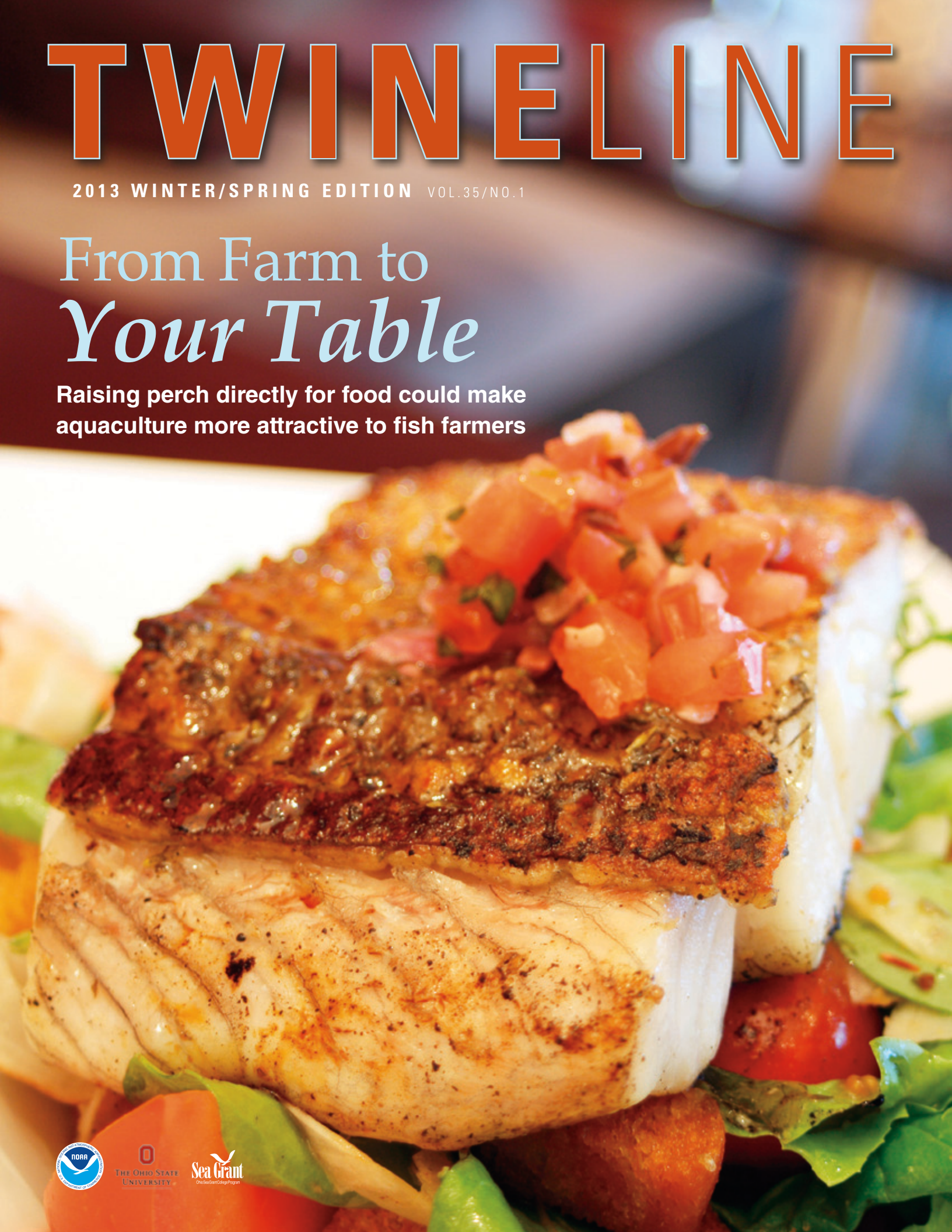
TWINELINE

2013 WINTER/SPRING EDITION VOL.35/NO.1

From Farm to *Your Table*

Raising perch directly for food could make aquaculture more attractive to fish farmers



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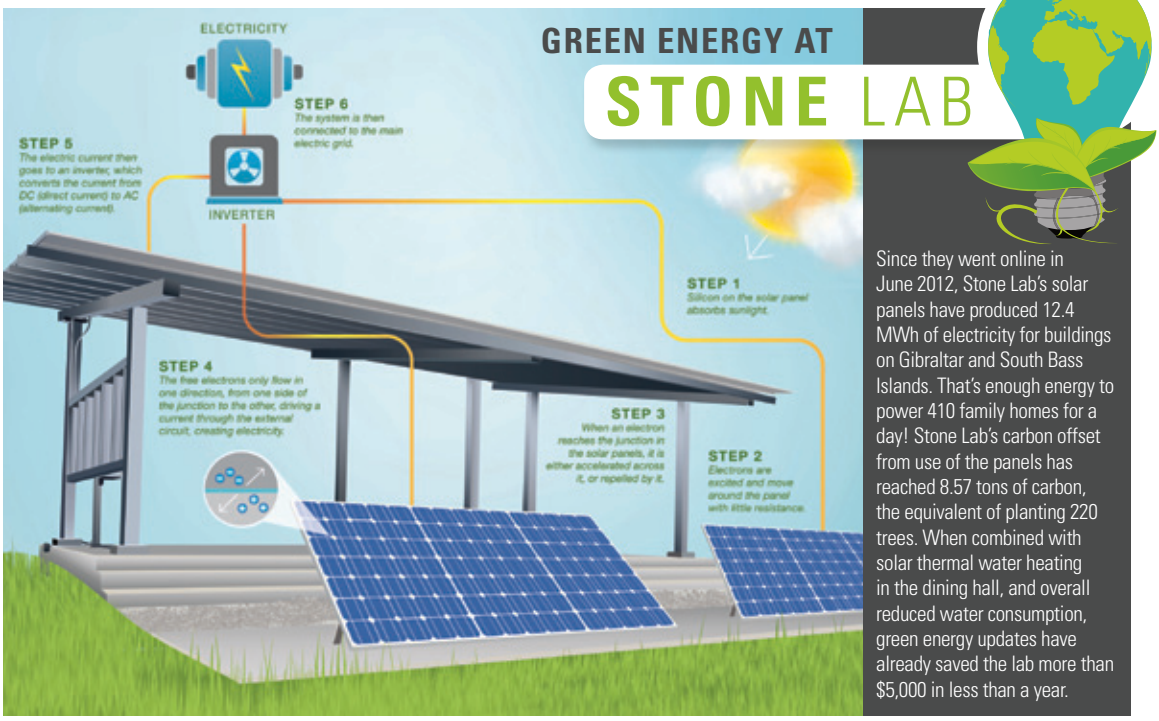

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New breed of yellow perch grows faster and more reliably in aquaculture operations

bigger, faster STRONGER

by Christina Dierkes, Ohio Sea Grant Communications

Yellow perch is a staple of Lake Erie restaurant menus, with menu boards along the shore advertising everything from classic fish fry to local specialties. While most of these fish were likely caught in the wild, some of them will have come from aquaculture: fish farms throughout the Great Lakes region raise yellow perch, and aquaculture sales in Ohio tripled from $1.8 million to $6.6 million in 2010.

▸ Larval fish, called fry, are ready to hatch after about two weeks of growth.

Photos: Main, dreamstime.com; inset, Great Lakes Fishery Commisision

As with all agriculture products, selective breeding – a process in which parents are selectively bred to enhance specific desired traits in their offspring – has improved production and led to most of the fruits, vegetables, and farm animals we know today. Corn kernels are larger and more uniformly colored than those produced by ancient corn plants, dairy cows produce more milk than their ancestors, and commercial bananas are larger and sweeter than their ancestors, to name just a few examples of genetically improved species.

Researchers at the Ohio State University's South Centers in Piketon, partially funded by Ohio Sea Grant, are now selectively breeding yellow perch to thrive in aquaculture operations, but they're using modern technology to give them an edge: genetic analysis. Dr. Han-Ping Wang and his colleagues are using DNA markers to separate sibling fish, thereby avoiding inbreeding that can negatively affect future generations by slowing growth rates and making fish more susceptible to disease. When combined with more traditional selection of favorable traits like size and overall health, this approach leads to a marked improvement in growth and resilience for the fish.

Now in the third generation, these improved yellow perch can reach their marketable size of 8.5 inches about 30% faster than unimproved fish, in 12 or 13 months instead of 18 months. "One of the reasons is that they genetically utilize the feed better," explains Wang, Director and Principal Scientist for the Ohio Aquaculture Research & Development Integration Program (OARDIP) at OSU South Centers. "So that means they use the same amount of feed, but they can reach market size in a shorter time. And that saves a lot of time, a lot of labor, a lot of feed, and a lot of cost."

To test the potential success of this new line of yellow perch in a commercial setting, the researchers are currently conducting on-farm and on-station tests at the Ohio Center for Aquaculture Research & Development (OCARD) and at Mill Creek Perch Farms in Ohio, at the University of Wisconsin's Northern Aquaculture Demonstration Facility, and at Coolwater Farms, LLC in Wisconsin. These locations provide a wide range of climates in which to raise the experimental fish, from southern Ohio (at latitude 39) to northern Wisconsin (at latitude 46).

Rearing protocols, which outline a consistent way of raising the fish from hatchlings to adults, were the same across locations to make sure results could be compared easily. The fish arrived at the farms as eggs, in long ribbons that contain about 20,000 eggs each. Those ribbons were placed in small containers kept at around 53° Fahrenheit, and the eggs hatched in two weeks. From there, the baby fish (called fry at this point) were transferred to a small pond containing cultured zooplankton to feed them during this early life stage.

▸ Workers harvest yellow perch from one of the ponds at OSU's aquaculture facility in Piketon. In unimproved perch lines, only about 50-60% of fish will be ready to sell at market, while Wang's improved yellow perch line grows about 30% faster for a higher percentage of marketable fish.

"After six weeks, we harvest the fish, we now call them fingerlings, and bring them to indoor tanks for feed training," Wang says. In the natural environment, juvenile and adult perch eat other fish, and need to be trained to accept commercial food pellets. This usually takes about three weeks, and then the fish can be returned to outdoor ponds to continue growing.

Genetically improved perch were raised in two ponds at most locations, along with unimproved local fish in two additional ponds. "The problem with this separate rearing is that sometimes it's not a good approach," Wang says. "If one pond gets much higher survival rates, that means in that pond, the density of fish is higher as well. That also means there is less feed, because we calculate the feeding amount based on the estimated survival rate, but if one pond got a higher survival rate, our original calculation of feed is much less than what the fish need."

This is what happened in both on-station tests: while the researchers assumed a 75% survival rate for all of the fish and based the amount of feed given on that number, the improved perch had a survival rate of 92%, 30% higher than the local fish. This means the fish actually got much less food and less oxygen, however, they still grew about 30% faster than unimproved fish with less variation in size. These higher growth and survival rates also resulted in 30-40% higher production from ponds with improved fish.

To address the density problem, one farm location used "communal rearing," raising improved and unimproved fish together in the same ponds. Before the hatchlings were placed into those ponds, the researchers determined the genotype of the parent fish, using eight unique genetic markers that would later allow them to determine which adult fish came from the local strain, and which were offspring of the genetically improved line.

"In that case, there's no environmental effect, because both kinds of fish grow up in the same pond," Wang explains. "And our results from the parentage analysis, looking at the genetic markers, show that in this case, our improved fish grow 32% faster than the unimproved fish."

Faster growth and more uniform size at the end of the culture period would be a definite advantage for fish farmers who traditionally raise perch for 18 months to have only about 50-60% of the slow-growing fish be of a size suitable for sale. "Our improved fish grow faster, so at the end of that culture period, the percentage of marketable size fish will be much higher," Wang says. In addition,

Above: Dr. Han-Ping Wang presents one of the fish in his genetically improved yellow perch line at OSU South Centers in Piketon. In addition to faster growth, the fish have also shown higher survival rates than local unimproved fish in the current experiments. // **Right:** More than 2.8 million pounds of yellow perch were harvested from Lake Erie in 2011. While the fishery is carefully managed, demand for the fish can put a strain on the ecosystem, and perch aquaculture could reduce that strain while providing new business opportunities. Photo: Ken Chamberlain

most of the fish will reach marketable size more quickly, in about 12 or 13 months, allowing farmers to sell them earlier.

Once the commercial market for these fast-growing fish is established, the number of farms growing yellow perch for food could rise quickly, as fish is valued as a lean and healthy protein source for a human population that continues to expand. With this in mind, Wang and his colleagues, along with Ohio State University's Technology Commercialization and Knowledge Transfer office, are exploring opportunities for widely distributing the genetically improved perch once commercial-scale testing is complete.

"Farm-testing our fish is a part of the process for future commercialization," says Wang. "But there are other things we need to consider as well, including how we can distribute these fish to farmers. Other agriculture species that already have genetically improved lines, such as salmon and tilapia that also began as research programs, some of the researchers partnered with large companies to distribute fish. The university's Office of Technology Transfer already came down last year to our location to discuss how to do that, so we have several thoughts."

Those ideas range from patenting the technology to applying for intellectual property rights that can then be transferred to a commercial company, as well as running a joint venture between the university and an industry representative. One large agriculture company has already expressed interest in the genetically improved fish, but final decisions will have to wait until all tests and evaluations are completed.

Another potential hurdle for commercialization is shifting the way people currently think about the yellow perch that are grown in Great Lakes aquaculture. Right now, many fish farms provide fish that are stocked in lakes and ponds in Ohio, Michigan, and Indiana, to replenish perch populations for recreational anglers or to restore populations that have been depleted by fish kills. For that purpose, fish don't need to be genetically improved, as their final size doesn't have to conform to specific market expectations. Genetic contamination, the flow of genes from a domestic or invasive species to native populations, is also a concern for stocking improved fish to natural water bodies.

However, yellow perch that grow more quickly on a smaller amount of feed, increasing the overall profit margin of raising perch directly for food, would make aquaculture more attractive to farmers who have previously been discouraged from investing in perch culture or expanding their current operations.

According to the Great Lakes Fishery Commission, more than 2.8 million pounds of wild yellow perch were harvested from Lake Erie in 2011, in both commercial and recreational fisheries. Not only could aquaculture have positive economic impacts on Ohio and the Great Lakes region, but it would also reduce the stress that fishing for yellow perch can place on the Lake Erie ecosystem. Management agencies work hard to maintain a sustainable fishery, but increasing the profit margin for cultured yellow perch could remove this potential strain from an ecosystem that already has a lot to deal with, and offer both ecological and economic benefits for the entire Great Lakes region. **TL**

For more information about this Ohio Sea Grant-funded project, contact Dr. Wang at ***wang.900@osu.edu***.

Tracking Viral INFECTION in Lake Erie Fish

by Christina Dierkes, Ohio Sea Grant Communications

NEW TEST FINDS FISH VIRUS FASTER AND MORE COST EFFECTIVELY

In the summer of 2006, students at the University of Toledo's Lake Erie Center made a ghastly discovery on the beach across the street: dead fish washed up on the shore, and struggling fish in the shallow water, all showing bright red hemorrhages on their sides. The students and their instructor, Dr. Carol Stepien, later found out that they had witnessed the first outbreak of viral hemorrhagic septicemia virus, or VHSv, in western Lake Erie.

VHSv infection signs in fish

Above: The first outbreak of VHSv in western Lake Erie left beaches littered with infected fish. Today, researchers have created a rapid and accurate diagnostic test for the virus.

Species Affected by VHSv in the Great Lakes: Walleye, Yellow Perch, Lake Herring, Channel Catfish, Bluegill, Chinook Salmon, Rainbow Trout, Pumpkinseed, Burbot, Black Crappie, Brown Bullhead, Emerald Shiner, Freshwater Drum, Gizzard Shad, Smallmouth Bass, and Common Carp.

"VHSv appears kind of like ebola for fish, where they get lesions and bleed out," says Stepien, Director of the Lake Erie Center and Professor of Ecology at the University of Toledo (UT). "It also was very virulent, like ebola. A lot of dead fish, including yellow perch and drum, were washing up on the beaches during these scattered outbreaks."

Of course, anything that could impact Lake Erie's fishing industry needs to be addressed. Almost seven years after that initial encounter, Stepien and her research partner Dr. James Willey from the UT Health Sciences campus, her PhD student Lindsey Pierce, and their technicians Erin Crawford and Vrushalee Palsule have developed a new rapid test for VHSv that is not only much faster than the traditional cell culture method, but also has a much higher degree of accuracy. The test is based on a procedure called StaRT-PCR (standardized reverse transcriptase polymerase chain reaction, a DNA-based testing method) developed by Dr. Willey, that is very accurate, since it uses built-in internal controls. The research group has now adapted their test to use a qRT-PCR (quantitative real-time polymerase chain reaction, another DNA-based method) platform, as that equipment is already a part of most fish diagnostic labs.

Other assays that have been developed for VHS include qRT-PCR tests that have a false negative rate of 14-47%, since they lack built-in internal controls. And cell culture assays, which are the standard method of virus testing, can take a month or more to run, making results untimely at best, and can have false negative rates of as high as 76%, according to previous research. "It's a long procedure, and what we were told by agencies and other researchers was to try to develop an accurate, low-cost test," Stepien relates.

And that's what the team did, with funding from Ohio Sea Grant and the USDA. "We've developed a very rapid and accurate test that can tell every strain of VHSv from all over the world," explains Stepien. "We can diagnose VHS 100%, and our test is negative for any other type of fish virus or human virus, so it's very accurate."

The test takes only a few hours, instead of a month or more with cell culture, and includes a built-in control that compares the study sample with a standardized virus sample. This ensures that a positive result is a true positive, and not the false negative often seen without an internal control. The test also allows researchers to determine the quantity of virus present in the sample, which can be an indicator of whether an infection is latent – not causing any symptoms – or if it's an acute infection that will soon kill affected fish.

In addition to developing a hands-on testing method for VHSv, Stepien and graduate student Lindsey Pierce have also traced the evolution of VHSv strains across the globe since its discovery in marine organisms. "VHSv was known since the 1920s in Europe," Stepien explains. "It was found in rainbow and brown trout in aquaculture, where you're keeping fish in very close captive environments, and they can easily transmit a virus from one to another." Here, the effects of VHSv can be especially devastating, and efficient detection of the virus and determination of which fish are infected is essential to prevent economic losses.

VHSv in the wild is spread especially during spawning season in the spring and early summer, when fish congregate in large numbers and remain in close contact for a few days. The virus is transmitted via mucus and other secretions, and can survive in cool water for up to 11 days, which allows it to be transported from one region to another via water currents.

Bait fish have also historically been shown to transmit VHSv from one body of water to another, leading to an agreement between Great Lakes states and Canadian provinces – part of the 2011 Aquatic Invasive Species Action Plan – to require fish to be certified as VHSv-free before they can be transported. Currently, a month-long cell culture is recommended for this certification, which significantly delays shipments.

Stepien is now collaborating with a number of other researchers on large-scale evaluations of the testing procedure to determine whether it could eventually replace the cell culture standard. Dr. Yan Zhang at the Ohio Department of Agriculture and Dr. Mohamed Faisal at Michigan State University, who performs testing for the state of Michigan and the upper Great Lakes, will both implement the new method in their labs to determine how well the test fares in a non-experimental setting.

Over recent years, an increasing number of fish species have tested positive for VHSv, but haven't shown symptoms, which indicates that fish may have developed resistance to the virus. However, these host fish can still spread the virus to other fish that may be more susceptible to infection, making accurate diagnosis and efficient preventive testing a priority for natural resource managers and fish farmers. And that's exactly what Stepien thinks this test will be able to do.

"We can test for VHSv with very high accuracy, and we're hoping that it's going to be very low cost, and easy to do," Stepien says. "It's been very fun to figure out the evolution of this virus. We've discovered all kinds of cool things about it." **TL**

For more about this Ohio Sea Grant-funded project, contact Dr. Stepien at ***carol.stepien@utoledo.edu***.

Above: When fish stay in close proximity, during spawning season or in aquaculture operations, VHSv can spread quickly throughout the population. Rapid and accurate testing that shows which of the sampled fish were infected can help fish farmers reduce the impact of VHSv infection. Photo: Lindsey Pierce

Learning from others: The conference, which is co-sponsored by Ohio Sea Grant, Ohio State University Extension, ODNR Division of Wildlife, and LECBA, was held at the Bowling Green State University Firelands Campus in Huron, OH. Information about next year's conference is available from Tory Gabriel, Ohio Sea Grant Fisheries Outreach Coordinator, ***gabriel.78@osu.edu***.

improving business

32nd Annual Charter Captains Conference Provides Successful Prelude to 2013 Fishing Season

by Christina Dierkes, Ohio Sea Grant Communications

Ohio Sea Grant's annual Charter Captains Conference has become a tradition for Lake Erie charter boat captains, with many attendees regularly returning for the latest updates in Lake Erie fishing, regulations, and business opportunities. This year's conference was no exception, with more than half of the 168 attendees indicating that they had been to a previous conference.

"By educating charter captains who can in turn educate other anglers on Lake Erie, we are able to reach thousands of fishermen," says Ohio Sea Grant Fisheries Outreach Coordinator Tory Gabriel, who organizes the annual event. "Not only do captains learn about how to improve their business, but they also hear about this year's fishing outlook and new regulations that will affect their day-to-day operation."

The keynote presentation was given by John Goss, Asian Carp Director for the White House Council on Environmental Quality, who provided an update on the Obama Administration's effort to prevent Asian Carp from becoming established in the Great Lakes. The invasive fish have already entered the Chicago Sanitary and Ship Canal that connects the Great Lakes to the Mississippi River in Chicago, making the maintenance of current fish barriers and finding new ways of deterring the fish from entering the Lakes a priority for ecosystem managers there.

Amy Jo Klei of the Ohio EPA introduced the Lake Erie Charter Boat Captain Sampling Program and other agency efforts to better monitor the health of the lake. The program, launched last year in a partnership with the Lake Erie Charter Boat Association (LECBA), recruits captains to take water samples during their normal charter outings and return them to Ohio EPA staff, who will transport the samples to the OEPA laboratory in Reynoldsburg for analysis.

OEPA has also awarded Stone Laboratory an environmental education grant to help fund a new Algal & Water Quality Lab, scheduled to open on South Bass Island later this year. In addition to processing some of the water samples closer to Lake Erie, the lab will provide additional opportunities for students and researchers studying water quality issues at Stone Lab.

"By partnering with Stone Lab and OEPA, charter captains have taken on a leadership role in protecting Lake Erie as a valuable resource," says Gabriel. "This lake is their livelihood, and they're fighting to keep it that way for future generations. The LECBA has proven to be a fantastic partner in the past and this new collaboration should be a perfect fit."

More information about the Algal & Water Quality Lab is available on page 14 of this issue.

Melinda Huntley, Executive Director of the Ohio Travel Association, provided an overview of opportunities for charter boat captains to partner with other members of the tourism industry. Huntley emphasized that by helping to sell a complete travel experience, charter captains can provide significant support for Ohio's $26 billion tourism industry, and receive support from other businesses in return.

"Outdoor activities are second only to special events as the reason why guests overnight in Ohio," Huntley explains. "And tourism is everybody's business in a community. From the charter captain who books the trip, to the bait shop that sells supplies, to the hotel that provides the guest lodging, to the accountant who manages their books, to the farmer who provides the produce needed to prepare meals, few

industries are untouched by the increased spending that occurs when guests spend their dollars within communities."

Other speakers included representatives from the Lake Erie Charter Boat Association, ODNR Division of Wildlife's Sandusky Fisheries Research Unit and Lake Erie Law Enforcement Unit, U.S. Customs and Border Protection, and the U.S. Coast Guard. Scott Zody, ODNR Division of Wildlife Chief, presented the Charter Captain of the Year Award to Captain Ron Eickholt.

In the survey Ohio Sea Grant conducts at each conference, 92% of respondents said that they learned new information they will be able to use in the future, and 91% plan to share the information with others. 53% of respondents intend to modify some of their habits as a result of the conference, and 94% felt that attendance at the 2013 conference was a worthwhile experience for them. Of respondents who had attended previous conferences, 40% felt that their profitability had increased after they attended an earlier event. **TL**

www.protectyourwaters.net

The Stop Aquatic Hitchhikers Campaign is a national campaign sponsored by the Aquatic Nuisance Species Task Force, the U.S. Fish & Wildlife Service, and the U.S. Coast Guard to educate boaters and other recreational water users about ways to prevent the spread of aquatic invasives between bodies of water.

Above: John Goss, Asian Carp Director for the White House Council on Environmental Quality, speaks to a reporter about the federal government's efforts to prevent Asian Carp from entering the Great Lakes.

lake erie day
AT CLEVELAND BOAT SHOW

Event Raises Funds for Stone Lab Scholarships

by Christina Dierkes, Ohio Sea Grant Communications

Visitors to the Progressive Mid-America Boat Show in Cleveland, held in January at the I-X Center, not only learned about some of the most important issues facing Lake Erie, they also helped raise funds for scholarships benefiting students who take summer classes at Stone Laboratory, Ohio State's Island Campus on Lake Erie.

The Lake Erie Marine Trades Association (LEMTA), which manages the boat show, donated $1 from every admission ticket purchased on January 21 – Lake Erie Day – raising $1031 for Stone Lab student scholarships. Ken Alvey, LEMTA President, was very pleased with the results: "On the weekend, the show was a blow-out, and attendance on almost every day doubled from last year." Alvey expects the number of show visitors to increase by 25% next year, and the organization plans to continue the Lake Erie Day fundraiser.

"Ohio Sea Grant's participation at the Progressive Mid-America Boat Show reminds us that everyone plays a role in our stewardship of Lake Erie," Alvey says. "From the Clean Marinas Program to the challenges of Asian carp, protecting Ohio's most important natural resource is job #1 for the Ohio Sea Grant Program. Lake Erie Day at the boat show brings hands-on science to our visitors and helps teach them how to protect and preserve our Great Lake."

During the five-day show, 40,000 people visited trade and educational booths, including the Ohio Sea Grant booth. Visitors were able to learn first-hand from Sea Grant experts, who answered questions about what causes harmful algal blooms, what to do with unwanted medicines, and how the "Stop Aquatic Hitchhikers!" campaign aims to prevent the introduction of new aquatic invasive species into the Great Lakes.

Between the Cleveland show and the Columbus Sports, Vacation & Boat Show, held in February and also organized by LEMTA, 80 visitors took the Ohio Clean Boater Pledge, a commitment to keeping Ohio's waterways clean while enjoying recreational boating opportunities. **TL**

More information about the program is available at ***ohiocleanboater.osu.edu***.

CLIMATE CHANGE IMPACT

FISHING FOR change

by Christina Dierkes, Ohio Sea Grant Communications

Lake Erie supports some of the most important fisheries in the Great Lakes, and many businesses along the shore rely on this influx of income, from restaurants and hotels to charter fishing operations. But as climate changes in the region, currently popular fish species like yellow perch may become less abundant, potentially forcing industries and customers alike to adapt their habits.

"What I think is so scary about climate change is that it can influence the physiology of individuals.... It really can touch upon every aspect of the existence of an individual organism."

— DR. STUART LUDSIN

Photos: Main, Troy Farmer; Inset, University of Wisconsin–La Crosse; Portrait, OSU-AEL

Dr. Stuart Ludsin, Assistant Professor in Ohio State University's Department of Evolution, Ecology and Organismal Biology (OSU-EEOB), is studying the potential impacts of climate change on fish in the Great Lakes, and focusing particularly on two predicted impacts: warming temperatures and an increase in extreme precipitation.

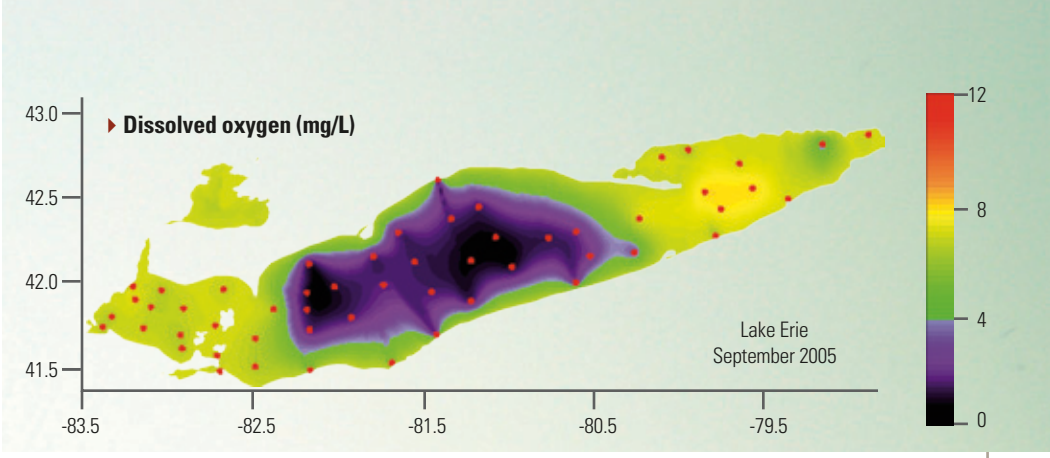
"What I think is so scary about climate change is that it can influence the physiology of individuals, it can influence interactions among individuals within a species as well as between species, and it can affect habitat, which includes the quality of the water, food resources, and availability of critical spawning habitat," Ludsin explains. "It really can touch upon every aspect of the existence of an individual organism."

A warming climate is already affecting the Great Lakes region, from shorter winters and fewer days below freezing to record high temperatures and drought conditions. Warmer air temperatures also lead to warmer water

Yellow perch larvae, at only 5 millimeters in length, are most likely to be impacted by harmful algal blooms, but little research is available on the topic. While the algal blooms provide refuge for larval fish, they also interfere with swimming, and cyanobacteria toxins can severely impact early development stages.

Hypoxia – the "dead zone" (purple area) – is common in the central basin of Lake Erie in late summer, when decomposing aquatic organisms use up dissolved oxygen faster than it can be replenished from the surface. The dots on the map represent stations where oxygen was measured in September 2005.

Graphic: Stuart Ludsin



temperatures, which could impact coolwater species like yellow perch and walleye, both species that support important recreational and commercial fisheries in addition to their ecological importance.

It's difficult to predict exactly how future conditions will affect these fish, but data collected by Ludsin and his colleagues at Ohio State's Aquatic Ecology Laboratory will help management agencies like ODNR Division of Wildlife draw better conclusions from their year-to-year observations. For example, analyses of ODNR data by Ludsin and other Ohio State colleagues show that very warm winters are followed by failed year-classes of both walleye and yellow perch the next spring, whereas good year-classes only occur following long, cold winters.

Year-class strength is an index used by agencies like the ODNR that signifies how many juvenile fish are present in the ecosystem during late summer, essentially serving as a proxy of that spawning season's reproductive success. That same index is also used by fisheries managers to help determine how many adults will recruit (survive) to the fishery two years later, and to help set quotas on how many adults can be harvested during a particular fishing season.

"One of our PhD students, Troy Farmer, is finishing up some experiments and doing a bunch of computer modeling to determine whether or not the warming during winter is negatively affecting yellow perch through reduced reproductive development," Ludsin explains. One potential explanation may be that short, warm winters do not give female yellow perch enough time to develop their ovaries, but Farmer's experiments also suggest that a link exists between winter duration and the quality of yellow perch eggs that are produced the next spring. Farmer is co-advised by Ludsin and Dr. Elizabeth Marschall (OSU-EEOB).

"Eggs produced after a long winter are significantly larger than eggs that are produced after a very short winter, and they're of higher quality, so we think it's going to come down to warm winters having a negative effect by reducing egg quality," Ludsin says. "Troy, with the help of an undergraduate, Chelsea Coble, is now looking to see if that egg quality difference translates into differential larval quality as well."

In addition to affecting reproduction, a warming Great Lakes climate could lead to an increase in harmful algal blooms (HABs). These are already a common occurrence in Lake Erie's western basin, where warm, shallow waters and nutrient runoff from the surrounding agricultural lands – which would increase with the more frequent heavy rains that climate models are predicting – provide prime environmental conditions for cyanobacteria, or blue-green algae.

The effects of these blooms on Lake Erie's fish community are only just being investigated by Ludsin, led by another of his PhD students, Ruth Briland. While little research exists in this area, limited study in other systems suggests that large algal blooms can impact how young fish forage for food, as the algal clumps impair lines of sight on prey and interfere with swimming. In addition, some cyanobacteria produce toxins that can severely impact egg and larval development, even with short-term exposure. More research is needed to determine whether these negative climate change effects outweigh positives, like the refuge algal blooms can provide for larval fish, especially as warming temperatures and increased precipitation are likely to lead to more algal blooms if nutrient runoff is not reduced.

Algal blooms can also be problematic after individual organisms die and sink to the bottom of the lake by promoting hypoxic events, or low-oxygen conditions. These "dead zones" have once again become common in Lake Erie's central basin, where decomposing algae and other forms of aquatic life use up dissolved oxygen faster than it can be replenished from the surface. These dead zones also occur in Lake Erie's western basin in late summer during calm periods with little wind.

More information about the Ohio State University Aquatic Ecology Laboratory is available at ***ael.osu.edu***. Dr. Ludsin has presented some of his research as part of the *Global Change, Local Impact* webinar series, archived at ***changingclimate.osu.edu***. The webinar series is a multi-departmental effort within Ohio State University, led by OSU Extension, Ohio Sea Grant, and Byrd Polar Research Center, to help localize the climate change issue for Ohioans and Great Lakes residents.

"Based on some work I've done with collaborators from the University of Michigan, particularly with James Roberts who was a PhD student with Thomas Höök, hypoxia can have a negative effect on yellow perch during summertime," Ludsin says. "The fish aren't growing and putting on lipids, their energy reserves, as well as they could be during the summer, because they're displaced from bottom habitat where cool water and preferred prey exist."

Reduced fat stores would mean that fish have less energy that can be devoted to reproduction during the winter and spring, which could compound potential problems with ovarian development during short, warm winters. It's a synergistic climate change effect, wherein summer hypoxia interacts with winter warming to negatively affect yellow perch reproduction the following spring in a way that is greater than the impact of either of these climate-induced stressors in isolation.

Lake Erie recreational and commercial fishing are multi-million dollar industries, and anything that would affect the economic value of the resources these industries are built upon is of concern to researchers and management officials alike. Dr. Ludsin's research – and there are many more projects currently in the works – is contributing important information to the overall knowledge of climate change effects on the Great Lakes in general, and Lake Erie specifically. And if all goes as climate modelers are suggesting, we'll be putting that knowledge to use soon. **TL**

methane SOURCES *in* LAKE ERIE

by Christina Dierkes, Ohio Sea Grant Communications

For more information about this project, contact Amy Townsend-Small at ***amy.townsend-small@uc.edu***.

On a late summer day on Lake Erie, what looks like an upside down bucket, surrounded by an inner tube and attached to hoses and wires, floats next to a Stone Lab research vessel. On the boat, a research team is taking air samples from below the bucket for later analysis, and measuring environmental conditions like air and water temperature.

Dr. Amy Townsend-Small and her students are measuring methane emissions from the surface of Lake Erie. Like carbon dioxide, methane acts as a greenhouse gas in the atmosphere, trapping heat and contributing to global warming. Globally, the major sources of methane are agriculture and industry – cattle operations, landfills, and leakage from natural gas pipelines – but one little-studied source of methane is decomposition of microscopic algae called phytoplankton in freshwater lakes such as Lake Erie.

"Methane is a powerful greenhouse gas – it's about 25 times better at trapping heat than carbon dioxide – and it can be produced in lakes when there's low oxygen concentrations in the bottom water and sediments," Townsend-Small, Assistant Professor of Biogeochemistry at the University of Cincinnati, explains. "This condition, called hypoxia, happens in Lake Erie in the late summer, so we measured emissions of methane from the surface of the lake to the atmosphere at the end of the summer to characterize how much of a source of greenhouse gases the lake might be."

When algae die, they sink to the bottom of the lake, where they are decomposed by resident bacteria. This process, along with the formation of a thermocline – a sharp delineation between an upper warm layer and a cold bottom layer of water – leads to the creation of the "dead zone." This low-oxygen, or hypoxic, area develops in the central basin of Lake Erie in late summer, when dissolved oxygen is used up faster than it can be replenished from the surface. When no oxygen is present, the decomposition process can produce methane instead of carbon dioxide.

In the process of working with Ohio Sea Grant to fund Townsend-Small's project, the researchers connected with a group at Environment Canada, who had also been working on measuring methane emissions in Lake Erie. The Canadian team had started to try to compare emissions of biological methane, such as would be produced in a hypoxic zone, to emission of fossil fuel methane from natural gas drilling.

"The Canadian side of the lake is very heavily mined for natural gas," says Townsend-Small. "Natural gas is 95-100% methane, and my previous work has found that these pipelines can leak quite significantly, which also contributes to atmospheric methane emissions."

During the research cruises onto the lake, those emissions are collected using flux chambers – basically upside-down buckets – that float on the water's surface and catch gases that are emitted from the lake to the

ABOUT METHANE

"Methane is a powerful greenhouse gas – it's about **25 times better at trapping heat than carbon dioxide** – and it can be produced in lakes when there's low oxygen concentrations in the bottom water and sediments."

— DR. AMY TOWNSEND-SMALL

atmosphere. Gas samples are taken every 3 minutes for a total of 15 minutes, methane concentrations in each sample are measured back in the Cincinnati lab, and from the rate of increase in methane concentration, the researchers can calculate the rate of methane emissions from the lake.

Of course, conditions on Lake Erie aren't always perfect for research like this. "This was my first experience on Lake Erie, and one thing we weren't really prepared for was how rough the water could get," Townsend-Small remembers. "It took us several tries to get the flux chamber method to work in these windy and wavy conditions, but we figured it out eventually."

So far, the researchers have compared emission rates in areas of the lake in both the United States and Canada, and have found that rates are up to ten times higher in the natural gas drilling areas on the Canadian side. Isotopic analysis of the methane samples, which can distinguish between natural and industrial methane sources, is still needed to confirm that the higher methane emissions are indeed linked to the pipelines' presence, but preliminary results suggest the connection.

Below: The flux chambers used to collect emissions from below the lake surface are a low-tech solution to address the project's needs, but have worked well after the researchers adjusted to often choppy conditions on Lake Erie. Back in the lab, the team will be able to distinguish industrial from natural methane emissions, an important step in managing their contribution to global warming.

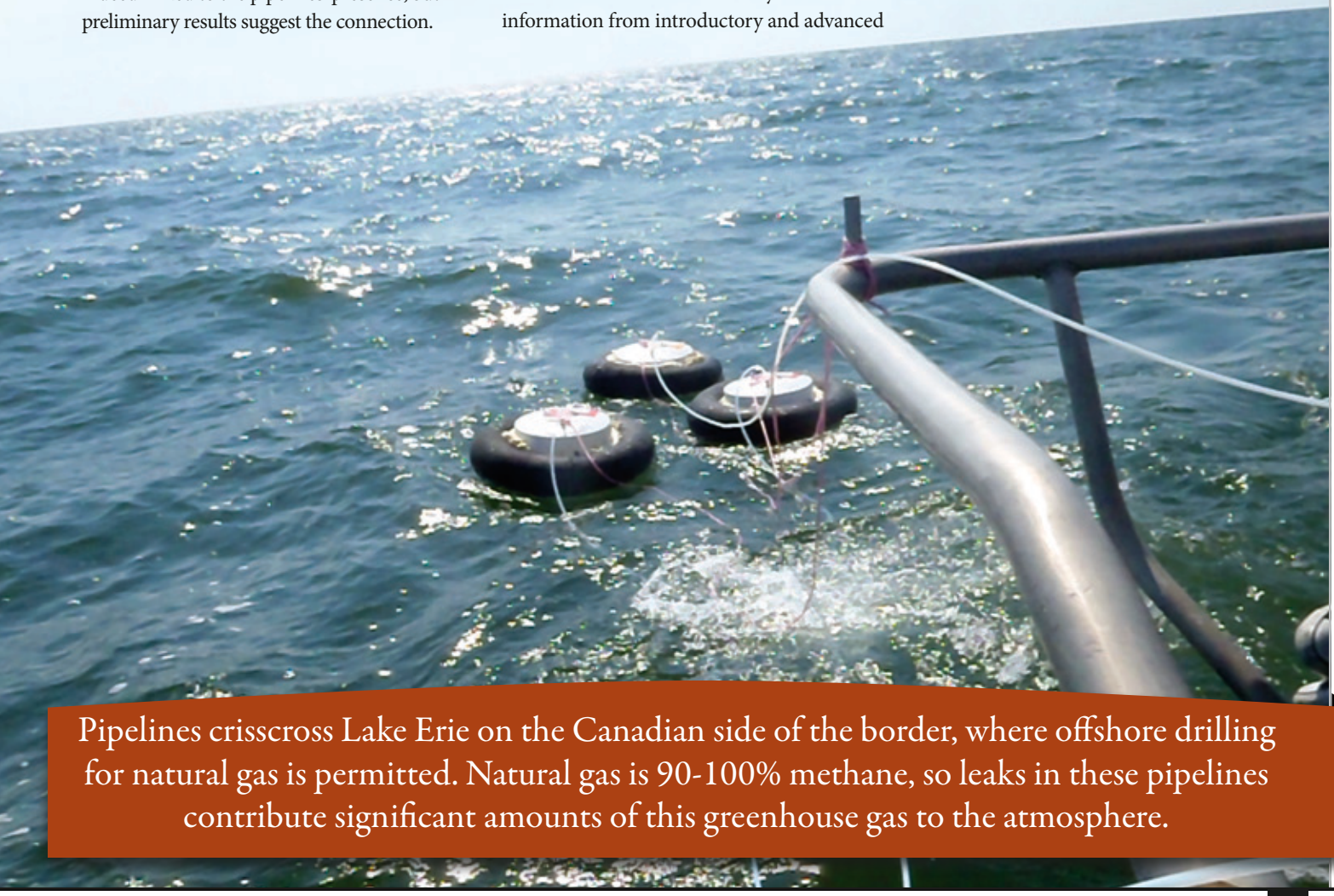
In addition to contributing to our knowledge of the Lake Erie ecosystem and industrial influences on its health, Townsend-Small's research is helping her students connect classwork to their lives outside the university.

"In Cincinnati, we live in one of the Earth's largest watersheds, the Mississippi River watershed, which I felt really excited about when I moved here," Townsend-Small says. "It's such a great illustration of water resources and human impacts on water resources, but when I started teaching, and using the Ohio and Mississippi Rivers as examples, the students didn't really respond. I found that even in Cincinnati, four hours south of Lake Erie, students have a lot of personal investment in the lake."

Townsend-Small credits the recreational opportunities available on the Great Lakes for creating that attachment, and has used the connection successfully to relate information from introductory and advanced science courses to her students' familiar environments. "We talk about lakes, and about hypoxia and methane, so the research from this summer already made it into the curriculum," she says.

Once the analysis of methane isotopes is completed, Townsend-Small will publish the results, but she also hopes to receive more funding to continue the research. "Our current study only has three days of samples, from one point in time. So it would be nice to get an idea of how methane emissions, especially biological emissions, vary throughout the summer and fall."

And combining those results with their knowledge about the impact of different methane sources should go a long way in better managing Lake Erie methane to mitigate its effects on global climate. **TL**



Pipelines crisscross Lake Erie on the Canadian side of the border, where offshore drilling for natural gas is permitted. Natural gas is 90-100% methane, so leaks in these pipelines contribute significant amounts of this greenhouse gas to the atmosphere.

STONE LAB *water quality* LAB Gets Ready for Its Close-Up

by Christina Dierkes, Ohio Sea Grant Communications

Below: Algal blooms are common in the western basin of Lake Erie, where warm, shallow waters provide a perfect environment for these events. The Water Quality Lab will help researchers better understand how blooms form, the first step in learning how to prevent them in the future. Photo: Brenda Culler, ODNR

Last year already saw a number of improvements at Stone Laboratory, but renovations and updates continue on South Bass and Gibraltar Islands. The newest addition to Stone Lab's facilities will be an Algae & Water Quality Lab, housed in the Stone Lab Research Building and slated to open this summer.

Adding significantly to Stone Lab's research capabilities, the Water Quality Lab will offer analysis services for a wide range of nutrients, cyanobacteria toxins, and suspended solids. Outside researchers will be able to request these tests from Stone Lab staff, and summer students in Stone Lab's Research Experience for Undergraduates (REU) Program will also be allowed to use the lab for their research projects.

"The new Water Quality Lab will focus on nutrient and phytoplankton analysis, which has previously been missing from Stone Lab research," says Dr. Justin Chaffin, Stone Lab Research Coordinator and the lab's primary technician. "Research in the new lab will address Lake Erie eutrophication and nutrient loading issues related to cyanobacterial blooms." Construction of the lab was funded by an Ohio Environmental Fund grant from the Ohio Environmental Protection Agency (OEPA).

"The new Water Quality Lab will focus on nutrient and phytoplankton analysis, which has previously been missing from Stone Lab research."

— DR. JUSTIN CHAFFIN

"Nutrient load" is the total amount of a nutrient, such as nitrogen or phosphorus, entering the water during a given time. Nutrients arrive in ecosystems in a variety of ways, such as from farm field runoff and combined sewer overflows, with phosphorus and nitrogen being of greatest concern. Once these nutrients enter the lake, they contribute to nuisance algal blooms, which are unattractive and may have a negative impact on tourism and water quality, and to harmful algal blooms, or HABs, which can threaten the health of people and animals.

HABs are an excessive growth of cyanobacteria, often called blue-green algae, which can produce toxins that damage the liver, nervous system, and skin. Cyanobacteria bloom when there is an excess of nutrients in warm water: freshwater HABs are generally caused by excess phosphorus and nitrogen. Dissolved phosphorus concentrations in Lake Erie have been rising since 1995, and HABs have been documented annually during summer and fall since 2002, with large blooms occurring 2008 through 2011.

"Once the Water Quality Lab is completed, the potential for collaborations will be

At Left: Stone Lab's new Algal & Water Quality Lab is housed in the Research Building on South Bass Island, allowing testing to be performed right on Lake Erie. Among other projects, the lab will run analyses for the Ohio EPA, who funded part of the equipment purchases.

incredibly wide-ranging," says Dr. Jeff Reutter, Director of Ohio Sea Grant and Stone Lab. "We'll be able to provide phosphorus concentrations and other data that we've been unable to provide in the past. The fact is that the HABs problem is not gone, and reducing phosphorus loading is as important as ever, so being able to quickly and accurately measure that loading is essential to improving the health of Lake Erie."

As part of Stone Lab's efforts to contribute to the monitoring and reduction of HABs, the Lab will continue and expand collaborations with NOAA researchers like Dr. Richard Stumpf, who issued the first harmful algal bloom forecast for Lake Erie's western basin from Stone Lab in 2012 (***go.osu.edu/habs2012***). Based on satellite images of the lake, NOAA will again be able to request samples taken at specific points in Lake Erie to help them continue to calibrate and improve their predictive computer models.

In addition to assessing phosphorus and nitrogen concentrations in Lake Erie, the Water Quality Lab is set up to test for different forms of bioavailable nitrogen (nitrogen that can be used by aquatic organisms) in lake water. Nitrogen is a critical component of microcystin, produced by *Microcystis* cyanobacteria and the main cyanotoxin in Lake Erie. According to Chaffin, "depletion of bioavailable nitrogen is a factor in why cyanobacterial blooms switch from *Microcystis* to *Anabaena*." Therefore, understanding bioavailable nitrogen concentrations and how they change throughout the year could in turn better inform our understanding of the causes of harmful algal blooms and toxin production triggers.

Other available tests will include plankton identification, which can help researchers focus on finding why that particular species is present in Lake Erie; chlorophyll content, which scientists use as a surrogate measurement for total amount of phytoplankton in a sample; and analysis of suspended solids, both organic and inorganic.

This last test focuses on water clarity in Lake Erie, which can impact anything from plankton growth to fish feeding and foraging by blocking sunlight for photosynthesis and making it hard for fish to see their prey. By drying sediment samples in a specialized oven and then heating them in a muffle furnace, researchers can determine the sample's make-up, including whether the suspended solids are organic algae or inorganic sediments. Using this data, scientists and ecosystem managers can determine potential sources of water clarity problems, such as excessive runoff from farm fields lining Lake Erie tributaries.

"The Water Quality Lab will allow Stone Lab researchers, as well as other scientists, to have a wide range of water testing performed right by the lake, instead of having to send samples farther away," Chaffin concludes. "This will not only make testing faster and more efficient, but should also free up research funds for additional tests that otherwise may not be within a project's budget."

And when it comes to protecting Lake Erie, arguably Ohio's most valuable natural resource, more knowledge will always help the lake's stewards as they continue their work. **TL**

For more information about the Stone Lab Water Quality Lab, contact Justin Chaffin at ***chaffin.46@osu.edu***.

Summer 2013

STONE LAB Workshops

Have you always wanted to take a Stone Lab class, but aren't ready to commit to a full week (or more)? Stone Lab's non-credit workshops are your chance to get a taste of island learning on Lake Erie!

Workshops last one to three days and are open to the public; participants must be at least 18 years old and have completed high school.

WORKSHOP SCHEDULE

JULY 14	Larval Fish Identification
AUG 5-6	Algae Identification
AUG 7-8	Dealing with Cyanobacteria, Algal Toxins and Taste & Odor Compounds
AUG 9-11	Outdoor Photography
SEPT 14-15	Fish Sampling Techniques
SEPT 20-22	Lake Erie Sport Fishing

For more information & applications visit ***stonelab.osu.edu/courses/noncredit***

history & science on the HIGH SEAS

by Christina Dierkes, Ohio Sea Grant Communications

> *"We have met the enemy, and they are ours."*

Ohio State University is offering this course as EEOB 3189 for two semester credit hours. For more information, contact Dr. Edwards at ***wje@niagara.edu***.

Above: There are few prerequisites for "Environmental Science on the *Brig Niagara*," and students are taught everything they need to know to sail the ship. However, a good sense of balance is definitely advantageous.

Top: Stone Lab Manager Matt Thomas (right) is one of four visiting instructors during the field course.

Those now-famous words from Commodore Oliver Hazard Perry after the Battle of Lake Erie were written aboard the B*rig Niagara*, a two-mast tall ship that became the American flagship during the 1813 battle with the British fleet. But the *Niagara*'s claim to fame doesn't end in the pages of history books – a replica of the ship still sails the Great Lakes today, serving as a backdrop for history lessons, sailing courses, and college classes.

One of those classes is "Environmental Science on the *Brig Niagara*," offered through a partnership between Niagara University, Penn State University, and Ohio State University's Stone Lab. Students from any college or university can live and study aboard the *Niagara* for three weeks, covering Great Lakes science, history, and environmental policy while actively helping to sail the ship.

"This fits right into the rest of the Stone Lab experience, where an hour of hands-on learning is better than 20 in the classroom," says Dr. Bill Edwards, Associate Professor of Biology at Niagara University and lead instructor for the course. "We'll take students on a trip across Lake Erie, Lake Huron, and Lake St. Clair, and we'll experience each ecosystem first hand: we'll get wet, encounter wildlife, get dirty, and do science at the same time as we sail the *Niagara*."

Edwards, along with Dr. Sam Mason of SUNY Fredonia's Department of Chemistry, will accompany students for the length of the trip, while experts in marine archaeology, ecology, and microbiology will join the class for a few days each as their area of expertise is discussed. The *Niagara* will travel from Erie, PA to Alpena, MI and back, taking water samples, covering regional history and current policy issues like harmful algal blooms, and stopping at field stations along the way for more in-depth looks at everything from Great Lakes ecology to shipwrecks and their history.

In addition to a stop at Stone Laboratory on Gibraltar Island in western Lake Erie, Stone Lab Manager Matt Thomas will join part of the trip, to help students send a remotely operated vehicle (ROV) to one of the shipwrecks at the National Marine Sanctuary in Alpena, and to teach about Lake Erie issues and potential solutions being researched at Stone Lab.

"I did my Ph.D. work at Stone Laboratory, and we felt that, with Stone Lab's position as the premier field station on the lower Great Lakes, that we had to make a stop there to understand the current ecology and research on Lake Erie," Edwards explains.

Sailing on the historical *Niagara* – as compared to sailing on a modern motorized vessel – adds a new dimension to experiencing Great Lakes science. "The history of the Great Lakes ecosystem is really the history of the region's people, and the Battle of Lake Erie opened up all the Great Lakes for settlement," Edwards says. "As humans settled the Great Lakes, the impacts from that settlement started playing a larger role, so the ship brings life to the larger historical view that the students would not get motoring around on another ship."

And really, the chance to live on a tall ship for a bit is just plain cool. "This opportunity to experience the Great Lakes first hand, to be a sailor and to be a scientist at the same time, won't happen twice in a lifetime," Edwards says. "You won't get that anywhere else on the Great Lakes." **TL**

Sharing knowledge with A NEW GENERATION

by Christina Dierkes, Ohio Sea Grant Communications

Educator classes at Stone Lab don't just give teachers new ideas for the classroom. For some, that first Stone Lab experience encourages them to expand their lessons beyond the traditional school setting, and may take them farther away from it than they ever expected.

Scott Hoff, a high school teacher at Bluffton Schools in northwestern Ohio, was introduced to Stone Lab 22 years ago, as a first-year teacher. "A colleague at Eastwood Schools, where I was teaching at the time, said 'Scott, you should really consider this,'" Hoff remembers. "I signed up for graduate school at Bowling Green, and getting to go to Stone Lab was part of it. It absolutely changed my life."

At Bowling Green State University, Dr. Cynthia Stong introduced Hoff to marine sciences, and to the opportunities available at Stone Lab, through a National Science Foundation project called Ocean Focus, which aimed to give teachers the opportunity to study hands-on aquatic biology in both fresh- and saltwater environments. The program included a class at Stone Lab, and sparked an idea in some of the attendees.

"A couple of us teachers looked at each other across the table and said: 'how can we apply this in our own classrooms?'" Hoff explains. "So we decided to start a marine science program. Since then, all the others have retired, but I'm still loving it."

Hoff's marine science course at Bluffton now includes a number of concepts he learned during this summer's Principles of Oceanography for Educators course. "I signed up for the course to help solidify my skills, and that's exactly what I got. Mark Peter, our instructor, introduced the class, and I knew it was exactly what I was looking for. I'm also incorporating those notes into my own class right away."

Of course, Hoff also encourages his own students to consider classes at Stone Lab. In addition to Stone Lab posters being a constant presence in his classroom, he actively tells them about his experience there. "As teachers, we try to motivate kids and pique their interest in certain things," he says. "I showed them pictures, and introduced them to the idea of living on an island for a week studying in that setting. It really got kids fired up, and of course everybody wants to go at that point. Then you introduce all the topics that you're going to learn, and how intense it actually is. And then I just sit back and wait, and eventually you get a few who are going to come up to me and say 'hey, tell me more,' and that's when I know I've got them hooked."

Living at the Lab also encourages students to learn from each other, as they share meals, classrooms, and living quarters. Hoff still communicates with fellow summer students to share ideas and further incorporate the experience into everyone's teaching.

"I learned so much, it's going to take me years just to incorporate all this into my high school class," Hoff says. "The learning that takes place at Stone Lab directly impacts the classroom." **FOSL**

"I learned so much, it's going to take me years just to incorporate all this into my high school class. The learning that takes place at Stone Lab directly impacts the classroom."

— SCOTT HOFF

Friends Of Stone Laboratory

Dear friends,

It was good to see many of you at the Silent Auction held at OSU on January 30. This event provides a time to catch up with members and others who came to see what FOSL is about and enjoy refreshment and conversation. Nancy Cruickshank and her crew did a great job collecting items for the auction. Thank you to all who contributed in any way. $2300 was raised for the lab from the event. Your generosity is much appreciated, allowing us to provide research opportunities for more students. Thanks are due to Jeff Reutter, Chris Winslow, Justin Chaffin and Kristin Stanford for their entertaining and informational talks regarding projects and progress at the lab.

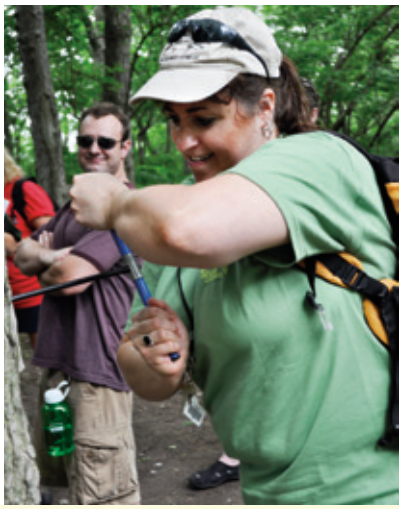
Hearing about the lab raises excitement to be there in person. The first opportunity of the season was the Spring Work Weekend on April 19-21. Please refer to ***stonelab.osu.edu/events*** *for details about future events, including the Summer Guest Lecture Series and the Stone Lab Open House on September 7.*

If you are reading this letter and are not yet a FOSL member, please consider becoming one. Your time and talents are so valuable to the lab but as with any organization, financial support is needed. Again, I will direct you to the Stone Lab website. There is a FOSL tab that details what becoming a member is about. Not sure? Join us in September or come to one of the summer lectures offered to all. Hop on a ferry and join in. A good experience is guaranteed.

Sincerely,
Sheila Lewicki, FOSL President

Ahoy: Teacher at Sea

Congratulations to Angela Greene, science teacher, Ohio Sea Grant Education & Outreach Associate, and FOSL board member, on her acceptance into the 2013 NOAA Teacher at Sea program! Angela was one of only 28 educators selected from across the country. See Angie's Teacher at Sea blog at ***http://teacheratsea.noaa.gov/2013/greene.html***. **FOSL**



An Island Paradox

There probably is no one answer as to why people are willing to travel from all over the state, board a ferry, and stay in a dormitory just to volunteer to work! Both the Spring Work Weekend and the popular "Buckeye Island Hop" in the fall have literally been "sold out" during the past two years. It is a great situation to have when you can have so many volunteers that you max out the available space to house them.

No matter what your talents or abilities, your time is valuable to Stone Lab. Meet up with old friends and classmates, make new friends, have fun, and experience the satisfaction of really helping out Stone Lab. See you there. **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

The Ohio State University
PO Box 119, Put-in-Bay, OH 43456
419.285.1800, 614.247.6500, Fax 614.247.6578, *stonelab.osu.edu*

STONE LAB STAFF

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Dr. Kristin Stanford, Lab Outreach Coordinator (*stanford.147@osu.edu*)
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Kelly Dress, Business Office Manager (*dress.3@osu.edu*)
Dr. Justin Chaffin, Research Coordinator (*chaffin.46@osu.edu*)

FOSL

Dates to Remember

September 6-8, 2013	Annual Stone Lab Open House
September 27-29, 2013	John Crites Student Reunion, Stone Lab
October 4-6, 2013	Buckeye Island HOP, Stone Lab

Ohio Sea Grant's 15th Annual Winter Program

The annual Winter Program & Silent Auction was held on January 30, 2013 at the beautiful Longaberger Alumni House. It was a wonderful evening of social and informational interaction. Everyone had an opportunity to learn of the latest updates about Ohio Sea Grant and Stone Laboratory.

Some of the highlights for the evening: Ohio Sea Grant is rated one of the top 5 programs in the country, Buckeye FOSL has been rejuvenated, a new research laboratory is to begin operating this summer, record attendance for summer 2012 classes, over 17,000 people participated in workshop and outreach activities, record amounts of scholarships and REUs were awarded for the 2012 season.

Throughout the evening, a silent auction also took place to raise funds that go directly to student scholarships. By the end of the evening, $2,300.00 was raised through the auction. **FOSL**

Thank you to the volunteers and staff who assisted with this year's spring cleanup.

THANK YOU FOR YOUR SUPPORT

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.

Anthony Thomas Candy
Black Swamp Conservancy, Lake Erie Island Chapter
Melody Bluemel
Lauren Bradley
Eugene Braig
CAPA
Center of Science and Industry
City Barbeque
Cleveland Botanical Garden
Columbus Blue Jackets Foundation
Columbus Guitar Society
Columbus Museum of Art
Columbus Zoo
Suzanne Cruickshank
Paula Deen Enterprises LLC
El Vaquero Mexican Restaurant
Graeter's Ice Cream
Katherine Graff
Great Lakes Science Center
Great Wolf Lodge
Gruviera Armonico
Pam Hansberger
Guy Harvey Publishing
Heineman's Winery
Island Transportation
Jolly Time Pop Corn
Lake Erie Islands Nature/Wildlife Center
John Mahilo
Miller Ferries to PIB & Middle Bass Island
Mohican Resort and Conference Center
OSU Athletic Ticket Office
OSU Trademark and Licensing
Packard Island Publishing
The Refectory
Kristin Stanford
Ronald Stuckey
Toledo Symphony
United Dairy Farmer/ Homemade Brand

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Stone Lab Guest Lectures

Tune in for the 2013 Stone Lab Guest Lecture Series, where Lake Erie researchers and agency officials will give you a first-hand look at the Lake Erie ecosystem and the issues it faces. You could also be the first to hear from the next generation of Lake Erie researchers as students in Stone Lab's Research Experience for Undergraduates Program present their summer projects!

JUN 13
Scott Zody, Chief
Ohio Division of Wildlife, ODNR
"Overview of ODNR – Division of Wildlife"

JUN 20
Dr. Charles E. Herdendorf, Director Emeritus
Ohio Sea Grant and Stone Lab
"Battle of Lake Erie: How Lake Processes Contributed to Perry's Victory"

JUN 27
Dr. Jeffrey M. Reutter, Director
Ohio Sea Grant and Stone Lab
"Solving Lake Erie's Nutrient Loading and Harmful Algal Bloom Problems"

Dr. Robyn Wilson, Assistant Professor
OSU School of Environment and Natural Resources, Environmental and Social Sustainability Lab
"Designing Restoration Efforts and Sustainability Initiatives that Work: Insights from the Social Sciences"

JULY 2
Scott Nally, Director
Ohio EPA
"OEPA Update/40th Anniversary"

JULY 11
Dr. Caroline C. Whitacre, Vice President for Research
The Ohio State University
"Research at The Ohio State University: An Update"

JULY 18
Research Experience for Undergraduates Scholarship Program Final Presentations

JULY 25
Gail Hesse, Executive Director, Ohio Lake Erie Commission
"The Ohio Lake Erie Phosphorus Task Force Phase II: Science-based Analysis for Policy Recommendations"

AUG 1
Ken Alvey, President,
Lake Erie Marine Trades Association
"Recreational Boating Trends, Challenges, and Opportunities"

Visit us on Gibraltar Island or at the Aquatic Visitors Center, or tune in for a live web broadcast.

More information at ▸ **go.osu.edu/stonelablectures**

Presented in collaboration with the Ohio Sea Grant College Program; the Friends of Stone Laboratory; the Ohio State University Office of Research; the College of Food, Agricultural and Environmental Sciences; the Office of Energy and Environment; the Environmental Sciences Network; The Ohio State University; and Gibraltar Island, Put-in-Bay, Ohio