

TWINELINE

2014 SUMMER / FALL EDITION VOL.36/NO.2

A close-up photograph of a Great Egret's head and neck. The bird has a long, sharp beak that is open, holding a small fish. The bird's feathers are a mix of grey and white, and its eye is a bright yellow. The background is a warm, golden-brown color with a bokeh effect, suggesting a sunset or sunrise. The overall mood is serene and natural.

Maintaining Healthy Lake Erie Shores

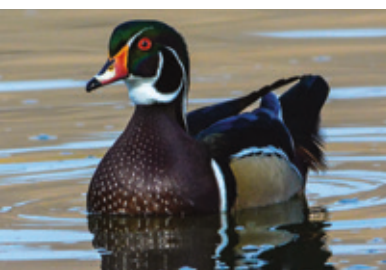
Ohio Sea Grant researchers keep
a watchful eye on migrating birds



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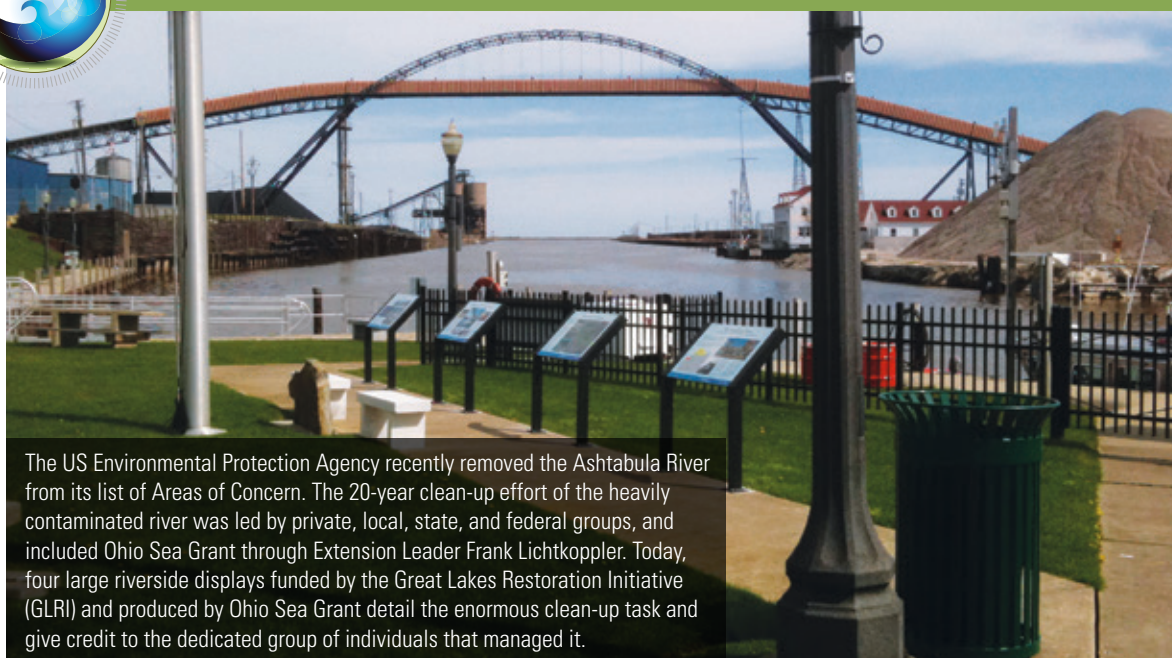
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Cleaning Up the Ashtabula River



The US Environmental Protection Agency recently removed the Ashtabula River from its list of Areas of Concern. The 20-year clean-up effort of the heavily contaminated river was led by private, local, state, and federal groups, and included Ohio Sea Grant through Extension Leader Frank Lichtkoppler. Today, four large riverside displays funded by the Great Lakes Restoration Initiative (GLRI) and produced by Ohio Sea Grant detail the enormous clean-up task and give credit to the dedicated group of individuals that managed it.

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by Christina Dierkes, Ohio Sea Grant Communications

after the birds HAVE GONE

Ohio Sea Grant researchers are monitoring northern Ohio wetlands for influenza viruses

The words “avian influenza” – more commonly referred to as “bird flu” – still have a scary ring to them, even a few years after the massive media coverage from Asia. While the stories have all but disappeared from American news, researchers around the world continue to focus on avian influenza viruses, tracking their movements, and working to prevent their spread and contain outbreaks.

Dr. Richard Slemons and Dr. Robert Gates at The Ohio State University are some of those researchers. They monitor northern Ohio wetlands for influenza viruses, determine how they might enter the Lake Erie ecosystem, and assist wildlife and human health experts in making decisions to protect waterfowl and humans. In a recently completed project funded by Ohio Sea Grant, the research team wanted to determine how long influenza viruses could be expected to stay viable in Lake Erie wetlands after they are introduced by migrating birds.

“The question is: how long would a virus of concern present a threat,” says Slemons, Professor Emeritus in Ohio State’s Department of Veterinary Preventive Medicine. “If the H5N1 influenza virus would be introduced into our ducks in North America, or if a new virus emerges that represents a direct threat to humans, how long do we have to keep duck hunters, swimmers or birders out of the marsh?”

▲ **Top:** Dr. Richard Slemons holds one of the birds from which the team collected samples during the study.
Inset: Virus samples are inoculated into chicken eggs for replication and easier detection.

T

o answer this question, the researchers are studying virus viability in the environment, using viruses that are routinely present in waterfowl in North America and don't pose a threat to human health.

Influenza A viruses, including the ones of concern for this study, are classified by two of the proteins on their surface: hemagglutinin (H) and neuraminidase (N), which is where names like H5N1 ("avian flu") or H1N1 ("swine flu") come from. There are 17 known H subtypes and 10 known N subtypes, according to the Centers for Disease Control and Prevention.

How long viruses can stay viable outside of the living host is important in controlling and stopping the spread of an infectious virus. Viruses can only replicate in the living cells of a susceptible host, such as a bird or a human, and replication is required for virus spread. Once the virus is shed from an infected host, it has to stay viable until it can infect the next host. If a virus does not stay viable in the environment for long (or at all) and exposure to new hosts is prevented or decreased, infections are self-limiting and die out.

"We do know that, at optimal temperatures and water conditions, influenza viruses can persist for 30 days, if not longer," says Slemons. "So determining environmental conditions

in Lake Erie marshes and developing a model to test influenza A virus viability in those conditions was what we were after when this research started. The specific question we asked with the Sea Grant project was, if an influenza A virus like the highly pathogenic Asian H5N1 was introduced into Ohio marshes, how long could that virus last in our marshes? That was our key question from the viewpoint of protecting the health of people."

The researchers created miniature versions of a Lake Erie wetland, based on data collected in large part by Dr. Gates and his student at a number of spots along the Lake Erie shore. Parameters like pH, salinity, oxygen content of the water, and temperature were compared, and while there were expected differences between the wetlands, the overall differences weren't too great. This allowed the research team to create an "average marsh" laboratory sample using materials obtained from one location that gave them unrestricted access to its private grounds.

To test virus viability in these "average marsh" microcosms – essentially plastic containers filled with water and mud similar to what is found in Lake Erie wetlands – the researchers added a known amount of influenza viruses, and then maintained the miniature wetlands in the lab for about 30 days. Once a week, they took samples from the microcosms to establish if the viruses they had added were still viable.

The wetland samples were added to a virus maintenance medium, mixed to suspend the viruses, and centrifuged to remove the dirt particles. The suspension of medium and virus particles was then inoculated into chicken eggs to allow the viruses to replicate for easier detection in lab tests.

"So we take the suspension that may or may not contain viable virus, and then it's a really high-tech method," jokes Jacqueline Nolting, Research Associate and Project Manager for the lab. "You use a nail to poke a little hole in the egg shell – you can hit an egg a lot harder than you probably think over the air cell – and then we use a syringe and inoculate the centrifuged microcosm suspension into the egg." Fertilized eggs are often used for viral research, as the cells of the embryonic membranes are excellent hosts for virus replication.

After three days of incubation, embryonic fluid was removed from the egg to be used in a hemagglutination test – whether the fluid will clump red blood cells – that is used to detect certain viruses. The test uses a suspension of chicken red blood cells in small round-bottom cups, to which fluid from the eggs is added.

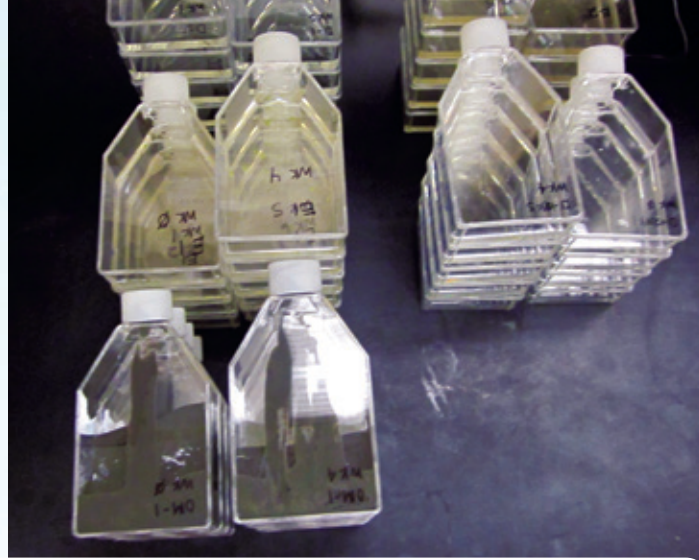
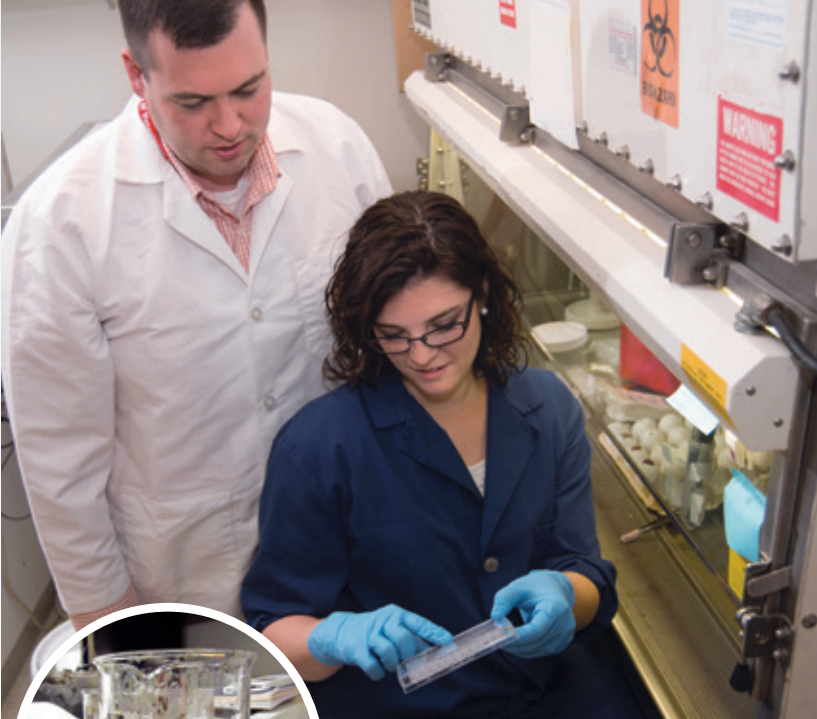
"After a 45-minute incubation on the benchtop, you see one of two results, a positive or a negative," explains Nolting. "In the negative, all the red blood



Left: The research team includes graduate and under-graduate students as well as professional staff.

Below: With hundreds of thousands of birds migrating through Lake Erie wetlands each spring and fall, this vital stopover could potentially expedite the spread of a viral infection across North America via migratory flyways.





Left: Dr. Andrew Bowman and Project Manager Jacqueline Nolting continue to monitor for the presence of avian influenza A in Lake Erie wetlands. Should the virus be detected, the team recommends that the marsh is closed to visitors for at least 30 days to prevent potential human infection. **Inset:** The researchers were able to use samples from one location to represent a "standardized" Lake Erie wetland.



“The specific question we asked with the Sea Grant project was, if an influenza A virus like the highly pathogenic Asian H5N1 was introduced into Ohio marshes, how long could that virus last in our marshes?” — DR. RICHARD SLEMONS

cells just pellet to the bottom of the plate well, and so you have just a tiny red dot at the bottom of the well. If it's positive, then the viruses will bind to the receptor sites on the red blood cells and it forms a matrix, so it looks like a sheet of red blood cells lining the bottom of the well, rather than just the little red dot.”

Because several viruses would lead to the same positive result, the researchers then use an influenza A test strip to confirm that the red blood cells are indeed reacting to an influenza A virus.

While the project did not go off without a hitch, the researchers are confident to say that some viruses can remain in the wetland environment of Lake Erie for at least 30 days, even without infected birds continuing to shed virus into the marshes. The larger project is ongoing, so the team hopes to expand the experiments to determine a more specific endpoint to the timespan and identify which strains of avian influenza virus, if any, can remain outside of a host longer.

Of course, the natural setting of Lake Erie marshes limits possible active intervention options if an influenza A virus of concern were to be introduced into Ohio's wetlands. “It's hard to manipulate a marsh, so you have to let Mother Nature inactivate the virus,” Slemons explains. “You can control or recommend limited access until the threat is decreased, but how long is that? We are working on getting more data to determine if 30 days is too short or too long.”

The researchers are continuing to try to find

an end point to the infectivity of viruses in the wetland environment, but ran into a problem with mold contamination of the wetland samples and maintaining desired oxygen levels in the microcosms in the laboratory. Their ongoing avian influenza research is in collaboration with a number of research labs and government agencies, including the USDA's National Veterinary Service Laboratory, and the National Institute of Allergy and Infectious Diseases (NIAID) Centers of Excellence for Influenza Research and Surveillance.

The ultimate goal of the research project is to be able to provide recommendations for wildlife managers and public health officials if a virus strain of concern is introduced to the Great Lakes, and to offer training and knowledge before the problem becomes acute. “Day in and day out, we have been planning for what would we do to prepare should a virus of concern be introduced,” says Slemons. “Having science-based data for decision making is extremely valuable if a threat is detected.”

Nolting is also working with local zoos to catalogue and monitor viruses that are present in their bird populations. Influenza infections in

zoo birds appear to be relatively common, but the viral strains found there are usually not a health threat to the birds or to the human keepers and visitors who come in contact with the animals.

“We now have some insight into what's going on in the zoos, it's apparent that the viruses we have detected do not present a crisis,” Slemons explains. “However if a virus of concern is detected, then zoo personnel would take appropriate action.”

At the moment though, the viruses being found in the Great Lakes aren't a concern for human health. “The viruses are very adapted to birds, and to waterfowl in particular,” Slemons says. “They may occasionally infect people, but nobody has ever been shown to have a clinical illness caused by one of these viruses. I have a runny nose today, that's about all it would be with this kind of virus.”

By following proper food safety standards – such as regular handwashing, keeping kitchen surfaces and equipment clean, and preventing cross contamination – hunters and those who consume wild birds shouldn't have to worry about health concerns, says Slemons. “Sticking to home economics 101 rules is important for all our food products, no matter where they come from.” **TL**



For more information about this Ohio Sea Grant supported project, contact Dr. Andrew Bowman, the project's new principal investigator, at [bowman.214@osu.edu](mailto:b Bowman.214@osu.edu).

Environmental EDUCATION GOES LOCAL

by Christina Dierkes, Ohio Sea Grant Communications



Students who live in Great Lakes states or near an ocean coast may know about the importance of those natural resources from school, but many have never had the chance to experience that particular ecosystem up close. To help them connect the theory of what they learn in class with hands-on experiences that bring them closer to their local natural areas, the National Oceanic and Atmospheric Administration (NOAA) created the Bay Watershed Education & Training (B-WET) program in 2002.

B-WET is an environmental education program, funded by NOAA's Office of Education, that promotes locally relevant learning through hands-on experiences for K-12 students. B-WET programs currently exist in seven regions: California, the Chesapeake Bay, the Great Lakes, the Gulf of Mexico, Hawaii, New England, and the Pacific Northwest.

In the Great Lakes region, one B-WET project, led by Pennsylvania Sea Grant in cooperation with Ohio Sea Grant, combines a three-day teacher education workshop with year-long support and funding for at least one stewardship project or other Meaningful

Watershed Educational Experience (MWEE), to be completed with students at the teachers' home schools. That support includes everything from funding to having B-WET staff help teachers come up with service projects and other ideas during visits and monthly phone calls.

"So many times, you go to a workshop and get ideas, but you never get any follow up from the program," says Lyndsey Manzo, Ohio Sea Grant Educator and one of the program organizers. "You want to take students to a water treatment plant, for example, but you don't have any money to cover a substitute teacher or the bus. Here we were providing all of that, and one of our goals was to be able to really let teachers implement what they learned with their students."

During the summer workshop, held in Erie, Pennsylvania and Bay Village, Ohio, teachers not only learned about some of the curriculum lessons available from state Sea Grant offices, but also became actively engaged in their own MWEEs. Participants removed invasive plant species with an Erie group called Weed Warriors, learned how to plan a rain garden, kayaked on Lake Erie, and cleaned up Huntington Beach, a local Cleveland beach, as part of the Alliance for the Great Lakes' Adopt-a-Beach program.

Ohio teachers Bonnie Sansenbaugher and Lisa Bircher from East Palestine High School near Youngstown have taken the ideas they got during the initial workshop and run with them back in their classrooms. They started a science club at their high school, which currently has 22 members who are all strongly engaged in the activities and learning experiences provided by the group.

"We have some students that would not have been in any other clubs because they think that they're not athletic, they don't have a lot of money, but science interests them," says Bircher. "Through the science club, we'll take some of these kids on field trips, and it allows them to be a part of something. We have 22 strong members, who are learning a lot about the Great Lakes, wetlands, watersheds, everything that we've presented to them they've just absorbed."

B-WET also requires teachers and their students to participate in the Ocean Conservancy's International Coastal Cleanup. "That experience was very powerful for them," says Sansenbaugher. "We removed a lot of trash, 235.5 pounds of it, and that really emphasized that most of the stuff that's in the ocean comes from land based activities,



► **Above:** Students from East Palestine High School visit Presque Isle in Pennsylvania. As part of the year-long B-WET program, teachers receive support for field trips and other programs so that they're able to fully implement what they learned in the initial workshops with their students.

“Through the science club, we’ll take some of these kids on field trips, and it allows them to be a part of something.”

— LISA BIRCHER

which is us, and if you clean it up now it has less chance of ending up in the ocean and in the Great Lakes.”

In addition to an overnight camp trip in the spring, science club members are planning a presentation to the school board, giving them valuable practice in public speaking and community participation. The students will present their ideas for an outdoor education area on school property, which would be accessible not only to the high school, but to middle and elementary school students as well.

“Our superintendent is jumping on board with that idea,” Sansenbaugher adds. “He’s definitely been excited about us doing this.”

Sansenbaugher and Bircher are also working on grant proposals that would fund additional activities for their students, such as another trip on the *Environaut*, Pennsylvania Sea Grant’s research and education vessel. Overall, the experience has shown them just how much they can accomplish for their students when they continue to motivate each other.

“There is no way either of us could have been anywhere near as productive as we’ve been this year, but this way, we’re really able to keep motivating each other” says Bircher. And if their students have anything to say about it, they’ll be having fun with their science club for quite a while yet. **TL**

► The EPA’s R/V Lake Guardian

For their own professional development, Bircher and Sansenbaugher are applying to spend part of their summer on the U.S. EPA research vessel *Lake Guardian*, which allows teachers to participate in the ship’s Great Lakes research and monitoring program.

This year, the *Guardian* traveled on Lake Erie, stopping in Cleveland, Erie, and Put-in-Bay for science experiences, and offering teachers the opportunity to learn first-hand about the Lake Erie ecosystem, its inhabitants, and the human impacts that affect it. Applications for 2015 cruise opportunities on Lake Michigan will open soon! **TL**





KEEPING *it* CLEAN

OHIO CLEAN MARINAS PROGRAM
CELEBRATES SUCCESSES



by Christina Dierkes, Ohio Sea Grant Communications



On a warm, sunny day, the Lake Erie shore abounds with visitors. From beachgoers and swimmers to anglers and boaters, people often travel from far away to spend time on the lakeshore, and businesses in the region rely on visitor spending for much of their income.

Those businesses include recreational marinas, where private boat owners and charter captains dock their vessels when they're not out on the lake. Because of their location right on (and in) the water, marinas along the Lake Erie shore contribute greatly to the health and wellbeing of the lake ecosystem.

A number of these marinas are Ohio Clean Marinas, meaning that they have pledged to follow a set of environmental guidelines that help protect and preserve the Lake Erie ecosystem for future generations. Their efforts have been certified by the Ohio Clean Marinas Program, a partnership between Ohio Sea Grant, the Ohio Department of Natural Resources, the Lake Erie Marine Trades Association, and other agency and industry representatives. A companion effort, the Ohio Clean Boater Program, focuses on the steps that individual boaters can take to help maintain the health of Lake Erie and its surrounding waters.

"The Ohio Clean Marinas Program encourages marinas to play a role in protecting our most valuable resources – clean air and water – and rewards marinas that go above and beyond to adopt best management practices at their facility," says Sarah Orlando, Ohio Clean Marinas Program Coordinator.

Above: Forest City Yacht Club in Cleveland is one of 44 certified Ohio Clean Marinas.

At right: The marina has been able to incorporate Clean Marinas Program recommendations into ongoing updates to the property.

Forest City Yacht Club in Cleveland, just a few miles east of downtown, is one of those certified Ohio Clean Marinas. John Hanson, Chairman of the Environmental & Clean Marina Committee at Forest City Yacht Club, uses information provided by the program to help club leadership understand and prioritize environmentally sound marina practices. In addition to used oil recycling and participating in the



In the future, Forest City Yacht Club plans to work closely with the Ohio EPA to show off its improvements and create an open dialogue between club members and regulators.



Ohio Clean Marinas Shrinkwrap Recycling Program, Forest City has planned ahead during some recent construction work to make sure the marina's boat wash area could in the future be connected to the sewer system instead of draining into the lake.

"Membership certainly agrees that they are all outdoor enthusiasts, so it makes a lot of sense to do the vast majority of the requirements to be a part of the program," Hanson says. "It's really driven a lot of very good conversations, and I'm grateful for the program being there because we can do these things under the banner of the Clean Marinas Program, not under the banner of laws and regulations."

The marina is also starting a sail recycling program in partnership with Forest City Portage, a Cleveland shop that creates unique totes and messenger bags from recycled materials. The marina is also considering construction of a new starting shack near the lakeshore that will result

in covered storage for recycling bins and used oil storage to prevent rainfall from potentially washing pollutants into the lake.

In the future, Forest City Yacht Club plans to work closely with the Ohio EPA to show off its improvements and create an open dialogue between club members and regulators. With the club being consistently certified as an Ohio Clean Marina for the past eight years, Hanson has set his sight on another environmental standard, the international Blue Flag label given to eco-friendly beaches and marinas across Europe, New Zealand, Canada, and the Caribbean.

"Blue Flag really sets standards for water quality, safety, and environmental education, and goes to marinas and beaches with the highest water quality standards," Hanson explains. "I view it as an unofficial next step that we're going to get everything dialed in in the next few years, to continue staying ahead of the pack." **TL**

Keeping Shrinkwrap Out of Landfills

In addition to managing the Clean Marinas and Clean Boater Programs for Ohio Sea Grant, Sarah Orlando is also in charge of the Shrinkwrap Recycling Program, which aims to reduce the amount of plastic sent into landfills each spring. Shrinkwrap is used by boaters to protect their vessels from the elements during harsh Ohio winters, and depending on size, each boat requires 20 to 30 pounds of plastic wrap to cover it completely.

Since the beginning of the shrinkwrap recycling program in 2006, marinas and greenhouses along Lake Erie have recycled more than 2.2 million pounds of shrinkwrap, the equivalent of filling 47 buses full of plastic. The shrinkwrap was recycled into guardrail blocks, which have been used along 411 miles of road in Ohio and neighboring states.

"The shrinkwrap recycling program is an excellent example of the capability of boaters and marinas to reduce their environmental impact," explains Orlando. "Each year new marinas and boaters contact us, wanting to take part and keep their plastic wrap out of landfills."

While the official Shrinkwrap Recycling Program is in transition between recycling partners this year, marinas across the Lake Erie shore are rallying to find new recyclers and other partners who will be able to use the shrinkwrap in some way. Forest City Portage, the bag manufacturer in Cleveland, is exploring incorporating plastic from Forest City Yacht Club into their products, while other marinas have partnered with new recycling companies nearby to keep plastic wrap out of landfills. **TL**

For more information about the Ohio Clean Marinas and Clean Boater Programs, or about the Shrinkwrap Recycling Program, visit ohioseagrant.osu.edu or contact Sarah Orlando at orlando.42@osu.edu.

WHAT TRIGGERS algal blooms IN SANDUSKY BAY?

Living on Lake Erie, people become familiar with the bright green paint look of *Microcystis* harmful algal blooms in the water, and management efforts have been focused on this nuisance for a while now. However, in Lake Erie's Sandusky Bay, another cyanobacterial species is more prevalent, as *Planktothrix* blooms stain the bay's water a dark olive green.

Both *Microcystis* and *Planktothrix* produce microcystin, a powerful toxin that can affect the liver, nervous system, and skin. However, the two species seem to prefer different nutrients: *Microcystis* uses phosphorus, while *Planktothrix* prefers nitrogen. Both types of algae also come in toxin-producing and non-toxic varieties, and little is known about what causes their blooms to become toxic.

Ohio Sea Grant researchers Dr. George Bullerjahn and Dr. R. Michael McKay, Professors of Biology at Bowling Green State University (BGSU), along with graduate student Taylor Tuttle, are planning to examine what makes *Planktothrix* in Sandusky Bay tick. The project, which stems from ongoing work done with Sue Watson and Tim Davis of Environment Canada, will look into two aspects of *Planktothrix* blooms in the bay: the basic science of what drives the algae's bloom in a relatively low-nitrogen environment, and the applied science of managing *Planktothrix* blooms and the associated toxin, which can contaminate drinking water.

"On an applied science level, here we have a nasty cyanobacterial bloom producing a toxin that we want to reduce," Bullerjahn says. "But on a basic science level it really intrigues me because if you go from the open lake into Sandusky Bay, you go from a *Microcystis* bloom to a *Planktothrix* bloom in about a mile. Why is that, what is it about the bay that supports a *Planktothrix* bloom versus *Microcystis* in the open lake? Is it temperature, is it nutrients, is it a combination of both, and we really don't know. That's a fundamental scientific problem I find interesting."

Phosphorus and nitrogen mostly enter the Lake Erie environment through fertilizer runoff from agricultural fields and discharge from sewage treatment and septic systems. Current management efforts focus on *Microcystis* blooms by reducing phosphorus use in the watershed – fertilizer manufacturer Scott's has removed phosphorus from all of its lawn care products – but studies show that controlling nitrogen could also play a big role in reducing blooms of other potentially toxic cyanobacteria.

Bullerjahn and McKay have previously tested this hypothesis in the lab: samples of water from Sandusky Bay that received added phosphorus did not change much, while algae in the

▼ BGSU Limnology students sampling Sandusky Bay in October 2013. Students will continue to collect samples throughout the project, giving them valuable experience with real-world research.

► Water samples from Sandusky Bay show an increase in algal growth when nitrogen is added (darker green color). The same happens in the Bay when nitrogen concentrations increase.



water grew visibly when nitrogen was added. This suggests that *Planktothrix* is always present in the bay, scavenging nitrogen wherever it can when the nutrient is present in very low concentrations. However, an influx of nitrogen from the landscape allows the cyanobacteria to grow quickly and enter a bloom stage.

“This is a situation in which you can never ignore the importance of phosphorus, but nitrogen is playing a bigger role here,” Bullerjahn says. “It points to management strategies in which you would control nitrogen as well as phosphorus.”

However, more research is needed to confirm this hypothesis, and also to find out what drives the change from non-toxic to toxic algal blooms. Previous studies have shown that there are multiple genotypes – different varieties of the same blue-green alga – of *Microcystis*, with some genotypes producing toxins while others don’t. Bullerjahn and McKay plan to determine whether the same is true in *Planktothrix*, and under which conditions toxic genotypes become predominant in Sandusky Bay.

“What we don’t know about Sandusky Bay is really how many different genotypes of

Planktothrix there are,” Bullerjahn says. “Are there toxic and non-toxic genotypes? Is it one single genotype? My guess is it isn’t, but we don’t know. And if you have non-toxic and toxic genotypes, how do they interact? Is one genotype better suited for a particular set of nutrients or temperature over another? So there’s a lot of basic work that needs to be done.”

To help with that work, the researchers will use a Sandusky Bay metagenome, which is created by sequencing all of the DNA in a water sample. The metagenome can be used to determine the microorganisms present in the water, which in turn lets researchers identify the biochemical reactions carried out by those organisms.

“One thing we know about the bay is that it’s a nitrogen-limited environment and if you go and sample the bay in June when the blooms are just starting, there’s virtually undetectable nitrate,” says Bullerjahn. “So somehow *Planktothrix* appears to be very good at scavenging nitrogen, and it’s not a nitrogen fixer.”

Some cyanobacteria, such as *Anabaena*, are nitrogen fixers and can support their nitrogen needs by taking in atmospheric nitrogen and making ammonia, but *Planktothrix* isn’t one

of those species. Yet it lives in an environment where there is very little free nitrogen available for its growth.

“So what is it about this environment where they can survive in low nitrogen conditions? Maybe they’re better at scavenging nitrogen than *Microcystis* is, or maybe they’re benefiting from the presence of other nitrogen fixers, that’s what we need to figure out,” Bullerjahn explains.

Once they have a better idea of what drives the *Planktothrix* blooms in Sandusky Bay, the researchers will also be able to make recommendations about its management. Once they know the role of nitrogen, and they can use lab evidence to document that it triggers both enhanced blooms and toxin formation, they can emphasize the importance of managing nitrogen from nonpoint sources like agriculture to control the extent of the Sandusky Bay blooms.

Bullerjahn and McKay will also incorporate education and outreach components into their project. Students from Perkins and Sandusky elementary schools will help to collect water samples for nutrient analysis as part of a STEM (science, technology, engineering, and mathematics) program called iEvolve, based at BGSU and funded by the National Science Foundation.

“We want to make sure that students realize they can collect and analyze relevant data while being guided by professional research scientists,” explains Ohio Sea Grant Assistant Director Dr. Chris Winslow, who is also part of the iEvolve project. “The citizen science components of these projects teach students how to collect that impactful data, so it can go toward real scientific findings, not just lab exercises.”

In addition, Dr. Kathy Durham, a former student of Bullerjahn’s, and her molecular biology students at Lorain County Community College will help the research team sequence environmental DNA from the different Lake Erie environments being studied.

With field sampling already underway to determine nutrient concentrations before spring runoff begins to add nitrogen to Sandusky Bay, the researchers have a busy two years ahead of them.

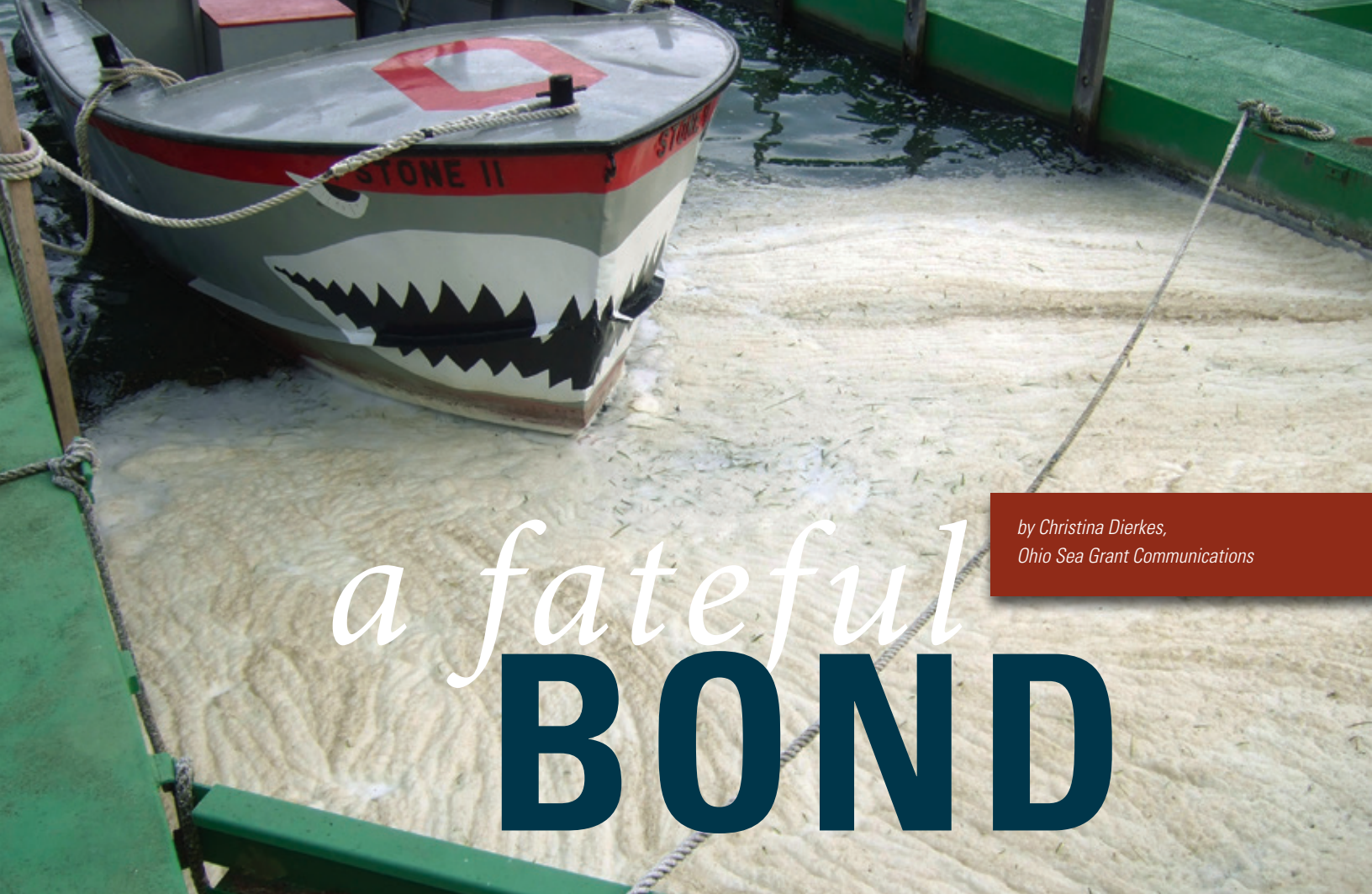
“What we want to do is look at nutrient levels in the bay throughout the year,” says Bullerjahn. “So we’re actually getting water samples even under the ice right now, looking at nitrogen and phosphorus, and seeing how the ratios change as seasons change.”

Final results are expected in February 2016. **TL**



“The citizen science components of these projects teach students how to collect that impactful data, so it can go toward real scientific findings, not just lab exercises.”

— DR. CHRIS WINSLOW



by Christina Dierkes,
Ohio Sea Grant Communications

a fateful BOND



When harmful algal blooms approach shoreline communities along Lake Erie, residents get worried: in addition to being generally unpleasant, the overabundance of blue-green algae could very well be producing microcystin, a toxin that affects the liver, skin, and nervous system. Water treatment plants that draw drinking water directly from the lake have learned to deal with the toxin, but the additional treatment cost can add up quickly at \$3,000 per day.

An additional problem is posed by the fact that not all algal blooms are toxic, not all seemingly clear water is free of microcystin, and not all of the microcystin produced in an algal bloom is dissolved in the water column. Some of it may also adhere to sediments, which would make the toxin stick around for longer than it would if it remained in the water.

To determine if this is the case, and which conditions are most likely to lead to microcystin being retained in sediments, Ohio State University researcher Dr. John Lenhart, along with former colleague Dr. Harold Walker (now at Stony Brook University), is assessing how microcystin and Lake Erie's clay sediments interact under various conditions, such as the water's pH.

"Certainly there's the question of how the microcystin is breaking down in the water column," says Lenhart. "But there's also the question of whether the sediment can serve as a reservoir of microcystin, and then subsequently release it if the solution conditions change. So the sediment potentially could become a source as well."

To date, the researchers have been testing how microcystin adheres to three different types of clay minerals common in Lake Erie sediments under various pH conditions. The pH level indicates how acidic or basic the water is – low pH indicates a high concentration of positively charged hydrogen ions in the water, making it acidic, while higher pH values indicate the

presence of negatively charged hydroxide ions that create basic conditions. A pH of 7 is considered “neutral,” where acidic and basic ions are balanced.

“Typical pH is around 7.5 to 8 in most lake natural water environments,” says Lenhart. “So we’ve looked at a range of pH values that have some relevance, from pH 5 to 9. Five is maybe a little bit low, but 9 and above is certainly a value that is observed during algal blooms.”

The results showed that microcystin interacts more strongly with the sediments under lower pH conditions, while a higher pH resulted in very weak interactions and adherence. Those findings are consistent with other research on the interactions between various dissolved compounds and sediments, but so far, microcystin had not been studied much in this context.

Interactions between the sediment and microcystin are based on physical and chemical influences. For example, the microcystin molecule and the sediment particles are negatively charged across the pH range included in the study, but the magnitude of this charge varies. At low pH, the negative charges on the sediment and microcystin are relatively small, so that the resulting repulsion can be overcome by other types of interactions that create attraction between the sediment and the microcystin. At high pH, however, the negative charge is larger, and the electrostatic repulsion produced limits attraction.

But even without knowing exactly what drives these interactions, knowing the conditions under which sediment could hold on to microcystin past the time that it can be detected in the water will help water treatment plant managers better plan for and protect citizens from the effects of harmful algal blooms.

“If we have a better understanding of these interactions, then we can predict to a higher degree of accuracy both microcystin concentrations and the longevity of the microcystin after the blooms,” Lenhart explains. “The utilities that draw their source water from

these impacted lakes are challenged with predicting when microcystin concentrations are going to be high, and when they’re going to have to alter their treatment plans to account for that. So any additional information to help them plan accordingly is a benefit to them and will save them some money.”

Lenhart and his team also examined how the presence of certain natural salts, which produce positively charged calcium or sodium ions, would influence the microcystin-sediment interactions. These cations attach to the slight negative charge present in the clay sediments, changing how the equally negative charge of the microcystin allows it to attach to the sediment particle. It turns out that calcium ions, such as would be produced by dissolving limestone rock along shorelines, attract more microcystin to the sediment particle than do sodium ions, likely because calcium ions usually carry a higher positive charge than sodium ions.

Ongoing work will examine the influence of organic materials on the interaction between sediments and microcystin, as the current sediment being used in the experiments has been treated to remove any organic molecules. These organic molecules are produced by the metabolism of living organisms in the water,

or as dead algae, for example, decompose, and Lenhart describes them as “bulk organic matter” of a variety of molecular shapes and sizes. These organics are attracted to sediments and tend to concentrate there, potentially changing the way in which microcystin can interact with the clay particles.

“The expectation is that the interactions will be enhanced in the presence of the organics, just because organic molecules like microcystin tend to be attracted to other organics,” Lenhart says. “The complicating factor is that microcystin is actually a negatively charged molecule from pH of around 2 to 12, so that negative charge may confound interactions with organic matter, as organic matter is also typically negatively charged.”

While Lenhart cautions that this project, which ends in February 2015, only looks at one of the most common forms of microcystin produced in a Lake Erie algal bloom – making up anywhere from 45 to 100 percent of total microcystin – knowing more about how the toxin interacts with the lake environment will always be helpful to communities that depend on the lake for water and income, and can provide a solid basis for further studies into keeping lakeshore residents safe from the negative impacts of harmful algal blooms. **TL**

“If we have a better understanding of these interactions, then we can predict [...] both microcystin concentrations and the longevity of the microcystin after the blooms.” — DR. JOHN LENHART



Harmful *Microcystis* blooms are obvious when the algae stain the water bright green, but research is examining whether microcystin, the toxin produced during blooms, is also present in the water after a bloom has subsided.



STONE LAB

TOURIST SPOTS

by Christina Dierkes, Ohio Sea Grant Communications

Visits to Ohio State University's Stone Lab on Lake Erie don't just have to be about science and research. Stone Lab staff also offer visitors the opportunity to interact with the Lake Erie environment in a casual setting, and to learn about some of the area's history in addition to its importance to the present day.

On South Bass Island, the Aquatic Visitors Center (AVC) introduces the public to issues affecting the Lake Erie ecosystem, from invasive species to harmful algal blooms. Exhibits also chronicle the history of the building as a former state fish hatchery, and some of the equipment from those days is still on display.

"Visitors can get a taste of the past, present and future of Lake Erie by touring our Aquatic Visitors Center," says Dr. Kristin Stanford, Stone Lab's Education & Outreach Coordinator.

In addition to the exhibits, the AVC also allows for some hands-on interaction with Lake Erie and its inhabitants. Microscope stations give visitors a peek at the lake's smallest inhabitants, tiny plants and animals collectively called plankton. Aquaria throughout the building display native Lake Erie fish like Yellow Perch and Smallmouth Bass as well as invasive species like the White Perch and Round Goby. A live video feed from an underwater camera off the dock outside may just help catch a glimpse of these fish in their natural habitat.

From the dock, children under 17 years of age can use the AVC's fishing gear to try for their first catch of Lake Erie fish. With sport fishing being a multi-million dollar industry along the lakeshore, getting an introduction to this popular activity at an early age helps kids understand both the importance and the appeal of sport fishing to many Great Lakes residents.

"Nothing but good things can come from getting a kid hooked on fishing," says Tory Gabriel, Ohio Sea Grant Fisheries Outreach Coordinator. "It gets them outdoors, keeps them out of trouble, and gets them excited about the lake and the world around them."

Stone Lab staff also offer two different tours during the summer season: the Gibraltar Island Tour and the South Bass Island Lighthouse Tour.

The Gibraltar Island Tour takes visitors into the heart of Ohio Sea



Grant's research and education efforts on Lake Erie. Stone Lab houses the oldest freshwater biological field station in the United States, and more than 200 college students from across the country come here each summer to learn about the lake ecosystem and its importance to the Great Lakes region.

Stops include Perry's Lookout, a rock formation overlooking Lake Erie; the glacial grooves on Gibraltar's south side; some of Stone Lab's buildings; and historic Cooke Castle. The tour also includes an overview of the research being conducted at the lab, and a chance to meet some of the students and researchers who call the island their summer home.

At the other end of South Bass Island lies the South Bass Island Lighthouse. The lighthouse grounds are open to visitors from dawn to dusk, but the guided tours include both information on the history of the building and a climb up the lighthouse tower steps to take in a scenic view of the Lake Erie islands and the neighboring mainland at Catawba Point.

"Whether folks come to learn about the rich history of our facilities, see what is being done to ensure the future of Lake Erie, or are just curious about what we do here at Stone Lab, they are sure to discover something of interest for the whole family," Stanford says.

In 2015, the Aquatic Visitors Center will be open from June 24 through September 12. Gibraltar Island Tours will run from June 24 through August 12, and the South Bass Island Lighthouse will be open from June 22 through August 11. **TL**



Main: Visitors to Gibraltar Island can enjoy the view from Perry's Lookout, where Commodore Oliver Hazard Perry kept watch for the British fleet during the Battle of Lake Erie. // **Above:** More than 20,000 people visit the Aquatic Visitors Center each year to learn about Lake Erie and its inhabitants.

Discover

by Christina Dierkes,
Ohio Sea Grant Communications

LAKE ERIE BIRDING

All Over Again (Or For The Very First Time)

The guide is available online through Ohio Sea Grant for \$13 per book and wholesale at \$175 per case of 14, plus shipping and handling costs. To order, visit ohioseagrant.osu.edu/publications or contact the Ohio Sea Grant office at 614-292-8971 with questions.

Each summer, locations along the Lake Erie coastline fill with visitors, cameras and bird guides in hand, ready to discover that next rare bird on their must-see list. Birding contributes \$30 million to northern Ohio's economy every year, and the Ohio Department of Natural Resources (ODNR) Division of Wildlife and Ohio Sea Grant have partnered in an effort to support and expand that contribution.

The *Lake Erie Birding Trail Guidebook* is a 232-page compilation of 88 popular and less well-known birding locations all along Ohio's Lake Erie coast, from Conneaut to Toledo. In addition to locations of parks and other birding spots, the book lists commonly sighted species and noteworthy rarities, park amenities like picnic shelters and restrooms, and online resources for visitors.

"Lake Erie and its environs are the premier birding destination in Ohio, and in the entire Great Lakes region," says Jim McCormac of ODNR. "Nearly 400 species have been found along the Ohio shoreline, and migration periods see enormous numbers of songbirds and waterbirds. Many Lake Erie birders are from out-of-state or elsewhere in Ohio, and the Lake Erie Birding Trail helps visitors navigate the best hotspots."

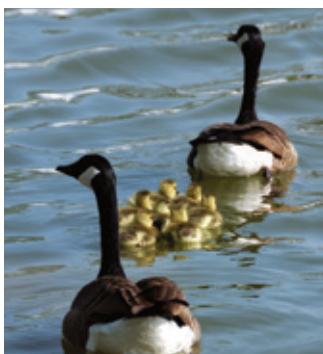
Ohio's 1.6 million self-identified birders alone spend over three quarters of a billion dollars annually on their pursuits. The *Lake Erie Birding Trail Guidebook* not only makes it easier for

them to spot both common and rare birds when visiting parks and preserves in northern Ohio, but it also gives birders the opportunity to point out their economic contribution to local businesses with a set of "birder calling cards" that link owners to more information.

"Every visitor to Lake Erie will consider this book an incredible resource and a must-have for their libraries," says Dr. Jeff Reutter, director of Ohio Sea Grant and Stone Lab. "We were very pleased to partner with ODNR Division of Wildlife, with funding from Wildlife, the Ohio Department of Transportation, and Ohio Sea Grant, to develop this guide."

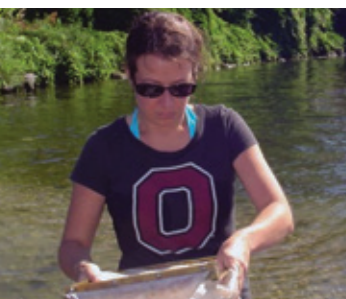
The book itself is a companion piece to the ODNR Division of Wildlife and Ohio Sea Grant website lakeerieohiobirding.info, which showcases birding sites across the Ohio Lake Erie coastline to residents and visitors alike.

"Connecting birders to birding and other tourism amenities in local Ohio communities will not only help attract more visitors to Ohio, but will also help us provide exceptional experiences to our guests," says Melinda Huntley, executive director of the Ohio Travel Association. **TL**



STONE LABORATORY Summer Courses 2015

Stone Lab offers one-day, two-day, one-week or five-week science courses as well as the five-week Research Experience for Undergraduates Scholarship Program. Detailed course descriptions can be found online at stonelab.osu.edu/courses.



INTRODUCTORY COURSES – 2 CREDITS

Run Sunday-Saturday and are open to advanced high school and current college students.

EEOB 1930	Introduction to Biological Studies – Aquatic Biology	June 14-20
KNSHP 1140.05	Lake Erie Sport Fishing	June 14-20
EARTHSC 1107	Field-Based Introduction to Oceanography	July 26-August 1
EEOB 1930	Introduction to Biological Studies – Aquatic Biology	July 26-August 1
ENR 2360	Ecology and Conservation of Birds	August 2-August 8
EEOB 1930	Introduction to Biological Studies – Aquatic Biology	August 2-August 8
EEOB 1910	Introduction to Biological Studies – Local Plants	August 2-August 8
ENTMLGY 1260	Introductory Insect Field Biology	August 2-August 8

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

EEOB 5420	Aquatic Ecosystems – Ecology of Inland Waters	June 21-July 25
EEOB 3410	Ecology	June 21-July 25
EEOB 3310	Evolution	June 21-July 25
EEOB 5940	Field Zoology	June 21-July 25
EEOB 5930	Ichthyology	June 21-July 25

One-Week Courses – 2 credits

EEOB 5910	Field Herpetology	June 14-June 20
EEOB 4950	Field Ecology	July 26-August 1
ENR 5194	Group Studies: Climate and Sustainability	July 26-August 1
EEOB 5210	Spider Biology	August 2-August 8

Other Courses

ENR 5699	Current Topics in Environment and Engineering (Guest/Research Lecture)	June 18-August 6, 1 credit, 5 weeks (Thursday evenings)
EEOB 5970	Larval Fish Identification Workshop*	June 28, .5 credit, 1 day
EEOB 5950	Algae Identification Workshop*	August 10-11 or August 13-14, .5 credit, 2 days
EEOB 3189	Field Course: Environmental Science on the Flagship <i>Brig Niagara</i>	July 25 - August 20, 2 credits, 4 weeks

*Can also be taken as a non-credit workshop

COURSES FOR EDUCATORS – 2 CREDITS

Can be taken for credit or as non-credit workshops.

EARTHSC 5584	Principles of Oceanography for Educators	June 14-June 20
ENR 5690	Workshop in Environmental Education: Great Lakes Research for Educators	June 14-June 20
ENR 5194	Group Studies: Climate and Sustainability	July 26-August 1
EEOB 4950	Field Ecology	July 26-August 1
ENR 5194	Group Studies: Water and Wildlife Training for Educators	July 26-August 1

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.

Dealing with Cyanobacteria, Algal Toxins and Taste and Odor Compounds	August 10-11 or August 13-14
Fisheries Fundamentals Workshop	August 17-19
Fish Aging Workshop	August 20
Lake Erie Sport Fishing Workshop	September 25-27
Fish-Sampling Techniques Workshop	September 26 or September 27
Outdoor Photography Workshop	October 9-11

REU PROGRAM

Expand your research skills with Stone Lab's Research Experience for Undergraduates (REU) Scholarship Program. Students spent their non-class days working one-on-one with research supervisors, collecting data, analyzing discoveries and preparing a final presentation.

- Ecology of the round goby: analysis of the condition of this invader of the Western Basin of Lake Erie (Ichthyology)
- Survival success of birds inhabiting the Lake Erie Islands (Ornithology)
- Fish investigations to inform fisheries management (Fisheries Research/ Management)
- Lake Erie Watersnake research to inform status of snake post-removal from endangered species list (Herpetology)
- 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 scholarship funds, which typically range from \$100 to \$2,500. Students enrolled in five-week courses can also apply for Stone Lab's part-time positions or find jobs at local Put-in-Bay businesses. For more information, [visit stonelab.osu.edu/applynow](http://stonelab.osu.edu/applynow).

Course credits are based on the Ohio State University semester credit system and are transferable to most colleges and universities.

by Christina Dierkes,
Ohio Sea Grant Communications

Exchange of IDEAS

A big part of the Stone Lab experience, aside from doing science in a real-world island setting, is exploring knowledge and sharing ideas with like-minded individuals from all over the Great Lakes region. This can be especially important for working professionals like the educators that take classes at Stone Lab every summer, as this exchange of ideas helps them adapt learning to their specific education setting.

Cammie Jones, a fourth-grade teacher at DeWitt Public Schools north of Lansing, Michigan, participated in the 2013 Great Lakes Education class at Stone Lab, and really enjoyed the networking that comes with living with your classmates on a Lake Erie island. The course was taught by Dr. Rosanne Fortner, Ohio Sea Grant's former Education Director, and Lyndsey Manzo, Ohio Sea Grant Educator and a science teacher at Westerville North High School.

The students included educators from elementary school to adult education at nature centers, and participants were able to expand their horizons by exchanging ideas with others who teach in areas not their own. "There were quite a diverse group of people in our class, and I think they all found ways to integrate those lessons into the settings where they were teaching," Cammie says. "It gave me a great perspective on all the different avenues people are using to reach the public, and it helped me see some ideas from their point of view that I could use in my classroom."

Her fourth-graders have also benefited from the data collection



▲ Cammie's Marine & Aquatic Education class included classroom teachers as well as educators from state parks, science centers and Ohio Sea Grant.

techniques Cammie learned about during the Stone Lab class. Each morning, the students would take simple environmental observations such as air temperature and wind direction in front of one of the lab buildings, both to get a feel for handling the scientific instruments required for measurements, and to contribute to a larger collection of environmental data at Stone Lab.

"Those elements were really helpful for me to integrate some new measurements into something that I do with my students each day called 'first look,'" Cammie says. "Basically, each day we go out in the morning to a certain spot on our playground where we have been doing some of that data collection, but I've extended that a bit and added some tools that I saw at the lab that I thought my kids could use."

Cammie also presented some of the curriculum materials at the 2013 Great Lakes Place-Based Education Conference at Grand Valley State University, along with course instructor Lyndsey Manzo. Their presentation allowed other educators to discover some of the lessons, which are freely available online at greatlakesliteracy.net, and to run through a few of them the same way they would with their students.

"It was also a fun extension to show how I adapted the lessons for young students, since some of them are originally designed for more of a middle school and up audience," Cammie says. "I found them to be very receptive to the ideas and the resources, and to seeing how you could use some of the presented strategies not just with the Great Lakes content, but with other things too." **FOSL**



Find out more

Cammie's video blog entry for the Great Lakes Education class is available at go.osu.edu/Cammie. Different educator courses are taught at Stone Lab each summer. Course applications are available at stonelab.osu.edu/applynow.

Friends Of Stone Laboratory

Dear friends,

Thanks to all who attended this year's Winter Program. This is always a good time to reconnect with each other and to invite new interest in the lab. This fundraiser makes it possible to offer more scholarships to students and teachers who wish to attend classes in the summer. We all know what an impact spending time on Gibraltar has on everyone who has the opportunity to come. Thank you once again. If you attended, we appreciate it and hope to see you again at further events.

This year in addition to scholarships, FOSL is focusing on funds to give Cooke Castle the face lift she deserves. The Castle has historic value and has the potential to be a conference destination and more. This would be quite an undertaking but one well worth the effort. When you are making a donation to Stone Lab, you can specify that it be directed toward castle renovations. Simply go to: stonelab.osu.edu/fosl/give and choose the Cooke Castle fund or one of the others.

While you are visiting that page, make sure to sign up for alerts so you can be made aware of all FOSL events. You can also go directly to our "events page" and find out what we have going on through the year.

Again, thank each of you for your continuous support. I hope to see you at future FOSL events.

*Sincerely,
Sheila Lewicki, FOSL President*

New Directions

To people who are relatively new to the Stone Lab experience, the program that they see now is quite amazing. Stone Lab and Ohio Sea Grant have become the authority that legislators, civic leaders, recreational sportsmen, educators, and scientists turn to for information, guidance and training on Lake Erie issues. The full time and part time staff are some of the most informative and dedicated personnel to be found anywhere.

Over 30 years ago, when FOSL was created, the Stone Lab experience was really quite different. The facilities were badly in need of maintenance, money was hard to come by, there was never enough staff to handle all of the needs, and there were almost no funds available for program enhancements and scholarships. From the very beginning, FOSL pitched in to provide very direct and hands-on assistance. Our funds were limited but we worked hard to generate scholarships and endowments. Over the years, the endowments have grown as well as the quality and visibility of the program. The stars have truly aligned in a miraculous way.

Due to the successes of these past years, FOSL needs to re-assess the roles that we can play to best support Stone Lab. There are still needs for events like the work weekends and open houses, but staff members now handle most of the miscellaneous maintenance issues that must be fulfilled. The future really calls for more support from FOSL in outreach and fundraising.

Members of FOSL can directly participate in outreach by speaking to teachers, schools, legislators, etc. about the benefits of the various Stone Lab programs and how people can benefit from those programs. Prepared PowerPoint presentations can be obtained through the Stone Lab office for those that wish to do public speaking on behalf of the lab. As always a wealth of information can be obtained via the Stone Lab website and Ohio Sea Grant publications. It is very easy to become a cheerleader for the lab.

Everyone is aware of the economic situations we all face both personally and institutionally. FOSL has created over \$1 million in endowments. While that is very impressive, the real needs are much higher than what the endowments can currently provide. The caliber of students is very high and more



Above: Historic Cooke Castle was once home to Civil War financier Jay Cooke.

scholarship money is always needed to continue attracting these high-achieving students. The REU program annually has to turn down a number of extremely impressive students because there is limited money to support them.

The staff has been very successful over the past few years in receiving grant money to accomplish many projects that have been highlighted in the pages of *Twine Line*. The one big project that has not been addressed yet is the restoration/remodel of Cooke Castle. The needs and uses that a restored castle could fulfill are endless. It would truly be the cherry on top of Gibraltar's sundae. FOSL wants to work with staff and the university to identify and attract potential donors to this special building project. The castle has been dormant for far too long. As Dr. Reutter has said, every weekend there are probably numerous people sitting on their boats in the bay who could help fund the castle restoration. The trick is identifying them. Can you play a role in making that happen?

FOSL has made historical and memorable progress in supporting Stone Lab. Different times now require different roles. Can you help FOSL identify and make those changes? Can you get off the sidelines and make a difference? Individually we all have our talents. When we work as a group, those combined talents can be a much greater asset than the individual talents alone. Come aboard and help FOSL move in some new directions.

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.

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Make a donation

Remember to make your tax-deductible donation before the end of the year!
 Visit stonelab.osu.edu/fosl/give for giving options.

Lake Erie Day 2014

Visitors to the Progressive Mid-America Boat Show supported Stone Lab scholarships with \$1,150 by purchasing admissions tickets on January 20, Lake Erie Day. The Lake Erie Marine Trades Association (LEMTA), the show's managing organization, donated \$1 from every ticket purchased that day to Stone Lab's education program.

"Through the Mid-America Boat Show, LEMTA creates an excellent opportunity to interact with a diverse audience," says Sarah Orlando, Clean Marinas Coordinator for Ohio Sea Grant. "A wide range of people frequent the show, and we are able to educate them on how best to protect Lake Erie every day. A new boater might learn how to prevent spills when fueling; a long-time boater might learn about the importance of switching to non-toxic cleaning products, and a child might learn to tie their first fishing lure."

In addition to answering questions about Lake Erie, sport fishing, and harmful algal blooms, Ohio Sea Grant and Stone Lab staff introduced visitors to the Ohio Clean Boater Program, unwanted medicine disposal options, and the "Stop Aquatic Hitchhikers!" campaign that aims to prevent the introduction of new aquatic invasive species into the Great Lakes. And of course, questions about Stone Lab's research, education and outreach programs on Gibraltar Island were always welcome.

"The show provides an incredible opportunity for students, teachers, and the general public to have their questions answered and interact with scientists from Ohio Sea Grant and Stone Lab who are working on Lake Erie," says Dr. Jeff Reutter, Ohio Sea Grant and Stone Lab Director.



2014 STONE LAB WINTER PROGRAM & SILENT AUCTION

Thank you to all of the individuals and organizations that donated items to the auction and to all of those who bid. The students of Stone Lab greatly appreciate your support.

- | | |
|--|---|
| Joan Bradley | Lake Erie Islands Nature and Wildlife Center |
| Lauren Bradley | Dr. John D. Mahilo |
| Eugene Braig | Miller Ferries to Put-in-Bay and Middle Bass Island |
| Carsonie's Stromboli and Pizza Kitchen | Mohican Lodge and Conference Center |
| Center of Science and Industry (COSI) | Mozart's Restaurant, Bakery, and Piano Café |
| City Barbeque | OSU Athletic Ticket Office |
| Columbus Guitar Society | OSU Marching and Athletic Bands |
| Columbus Zoo | OSU Office of Trademark and Licensing |
| Suzanne Cruickshank | The Refectory Restaurant and Bistro |
| Flute Cocktail | Respect the Snake |
| Graeter's Ice Cream | Robert Rothschild Farm, LLC |
| Great Wolf Lodge, Sandusky | Dr. Ronald L. Stuckey |
| Dr. Thomas J. Hall | Sunnybrook Trout Club |
| Pam Hansberger | |
| Heineman's Winery | |
| Lake Erie Islands Chapter of the Black Swamp Conservancy | |





THE OHIO STATE UNIVERSITY

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The Ohio State University
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STONE LAB

>>>STUDENT PROFILE

In 1993, Kent Vertrees was a lab assistant at Stone Lab, taking courses in fish ecology and limnology. Today, he helps manage water use on Colorado's Yampa River, and shows visitors the best places to enjoy skiing in the Rocky Mountains.

