they're doing there is. It's impacting people's drinking water," Dalton said.

Dalton previously took a one-week course, Field Ecology, in 2015. In comparison to that one-week class, which was almost entirely spent in the field, the five-week Field Zoology course she took in 2016 allowed for a mix of field work and classroom instruction – and more time to get to know the instructors and her fellow students.

For all of the students, the extra time at the lab gives them a chance to just enjoy living on a Lake Erie island for a month. A centrally located volleyball court and cornhole boards invite study breaks with students from other classes. On the Western shore of the island is a rocky beach where they can swim and snorkel.

"During free time we would go swimming, watch movies or have our usual study parties," Weaver said, adding with a laugh, "I tried to go fishing a few times, but I was not very successful."

Kyleigh Godsey (left) and her classmates get an up-close look at Lake Erie fish during one of two five-week courses she took at Stone Lab.

For some students whose roommates during the school year aren't science majors, it's a new experience to spend time outside of the classroom with those who share their interests.

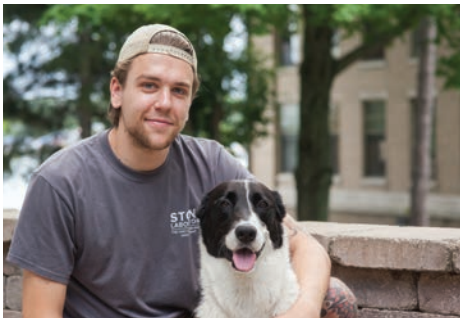
"It's a cool atmosphere to be able to learn and have fun at the same time," said Max Frankenberry, an Ohio State student who took Evolution in 2015. "You have a group of people that are all extremely interested in the same things you're interested in, so the community here on Gibraltar is really cool. You sit in the dining hall talking about an invasive species moving in for an hour."

If they don't have class after dinner or too much studying to do, an evening at the firepit with professors, staff and students can stretch late into the night. Weekly guest lectures held during the term give students the chance to interact with specialists in a variety of fields.

All of those opportunities help bring together people who may not have met if they were taking summer courses on a traditional campus, forging valuable social connections and offering networking opportunities that could very well lead to recommendation letters or graduate school spots.

"You get to meet and talk to people that you normally wouldn't get to," Dalton said of the intimate environment at the lab that promotes conversations between students and guest lecturers such as Craig Butler, director of the Ohio Environmental Protection Agency. "It's a once in a lifetime opportunity." **TL**


Brittany Dalton completed a limnology research project while taking a five-week Stone Lab course.


For Max Frankenberry, a large benefit during his five-week Evolution class was really getting to know classmates who shared his interest in science.

A full list of Stone Lab's five-week courses is available at ***go.osu/edu/upper***. Information on the REU program is available at ***go.osu.edu/reu***.

# HARMFUL ALGAL BLOOM
## RESEARCH INITIATIVE SERIES

The Ohio Department of Higher Education's Harmful Algal Bloom Research Initiative (HABRI) continues to support research efforts focused on solving Ohio's harmful algal bloom problem. Started in response to Toledo's 2014 harmful algal bloom and subsequent drinking water ban, the initiative has provided $4 million in funding for projects ranging from monitoring algal blooms as they develop in Lake Erie to studying the impacts of microcystin on liver disease.

Led by representatives from The Ohio State University and the University of Toledo, and managed by Ohio Sea Grant, HABRI encompasses research projects in four major focus areas: tracking blooms from the source, protecting public health, producing safe drinking water, and educating and engaging people about addressing harmful algal blooms.

For more information about this project, contact Dr. Seo at ***youngwoo.seo@utoledo.edu***.

More information about the Harmful Algal Bloom Research Initiative is available at ***go.osu.edu/habri***.

## Producing Safe Drinking Water for Lake Erie Residents

*by Christina Dierkes, Ohio Sea Grant Communications*

One of the most direct impacts of algal blooms on humans is the safety of drinking water. The August 2014 harmful algal bloom in Toledo shut off water for more than three days, an impact felt by residents and businesses alike. In addition to monitoring bloom locations and adjusting both water intake and treatment methods accordingly, new treatments for contaminated drinking water are being developed to remove both algal particles in general and the toxins produced by cyanobacteria in particular.

Dr. Youngwoo Seo at the University of Toledo, along with Dr. Isabel Escobar at the University of Kentucky, are developing new methods to remove microcystin, the main toxin produced by harmful algal blooms, from drinking water using various filtration methods as well as ozone gas.

"We currently study multiple processes in the water treatment train, and each step can provide an additional barrier to remove a contaminant from water," Seo explained. "As part of the study, we consider both conventional and membrane filtration systems, coupled with ozonation that can oxidize and break down all the organic matter, including algal toxin, in the water."

Laboratory results so far have shown that bubbling ozone into a microcystin solution can lead to 100% destruction of the toxin, but further experiments will be needed to achieve similar results at the desired ozone concentration and treatment time with filtration. A range of filtration systems are also showing promising results, removing up to 96.9% of microcystin from the tested solutions.

Once these separate experiments are completed, combinations of ozone and filtration systems will be examined to determine the best pairing for toxin removal and cost effectiveness. The laboratory models can eventually be scaled up for use at water treatment plants that deal with harmful algal blooms in their water supply. **TL**

**Preliminary results** have shown

**100%**

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

# NOAA and Partners Issue Fifth Seasonal Harmful Algal Bloom Forecast from Stone Lab

*by Christina Dierkes, Ohio Sea Grant Communications*

Drought conditions are rarely good news in the Midwest, but the low amounts of rainfall in early 2016 did one good thing: ensuring that the predicted 2016 Lake Erie harmful algal bloom ranks much lower on the severity scale than 2015's record bloom. That announcement was made on July 7 at the National Oceanic and Atmospheric Administration (NOAA)'s 2016 Harmful Algal Bloom Forecast for western Lake Erie, held at Ohio State's Stone Lab.

The scale, first introduced at the 2014 forecast, runs from a 10, which is equivalent to the bloom observed in 2011, down to zero. The 2015 bloom was rated at 10.5, Lake Erie's most severe bloom to date, while 2016's bloom is predicted to measure at 5.5. Any score above 5 is considered to be of concern.

"However, people will know where the bloom is located, so there is no reason not to travel to Lake Erie for boating or other activities," said Dr. Richard Stumpf, Oceanographer at NOAA's National Centers for Coastal Ocean Science (NCCOS). "You can find a place that's clear" by using NOAA's Lake Erie HABs bulletin, Stumpf emphasized, adding that "most of the lake will be fine."

Harmful algal blooms in Lake Erie most often consist of *Microcystis*, a cyanobacterium — more commonly called blue-green algae — that can produce a liver toxin called microcystin. The toxin can be removed from drinking water drawn from the lake, but significantly increases the cost of water treatment. In addition, harmful algal blooms can severely reduce tourism income, as recreational water use is made hazardous by the toxin, or unpleasant by layers of blue-green algae floating on the water's surface.

Being able to forecast the HAB's extent allows community officials and tourism managers to prepare for its impacts and adjust seasonal budgets in advance instead of reacting to the event as it happens. Stumpf recommends that those interested in getting updates about HABs in Lake Erie subscribe to NOAA's Harmful Algal Blooms in Lake Erie Bulletin, which offers weekly updates of bloom locations and impacts.

The NOAA model that generates the forecast relies on phosphorous data from Heidelberg University as well as on input from three other Lake Erie HAB models, all of which are continually refined as scientists learn more about algal blooms. This year, all four models incorporated last year's extreme bloom and take into account leftover phosphorous and algal cells still present in the lake from 2015 — something Tom Bridgeman of the University of Toledo called a "phosphorous hangover." Without inclusion of this "hangover" and little to no rain between now and the end of July, the models would have predicted a severity as small as 3 for this year's bloom.

Stumpf and Bridgeman both emphasized that this kind of carryover was in large part due to the severity of the 2015 bloom, and that carryover from previous years does not continue indefinitely but likely only impacts the next year's bloom.

Phosphorus, which is contained in animal manure and many commercial fertilizers, tends to be the nutrient that determines the size of the bloom. Phosphorus usually enters the lake in the form of fertilizer and manure runoff, as well as sewage runoff from treatment plants and combined sewer overflows caused by heavy rains.

In addition to monitoring and forecast efforts, the event included presentations from Dr. Christopher Winslow of Ohio Sea Grant and Dr. Jay Martin of The Ohio State University, who spoke about two sets of collaborative research efforts aimed at harmful algal bloom monitoring and reduction. A grant from Ohio's Department of Higher Education, along with funds from Ohio State's Field to Faucet Initiative and Ohio Sea Grant, supports projects at a number of Ohio universities aimed at addressing HABs in the state.


Dr. Laura Johnson of Heidelberg University and Dr. Rick Stumpf of NOAA explain the 2016 Harmful Algal Bloom Forecast to journalists and students at Ohio State's Stone Lab.

Representatives from NOAA, The Ohio State University, Heidelberg University, the University of Toledo, the National Wildlife Federation, Bowling Green State University and LimnoTech were also on hand to answer questions related to the forecast and HABs in general. State and federal Ohio congressional districts were also represented at the event, along with Ohio Governor Kasich's office. TL

A recording of the forecast is available for viewing at ***go.osu.edu/habsforecast2016***.
Additional information on HABs can be found at ***go.osu.edu/habsinfo***.


Charter boat captain Dave Spangler (center) demonstrates the water sampling procedure at Stone Lab's 2016 Harmful Algal Bloom Forecast. Citizen science projects like the charter captains sampling program can play an essential role in educating the public about environmental issues like Lake Erie water quality, according to Stone Lab's Dr. Justin Chaffin (right).

# Lake Erie Charter Captains Play a Major Role in Water Quality Sampling

*by Christina Dierkes, Ohio Sea Grant Communications*

Finding time and money to take regular water quality samples in a space as large as Lake Erie's western basin can be difficult for even the most dedicated researchers. But sometimes, help shows up on a lab doorstep and is too good to turn away.

That was the case in 2012, when a group of Lake Erie charter boat captains approached the Ohio Environmental Protection Agency (OEPA) to ask how they could help monitor and improve water quality in the lake on which their businesses depend. They had seen the impact the severe 2011 harmful algal bloom (HAB) had had on their fishing charters and on other Lake Erie businesses, and wanted to contribute to improving the health of the lake.

OEPA had already trained 12 captains in how to collect water samples, before Stone Lab staff took over coordination of the sampling program in 2013. Managed by Stone Lab Research Coordinator Dr. Justin Chaffin, the program currently works with about 10 captains in the western Lake Erie basin to collect weekly water samples during their regular charter fishing trips from April through October. Captains are recruited with help from the Lake Erie Charter Boat Association (LECBA) and currently hail from five different Ohio marinas, all located between the city of Oregon and the village of Marblehead.

"Charter captains will grab a water sample for us after they've finished fishing, and then my staff picks it up and processes it," said Chaffin. On those weekly runs to pick up samples and drop off clean sample containers, staff members also provide the captains with data sheets on previous weeks' water quality results. That way, captains are able to provide their fishing clients with science-based information on Lake Erie water quality. Yearly training also ensures that captains have a basic understanding of how harmful algal blooms form and what can be done to reduce the blooms' impacts on Lake Erie in general and on their fishing clientele in particular.

"To solve this HABs problem, we need a lot of public outreach, and I believe citizen science can help with this," Chaffin said. "If we're training captains to collect samples, and we also give them accurate information about HABs, they can help us spread that information. But we're also getting a pretty good dataset in return, so this project is really a science, education and outreach project."

The data the captains have collected has been used in NOAA research to confirm bloom observations via satellite and by researchers from the University of Toledo who were comparing different sampling methods. A current project at NOAA's Great Lakes Environmental Research Laboratory is developing a model to predict microcystin concentrations in Lake Erie, and charter captain samples help assess the accuracy of those predictions.

In addition, Stone Lab outreach events often incorporate the trends shown in the water samples into their programming, giving adult tour groups and other visitors a chance to see how citizen science projects like this contribute to larger research and monitoring efforts that help safeguard Lake Erie water quality. **TL**

A video overview of the sampling program and a two-page print overview are available at ***ohioseagrant.osu.edu/research/live/water***.

# How'd THAT get there?

## Ohio Sea Grant research to gather phosphorus signatures that can help in HABs management

*by Christina Dierkes, Ohio Sea Grant Communications*

Phosphorus in Lake Erie is known to contribute to harmful algal blooms (HABs) by providing the cyanobacteria that cause them with a major nutrient they need to grow. Management efforts often focus on reducing the amount of phosphorus that reaches the lake, but targeting those efforts can be difficult when phosphorus could be coming from a wide range of sources.

However, some researchers are digging deeper into ways to identify where exactly that problematic phosphorus is really coming from, drilling down to the molecular level by looking at what other elements are bound to phosphorus in the Lake Erie watershed and finding clues to its origins that way.

Dr. Paula Mouser, assistant professor in the Department of Civil, Environmental and Geodetic Engineering at The Ohio State University and PhD candidate Michael Brooker are using some new techniques to detect organic phosphorus compounds – those containing to some form of carbon – in water samples.

Historically, harmful algal bloom research has focused on phosphate, an inorganic phosphorus compound commonly used in fertilizers, as well as other soluble reactive phosphorus (SRP) forms. Phosphates are the dominant form of phosphorus in natural waters, and the relative ease of identifying them has made them the standard measurement for routine phosphorus monitoring in rivers and streams leading into Lake Erie. However, organic compounds containing phosphorus can come in literally hundreds of forms, and from a wide variety of sources.

For this study, the Ohio State team collected samples from six different sources in the Sandusky River watershed: chicken, dairy and hog farm manure, runoff from farm fields with row crops, and wastewater treatment plant discharge, along with river water from farther downstream. Within each of those samples, the researchers detected between 100 and 300 different organic phosphorus compounds, based on preliminary study data.

The researchers extracted organic phosphorus compounds from the water samples and analyzed them using a technique called Electrospray Ionization Fourier Transform Ion Cyclotron Resonance Mass Spectrometry – "quite a mouthful," Mouser agreed – to identify the molecules without breaking the often delicate bonds that hold them together (since breaking the bonds would mean the molecule was no longer the same one that occurred in the sample). That analysis is performed at the Woods Hole Oceanographic Institution, one of the few places in the United States to house this particular kind of equipment.

Doctoral student Michael Brooker isolates and concentrates organic compounds from water samples collected in the Sandusky River watershed. Once each phosphorus compound is identified, the researchers can develop a "signature" for phosphorus coming from specific sources, helping water managers to better target phosphorus reduction efforts to those sources.

The result of this analysis then develops into a unique signature for each of the samples, showing both similarities and major differences. For example, the farm field runoff and the treatment plant discharge had the highest number of shared phosphorus compounds, while the manures had more unshared, unique formulas.

"Right now we are characterizing what the phosphorus signature is for each of those sources," said Mouser. "As the ultimate goal, once we know which phosphorus compounds come from each source, we can try to link those organic phosphorus compounds in rivers and lakes impacted by HABs to a likely upstream source location."

Mouser doesn't expect this project alone to provide that information, of course. Complementary projects led by Kevin McCluney at Bowling Green State University and Laura Johnson at Heidelberg University will provide information on sources of inorganic, total and dissolved reactive phosphorus in the watershed. The researchers hope that pulling all of this information together will help guide pollution management strategies in the Sandusky River watershed by focusing efforts on specific phosphorus sources that contribute most to the total phosphorus going into the watershed.

The project is funded by Ohio State's Field to Faucet Initiative and by the Ohio Department of Higher Education's Harmful Algal Bloom Research Initiative (HABRI), which is managed by Ohio Sea Grant. More information about other projects in these initiatives is available online at ***go.osu.edu/habsinfo***. TL

For more information about this research, contact Dr. Mouser at ***mouser.19@osu.edu***.




# STONE LABORATORY Summer Courses 2017

## Introductory Courses – 2 credits

*Sunday-Saturday. Open to advanced high school students and current college students.*

**June 11-17**

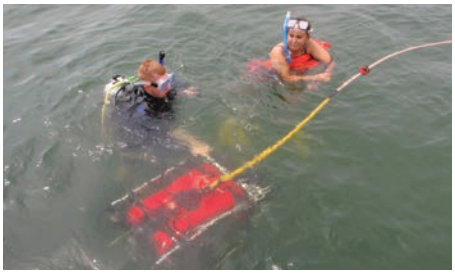
| | |
|---|---|
| ENR 2360 | Ecology and Conservation of Birds |
| EARTHSC 1107 | Field-Based Introduction to Oceanography |
| EEOB 1930 | Introduction to Biological Studies – Aquatic Biology |
| KNSHP 1140.05 | Lake Erie Sport Fishing |

**July 23-29**

| | |
|---|---|
| EEOB 1930 | Introduction to Biological Studies – Aquatic Biology |
| EEOB 1920 | Introduction to Biological Studies – Birds |

**July 30-August 5**

| | |
|---|---|
| EEOB 1930 | Introduction to Biological Studies – Aquatic Biology |
| EEOB 1910 | Introduction to Biological Studies – Local Plants |
| ENTMLGY 1260 | Introductory Insect Field Biology |



## Upper-Level Courses

*Open to college students who are studying biological sciences, education and natural resources as well as science teachers.*

### FIVE-WEEK COURSES – 4 CREDITS

**June 18-July 22**
Monday, Wednesday and Friday OR Tuesday, Thursday and Saturday.

| | |
|---|---|
| EEOB 5420 | Aquatic Ecosystems – Ecology of Inland Waters (TRS) |
| EEOB 3420 | Behavioral Ecology (MWF) |
| EEOB 3410 | Ecology (TRS) |
| EEOB 3310 | Evolution (MWF) |
| EEOB 5940 | Field Zoology (TRS) |
| EEOB 5930 | Ichthyology (MWF) |

### ONE-WEEK COURSES – 2 CREDITS

**May 21-27**

| | |
|---|---|
| EEOB 5910 | Field Herpetology |

**July 23-29**

| | |
|---|---|
| EEOB 4950 | Field Ecology |

**July 30-August 5**

| | |
|---|---|
| EEOB 5210 | Spider Biology |

## Non-Credit Workshops

*One- to three-day courses open to the public. Participants must be at least 18 years of age and have completed high school. Visit **go.osu.edu/SLworkshops** for more information and additional workshops.*

- Algae Identification
- Aquatic Invasive Species – Hazard Analysis and Critical Control Point (AIS-HACCP)
- Dealing with Cyanobacteria, Algal Toxins and Taste & Odor Compounds
- Fish Aging
- Fish-Sampling Techniques
- Fisheries Fundamentals
- Lake Erie Sport Fishing
- Larval Fish Identification
- Outdoor Photography

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**stonelab.osu.edu**

## Educator Courses – 2 credits

*Open to both formal and informal educators and college students studying education.*

| | |
|---|---|
| **June 11-17** | Water and Wildlife Training for Educators |
| **July 15-21** | Field Geology for Educators: Geologic Setting of Lake Erie |
| **July 23-29** | Field Ecology |

## REU Program

Stone Lab's five-week Research Experience for Undergraduates (REU) Scholarship Program runs concurrently with the five-week upper-level courses. REUs spend non-class days working one-on-one with research supervisors, collecting data, analyzing discoveries and preparing a final presentation.

- Invasive species and forest composition of the Lake Erie Islands (Botany)
- Ecology and conservation issues in northern Ohio crayfish (Ecology)
- Visual ecology of walleye and emerald shiners (Ichthyology)
- Survival of birds inhabiting the Lake Erie Islands (Ornithology)
- Fish investigations to inform fisheries management (Fisheries Research/ Management)
- Exploration of Lake Erie nutrient loading, hypoxic events (the "dead zone") and harmful algal blooms (Limnology)

## Tuition Assistance and Jobs

All students taking for-credit courses are eligible for scholarships. High school students are awarded an average of $700 each, while undergraduate students were awarded an average of $900.

*Course credits are based on The Ohio State University semester credit system and are transferrable to most colleges.*

20/20 VISION

**STUDENT** SPOTLIGHT

*by Lisa Aurand Rice, Ohio Sea Grant Communications*

# Tiny **BUT MIGHTY**

Small classes made a big impact on Ella Weaver

An Ohio State University education and a career in science almost seemed like a predetermined fate for Ella Weaver.

Nearly all her family members attended Ohio State, said Weaver, who is from Archbold in Fulton County, Ohio and is currently a senior on track to graduate in December 2016. Her father, Michael, was a soil conservationist and her uncle works for the Environmental Protection Agency. That, in addition to being raised in the country, helped Weaver feel a connection with nature early on.

"We lived right next to a creek and I was always playing in the creek," Weaver said. "Whenever we got together a lot of our family gatherings were focused on being outside."

Now she's majoring in environmental science and has a job at Ohio State's Kottman Hall, where the administrative offices for the School of Environment and Natural Resources are located. It was there that she first heard about Stone Lab from some of the academic advisors.

"My major is really geared toward more field work, so I thought a Stone Lab course would be a good complement as far as what skills I need," Weaver said, adding that she needed to take Ecology in order to graduate. "It was kind of good timing."

Arriving at Gibraltar Island in mid-June, Weaver was astonished at how small the island was and how intimate the classes were; her class had just seven other students – a far cry from the large classes she was used to taking at Ohio State.

"I've never really been anywhere with that few students," she said. "I got to know everybody there. I was kind of surprised that many people came from other colleges, too." Students from any university can take classes at Stone Lab, as the credits are transferrable to most schools.

Weaver said the about 30 students who lived on Gibraltar during the 5-week term grew very close in just a few short days.

"I really felt like after a week or so that I was part of the island life," she said. One of her favorite things about her time at Stone Lab was spending time with others who shared her interest in science. "We're still really good friends even though some of the students didn't go to Ohio State. We really did bond while we were there."

Weaver was one of eight student workers who earn free room and board in exchange for helping with daily operations of the lab, including housekeeping and kitchen duties, and assisting with tours at the Aquatic Visitors Center (AVC) and South Bass Island Lighthouse.

On class days, they'd either attend lecture on Gibraltar or go out into the field to do macroinvertebrate sampling or seining, or to study photosynthesis.

"It was a great experience and I'm really glad that I got to do it," Weaver said. "It's completely different from a traditional classroom setting. It gets you the hands-on experience that all science majors should have, and it really gave me a dynamic understanding of Lake Erie and its ecosystems that has carried over into my other classes," she said.

But the hours she spent leading tours at the AVC and lighthouse were just as worthwhile; Weaver plans to pursue a job in environmental education after she graduates, and those face-to-face interactions will be an invaluable addition to her resume. **FOSL**

# Friends Of Stone Laboratory

## Dear friends,

*Fall is upon us and we have completed another successful Open House at Stone Lab. This year, in spite of the rain, we hosted 1,269 visitors to Gibraltar and 427 at the lighthouse. Based on the responses from the tours I guided I would say about 70% of the adults were first-timers on the island. This is a great way to expose people to what we do at the lab and hopefully one result of that will be more enrollees in our classes and workshops. Also thanks to all our volunteers who, as usual, made the weekend run like clockwork.*

*On a personal note I want to thank the membership for allowing me to serve for a third year as President of FOSL. I am now "term limited," and this will be my last year, but we have an exciting new Board and some promising new initiatives so I hope it will be a productive time.*

*As I write this I'm sitting on my boat enjoying a beautiful late summer afternoon on Lake Erie. Those of us who spend a lot of time here know what a valuable resource this lake is to all of Ohio and the Midwest. The research and the education that are what Stone Lab is all about is of critical importance as we face the dual threats of algal blooms and invasive species. Please help us to spread the word about the lab and its programs, so that we can continue to address these issues, and ultimately a new generation of fishers, boaters and vacationers will be able to appreciate and enjoy this beautiful lake.*

*Finally, as we enter the "off season" for the lab, and the holidays approach (can it be that time already?), please consider a contribution to any of our 20+ endowments so that we may welcome you as a new or renewing Friend of Stone Lab. The donations page can be found at* ***ohioseagrant.osu.edu/giving****. Thanks and have a great Fall!*

*Sincerely,*
*Ken Scott*
*FOSL President*

### Friends of Stone Lab Open House September 2016

The 2016 Stone Lab Open House was held on September 10. While a less than ideal weather forecast put a damper on some guests' travel plans, many still took advantage of what turned out to be a nice fall day to spend on a Lake Erie island.

More than 780 guests visited Gibraltar Island to learn about Lake Erie science and history from FOSL volunteers and Stone Lab staff members. Fish dissections and visits with the Stone Lab outreach snakes were popular with many of the guests, as was simply enjoying the scenic view from Perry's Lookout.

The 167 visitors at the South Bass Island Lighthouse were treated to a lighthouse tour, including a winding trip up the narrow stairs of the lighthouse tower. 260 more guests visited the lighthouse grounds to take in the view and listen to butterfly garden talks about Stone Lab's waystations for Monarch butterfly migration.

And at the Aquatic Visitors Center, guests got a chance to peer through microscopes at plankton, Lake Erie's tiniest inhabitants, and to take a closer look at some of the fish who call the lake and its tributaries home.


Many thanks go to the staff members and FOSL volunteers who helped make the 2016 Open House another success. Plans for the 2017 event, tentatively scheduled for September 9, are underway.

# FOSL

*The Friends of Stone Laboratory (FOSL) began in 1981 as a support group to "bring Stone Laboratory into the 21st century with the best possible facilities, equipment, and professors, and make this an unequaled learning experience available to all outstanding students." Members of the Friends provide a way for former students to support the facility by raising awareness and funds for scholarships, research and equipment.*



**F.T. STONE LABORATORY FIELD STATION**

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## Save the Dates

**Winter Program** *February 7, 2017*
**Spring Work Weekend** *April 22-23, 2017*
**Open House** *September 9, 2017*
**Buckeye Island Hop** *October 20-22, 2017*

# State Science Day Students Win Stone Lab Scholarships

Every year at Ohio State Science Day, students not only compete for a title – they're also eligible to win a scholarship covering room and meals at Stone Lab during a one-week course. Funded in part by the Friends of Stone Lab (FOSL), the scholarship gives outstanding high school students a chance to get a head start on college science classes at a reduced cost, and immerses them in Lake Erie science right when they're starting to figure out whether a career in the sciences is the right fit for them.

High school juniors and seniors can apply for any of Stone Lab's one-week introductory classes, such as aquatic biology, plant biology or ornithology, the study of birds. Stone Lab credits are transferable to most universities, and recommendation letters from college-level instructors always look good in college applications.


## 2016 State Science Day Scholarship Winners

**Michael Chmura**, St. Vincent St. Mary High School
**Aylisa Grenald**, Horizon Science Academy
**Mary Harris**, Mt. Vernon High School
**Anna Kruse**, Bloom Carroll High School
**Gretchen Lee**, Pettisville High School
**Maya Quale**, Dayton Regional STEM School
**Akul Rajan**, William Mason High School
**Caleb Rykaczewski**, Mentor High School
**Holly Schmenk**, Patrick Henry High School
**Sarah Seeley**, Benjamin Logan High School
**Riley Sheets**, Rutherford B. Hayes High School
**Jordan Skates**, Pettisville High School
**Kavin Vedamoorthy**, New Albany High School
**Ashwin Veeramani**, The University School
**Kaci Way**, Northwestern High School

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# 2020 VISION

In 2001, Adam Betuel was a high school student at Stone Lab, taking a class in ornithology, the study of birds. Today, he's the director of conservation for the Atlanta Audubon Society, working to make Atlanta a more bird-friendly place.

"My experience at Stone Lab was exciting and enlightening and steered me toward a personal and professional interest in birds and wildlife. The immersive nature of the course, the bond our small class had, and the frequent trips to the wild lands of Lake Erie and northern Ohio were a few of the reasons I so greatly enjoyed my time there."

Your donations to Stone Lab support students like Adam by funding scholarships, lab equipment and teaching facilities. Donate at ***go.osu.edu/SLgift***.

OHSU-TL-1552