

# ENVIRONMENTAL monitor

FALL 2016

APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS

## LAKE ERIE RESEARCH FROM THE WESTERN BASIN

### Nutrient Target

What It Will Take To Cut Lake Erie's Phosphorus By 40 Percent

### Ohio Stream Monitoring

A Visit To The National Center For Water Quality Research

### Iceland's Glaciers

Dynamic And Understudied Ice Sheets Contribute To Flood Risks



14



30



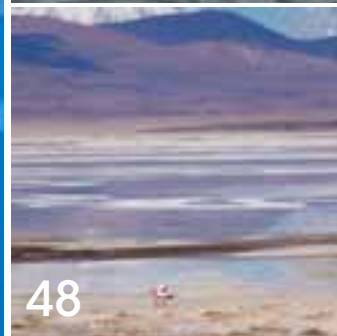
34



44



46



48

ENVIRONMENTAL  
**monitor** Subscription

The Environmental Monitor magazine is a publication providing the environmental professional with the latest in monitoring technology, product information and environmental applications. **Subscription is free.**



Sign up today at [fondriest.com/news/subscribe](http://fondriest.com/news/subscribe)

**CONTENTS**

ENVIRONMENTAL MONITOR | FALL 2016

- 03 Web Exclusives
- 04 In the News
- 06 Featured Photo
- 08 Environmental Education
- 10 G2-RAIN Alert System
- 12 Infographic: Lake Erie
- 14 Phosphorus In Sediments
- 16 A 40 Percent Reduction
- 18 Achieving Nutrient Targets
- 20 Port of Toledo
- 22 Heidelberg University NCWQR
- 30 Dynamic Ice Sheets
- 32 Lake Mendota Gas Flux
- 34 Arctic Permafrost Burning
- 36 Everglades Greenhouse Gases
- 38 Endangered Pallid Sturgeon
- 40 New Jersey Dredging
- 42 Monitoring Gear
- 44 DIY Divers
- 46 Suttle Lake Salmon
- 48 Chilean Salt Flat
- 50 Fishing Apps
- 52 In the Great Lakes
- 55 Warming Lake Tahoe
- 56 Industry Profile
- 58 New Technology
- 60 Crossword Puzzle

**IN THE NEXT EDITION**

A NexSens data buoy off Lake Erie's Gibraltar Island is aiding research and curriculum development at Ohio State University's Stone Laboratory (back cover photo).

Cover Photo: Nate Christopher / Fondriest Environmental

Find it at  
**fondriest.com**



**FONDRIEST**  
ENVIRONMENTAL  
888.426.2151

**WELCOME...**

Welcome to the Fall 2016 edition of the Environmental Monitor, a quarterly collection of the best of our online news publication. In this edition, we take you to Lake Erie's western basin to learn more about the incredible research efforts underway to reduce algal blooms.

This includes a look at several studies that consider what it will take to reach the goal of reducing phosphorus entering the lake by 40 percent as well as associated costs. We also stop by the National Center for Water Quality Research at Heidelberg University, where investigators oversee 18 monitoring stations that gather stream data used by Lake Erie modelers near and far.

You'll also read about the High Lakes Aquatic Alliance Foundation's efforts to document the food web in Oregon's Suttle Lake to help salmon stocks there. And don't miss work by scientists at Western Kentucky University to dissect glaciers in Iceland, some of the most dynamic – yet understudied – glaciers on Earth.

Located in Fairborn, Ohio, Fondriest Environmental is the trusted partner you can turn to for help with environmental monitoring projects. We can assist in everything from planning and monitoring to systems integration, equipment calibration and even staff training. Our applications engineers assemble, integrate and calibrate all equipment – when you get it, it's ready to use. Our specialists have years of experience developing and deploying remote systems and working with leading suppliers such as YSI, Hach, Thermo Scientific, In-Situ, Solinst, NexSens and many more.

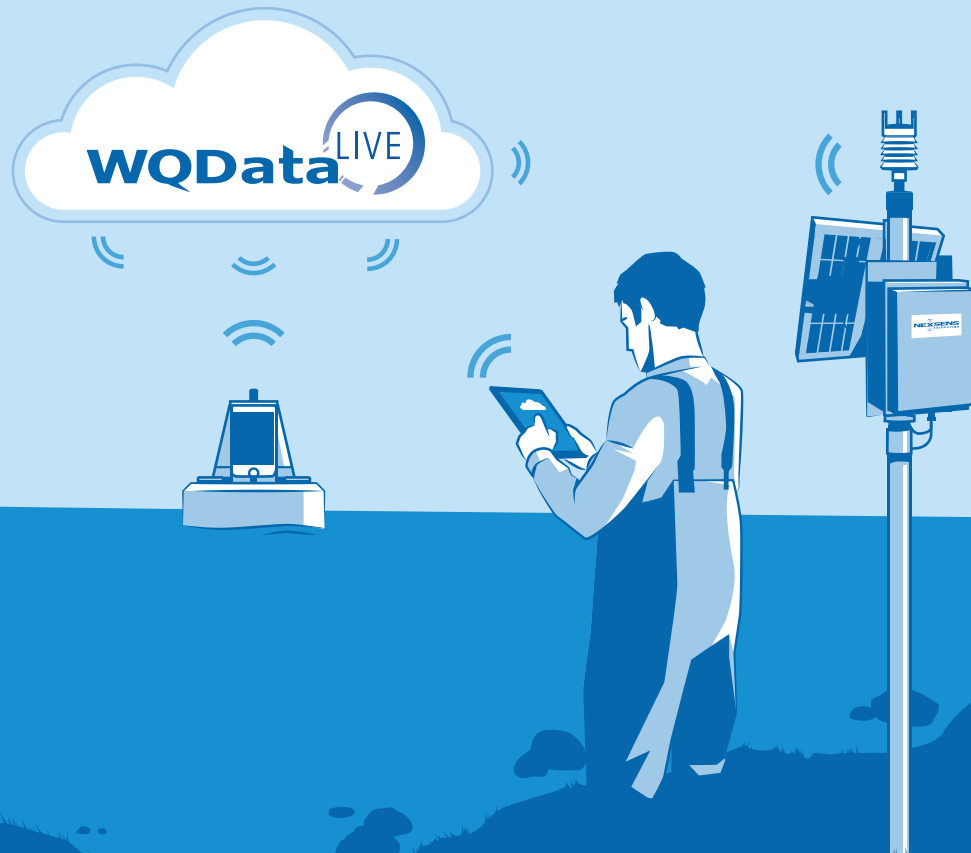
**Fondriest Environmental, Inc.** | tel: 888.426.2151  
2091 Exchange Court | fax: 937.426.1125  
Fairborn, OH 45324 | [customer@fondriest.com](mailto:customer@fondriest.com)

**STAFF**

- Steve Fondriest**, President  
[steve@fondriest.com](mailto:steve@fondriest.com)
- Paul Nieberding**, General Manager  
[paul@fondriest.com](mailto:paul@fondriest.com)
- Daniel Kelly**, Editor  
[daniel@fondriest.com](mailto:daniel@fondriest.com)
- Nate Christopher**, Graphic Designer  
[nate@fondriest.com](mailto:nate@fondriest.com)
- Tyler Fondriest**, Mechanical Engineer  
[tyler@fondriest.com](mailto:tyler@fondriest.com)

Thanks for reading the  
Environmental Monitor

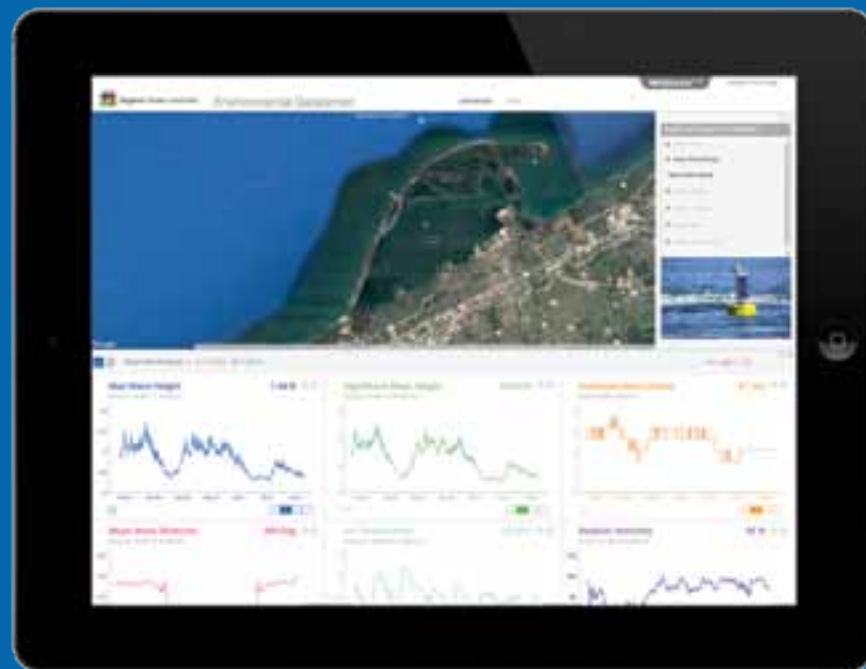
Use discount code  
**EM1610**  
to save on your  
next purchase at  
[fondriest.com](http://fondriest.com)



## Managing environmental project data should be easy.

## Keep it simple with WQData LIVE.

The new Dashboard makes it easier than ever to monitor all project data in one place. Stay connected anytime, anywhere with the cloud-based datacenter.



LEARN MORE AT [WQDATA.LIVE.COM](http://WQDATA.LIVE.COM)

# WEB EXCLUSIVES

Read more @ [fondriest.com/news](http://fondriest.com/news)



### Texas Playa Lakes Help Recharge Ogallala Aquifer

Managing groundwater is important everywhere, but especially so for the state of Texas that sustains periodic droughts. In the state's panhandle, where farmers depend on Ogallala Aquifer recharge to irrigate their crops, it is probably even more so.

Monitoring the aquifer's recharge in this area would be similar in approach to other efforts that study groundwater infiltration if it weren't for all the playa lakes that dot the panhandle. In fact, there are more than 19,000 shallow, ephemeral lakes that dot the Texas High Plains, making the region home to the highest density of playa lakes in North America.

"Playas are real simple, closed hydrological systems. Water flows in after exceptionally heavy rainfall and ponds once the soil moisture deficits are filled. After that, the water either evaporates or infiltrates more deeply into the soil, eventually contributing to groundwater recharge," said Andrew Weinberg, hydrogeologist with the Texas Water Development Board, who has been involved in a study of the lakes since 2011.

### Water Level Sensors Show Promise Of New Haven Rain Gardens

The city of New Haven, Conn. has combined sewer overflows that ferry excess water during storms into nearby waterways. While that is good for flood protection, it creates water pollution issues downstream as runoff from urban areas goes straight into waiting streams.

Like many other cities around the United States, New Haven is trying to tackle that issue to both provide ongoing and reliable protection from floods while also improving the health of waterways downstream. One option is to separate storm drains and sewer systems, which is likely to be quite expensive moving forward. Luckily, investigators at Yale University are showing that rain gardens may be able to provide the same benefits as such a separation while coming in at much lower costs.

Researchers at the university are in the second year of a project that has overseen the installation of around a dozen rain gardens throughout the city. Using V-Notch weirs and water level sensors, investigators are keeping tabs on runoff that comes through the gardens.



### Lake Michigan: Low Bycatch In Lake Whitefish Trawling Study

Commercial fishermen in Wisconsin want to be able to trawl for lake whitefish in Lake Michigan. The approach is easier than using trap nets, which are set for months at a time and have to be cleaned periodically. But doing that would require a rule change, something that can't be accomplished without scientific knowhow showing that the practice wouldn't be harmful to the lake's other species of fish.

An ongoing effort carried out in partnership between the Wisconsin Department of Natural Resources, Wisconsin Sea Grant and commercial fishermen is gathering data to inform a possible change. Results so far are positive as the effort wraps up its second year of trawling and, though a rule change isn't guaranteed, data are helping to underscore that Lake Michigan isn't the lake it used to be.

"The study is limited to areas that were limited to trawling in the past," said Titus Seilheimer, fisheries specialist with the Wisconsin Sea Grant. "... We're looking to see, if that gear was used on Lake Michigan, what would the effects be on other species?"

Photo: (top) Thayne Tuason / CC BY-SA 3.0; (center) Kelsey Semrod / Yale University; (bottom) Titus Seilheimer / Wisconsin Sea Grant

# IN THE NEWS

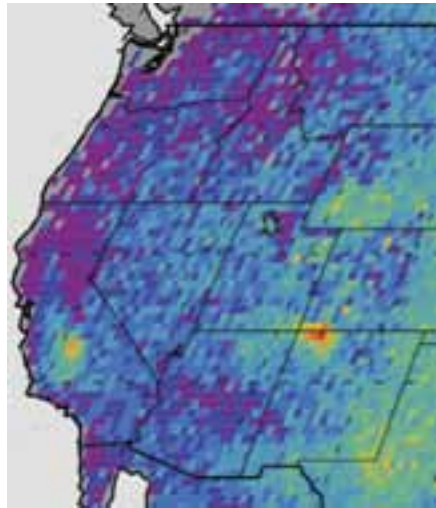


## Air Quality Gains Improving Chesapeake Bay

Chesapeake Bay, the nation's largest estuary, has suffered from excessive nutrient pollution and widespread hypoxic (low-oxygen) conditions for decades. And while best management practices on land and upgrades to wastewater treatment plants have helped to turn the tide against nutrient pollution, scientists at the University of Maryland have found that gains in air quality may also be improving the bay.

Investigators say that it appears that recent water quality improvements in Chesapeake Bay are driven more by air quality regulations than efforts to clean up water. The find comes as a surprise, as the Clean Air Act of 1990 was meant to address human health issues and streams sensitive to acidity.

Specifically, researchers say that reductions in atmospheric nitrogen deposition have been the primary driver of improvements in water quality in the Upper Potomac River Basin, which covers nearly 12,000 square miles in Maryland, Virginia, West Virginia, Pennsylvania and the District of Columbia. These benefits have trickled downstream to the bay.



## Four Corners Methane Hotspot Imaged For First Time

Researchers at NASA and the University of Michigan first identified the Four Corners hotspot of methane in 2014. The area, where Arizona, Colorado, New Mexico and Utah intersect, was found to pump out the largest concentrations of methane in the United States. The discovery led to questions as to why such a hotspot could exist or what was causing it.

In an effort to learn more about the Four Corners region and its relationship with methane levels in the air, a team of scientists from NASA has led a recently completed investigation. They used airborne tools as well as sensors on the ground to dissect methane concentrations in the area.

Two NASA spectrometers mounted on research aircraft were able to identify and measure more than 250 sources of methane in the Four Corners. One of the devices used visible and infrared imaging to observe a spectra of reflected sunlight while the other was geared more toward methane's thermal properties. Researchers managed to image methane at a spatial resolution of 3 square feet.



## Marine Larvae Movements Studied By 'Minion' Robots

Oceanographers know a lot about marine larvae, including where they likely come from. But it's different when describing how the larvae — including those from baby crabs, mussels, clams and fish — got to where they are. There is little understanding of that process.

To help learn more about larval movement, researchers at the University of California, Davis, have come up with larvae robots capable of mimicking natural movement. The hope is that these robots, which resemble in some ways the "minions" from the movie *Despicable Me*, can reveal where marine larvae go. Scientists are also looking to discover what the mechanisms are that allow them to move back and forth.

The robots' bodies are fire extinguisher cylinders painted bright yellow. They have white fan blades at their waists that make them spin as they rise or sink, and a gyro inside estimates vertical speed. On their black tops are satellite communications, antennas, GPS and marine lights. The crafts also hold sensors to gather measurements on temperature, conductivity, depth, light penetration in the water column and speed of movement.

Photo: (left) Public domain; (center) Ohio State University; (right) University of California, Davis



## Historic Floods in Louisiana Break Streamgauge Records

During the recent historic floods in Louisiana, six streamgages operated by the U.S. Geological Survey registered new peak records, according to a statement from the agency. An additional 50 stations were overtopped by the floodwaters.

Thirty of the agency's gages registered over the flood stage for several days, and many were damaged. Some were overcome by flood waters, while others were destroyed by debris carried downstream by the fast-moving deluge.

Graphs of data logged by the streamgages give striking timelines of the flooding. One deployed on the Comite River began to register water level rises on Aug. 11, 2016 and passed its peak record sometime early on Aug. 13. From that point, it stayed above the old record, around 36 feet, until near the end of Aug. 15.

Because of the large-scale, unprecedented floods in Louisiana and the damage they caused, agency crews are out servicing all of the affected gages. Where gages are out, crews are surveying high-water marks and taking indirect measurements to determine streamflow.

Photo: (left) mcandrus / CC BY 2.0; (right) NASA/JPL-Caltech / University of Michigan



## Scientists Document Groundwater and Seawater Mixing on US Coasts

Scientists have long known that groundwater and seawater mix along America's coastlines. But they have also been limited in knowing where or how much of that mixing was happening, except in a few locations.

Thanks to researchers at Ohio State University, in partnership with others at NASA's Jet Propulsion Laboratory, we now have a better idea of what's going on along and underneath the coasts. They have developed a map of underground drainage systems that connect fresh groundwater and seawater, pinpointing areas where a great deal of unseen mixing takes place.

A more technical term for the mixing is "submarine groundwater discharge," and investigators documented it along coastlines using data from a large number of collaborating institutions. The result is an expansive map showing where drinking water, typically groundwater, is vulnerable to saltwater intrusion now and in the future.



## TS210 thermistor string

- Fast response.
- Rugged design.
- Modbus interface.
- Buoy options.

# Morning Fog

The Columbia River is the fourth-largest river in the United States by volume, with a drainage basin roughly as large as France. Beginning in the Rocky Mountains of Canada's British Columbia, the river first flows northwest and then south into the U.S. where it sustains 14 hydroelectric dams and runs through seven states. Not surprisingly, there are numerous U.S. Geological Survey (USGS) stream gages along its shores.

In this shot, a USGS hydrologic technician prepares to service a gage station near Stevenson, Wash. The morning fog rolls in off nearby Mt. Hood National Forest, which sits to the south of the Columbia River Gorge and is home to more than 60 miles of forested mountains, lakes and streams.

This particular stream gage first began collecting data on the Columbia River in October 1973. Since then, it has recorded water levels as low as 71 feet and as high as nearly 80 feet. The painted markings on the gage station that go up to 99 feet serve as a nice reference point. When 80-foot-high waters happen, the gage station still has about 20 feet of working room. But the small island just offshore is likely submerged.

*Photo: Ann McGowan / U.S. Geological Survey*





## Precision Conservation | Bucknell University

For some time, the Chesapeake Bay has been troubled by a dead zone each year, typically coming about in the summer months. This low-oxygen region of the bay makes for poor, if not impossible, living conditions for aquatic life.

A large reason for the dead zone, as in other prominent ones like the annual Gulf of Mexico dead zone, is runoff that gets washed off surrounding farms and transported down tributaries to concentrate in the bay. But concerned environmental groups, like the Chesapeake Bay Conservancy, are aware of the problem and have begun working on some efforts that can help alleviate it.

In one example, officials at the conservancy have recently partnered with experts at Bucknell University to train students there how to use remotely-sensed data within a GIS (geographic information system) to identify important runoff flow paths on farms along Buffalo Creek, a tributary of the Susquehanna River that links to the bay downstream.

The idea was pretty simple: Train the students to use the data and then let them go out and talk to farmers in the region to see which of their ideas might actually work in the real world. From there, the students would put together suggestions on treatments that could reduce runoff and present some of their

thoughts to the farmers. Actually implementing the proposals would be left up to those who owned the land.

The approach is an example of precision conservation, a methodology gaining popularity these days that aims to reduce nutrient pollution by pinpointing the farms with the most runoff and then finding, and addressing, the source on each one.

To do that for the farms that they were looking at, Bucknell students were trained to use the methodology developed by staff at the Chesapeake Conservancy to look for the flow paths of runoff. These are influenced by the combination of elevation and land cover.

"I'm not a hydrologist, but my understanding of it is that mapping the unweighted flow paths gives us a profile of where higher volume runoff is occurring," said Janine Glathar, GIS specialist at Bucknell. "Mapping weighted flow paths adds in information on how land cover types differ in the type of pollutants they introduce into runoff."

For the Mennonite farms along Buffalo Creek, the pollutants were mostly linked with the application of fertilizers used to support growing crops. It was the students' task to figure out where they were coming from and then come up with ideas for treatment.

Photo: Bucknell University



## Stream Sampling | Gustavus Adolphus College

Many college students prefer to relax over their summer breaks, but a few at Gustavus Adolphus College had another goal for their time off. They were looking instead to sample various streams that are part of Minnesota's Seven Mile Creek watershed.

Their efforts completed this summer are just the first steps in a project planned for the next five to 10 years that will explore how water quality can improve when farmers and landowners nearby manage their fields in different ways. In the watershed, as well as many other areas, the hope is that updating management practices can help to make water quality better.

Sampling during this first year can gather useful baseline data to allow for gauging changes to water quality that come. It has involved checking water quality via Secchi disk and gathering discrete samples from the watershed's streams for lab analysis. The student researchers, as well as environmental studies Associate Professor Laura Triplett who led the work, analyzed the samples' sediments and nitrate levels. Additional data on E. coli bacteria concentrations were also gathered.

"We're putting the puzzle together," said Jake Westfield, a junior biology and environmental studies major. "We want to learn as much as we can about this watershed."

Photo: Gustavus Adolphus College

By taking water samples at different times of the day and through changing weather patterns, the researchers are building a database that will help them to analyze how the streams vary based on time of year, precipitation levels and farm management practices in place. The data will also help to inform future agricultural and land management practices to support cleaner rivers in southern Minnesota.

"We catch each other's mistakes and make sure we're always using the correct methodology," said Westfield.

Gathering all the measurements has helped to expose the students to both lab and field science, while also giving them opportunities to interact with groups working to improve conditions in the Minnesota River basin. Some of those include the Minnesota Pollution Control Agency, U.S. Army Corps of Engineers and the University of Minnesota.

"I love the community aspect of science," said Triplett. "People picture scientists sitting alone in a lab, but that's not how environmental studies works. The team dynamic and energy that each student brings is what makes our project click."



PRODUCT  
INNOVATION

# G2-RAIN ALERT SYSTEM

NexSens Technology's affordable, all-in-one solution for remote rain measurements that offers low maintenance and real-time data and alerts through a user-friendly web datacenter.

BY DANIEL KELLY

Rain data are some of the most basic measurements that environmental scientists collect. But ensuring quality data collection can be much less straightforward. This is because most rain alert systems out there simply don't have the durability or features that pros need, despite high price tags.

The NexSens G2-RAIN Alert System stands out as an exception. It is an all-in-one tipping bucket rain gauge and data logger built for easy setup, remote accessibility and simple data management.

Let's start with its construction that provides for easy deployment, but also durability over the long term. At its base, the G2-RAIN is typically attached to an aluminum mounting pole with 2-inch NPT threads. This pole can easily be set in concrete to ensure a sturdy, level support that stands up to whatever storm conditions pass over. The stability eliminates the issue of false rain gauge tips.

"It can be used in flood alert systems, construction site monitoring as well as stormwater applications," said Kevin Stevens, product manager at NexSens Technology. "It's a complete product. Just stick it on a pole and walk away. Flip the switch and let it run."

Much of that flexibility is thanks to the NexSens data logger at the heart of the rain alert system. It's powered from a battery boasting a 4-year life, or an optional solar power pack, and is equipped with a Verizon 3G cellular modem that permits real-time data transmission from anywhere there is cell coverage.

All data are then sent to a secure WQData LIVE web datacenter where project managers can view and share readings instantly. And if there's a need for more monitoring sites, these can be easily added to the datacenter to create a network of rain alert systems.

That continuous connection is one of the things that environmental pros will really appreciate about the G2-RAIN.

"The device is configured from the web. You can reconfigure and change settings right from the web without having to go out to the site," said Stevens. "There's also a quick overview of all your sites and it's easy to see the system status from a quick glance."

The web datacenter service also supports rainfall notifications in real time and can be configured to alert when levels hit a user-defined threshold. All sites and data are viewable through any

internet browser. Measurements can also be viewed on tablets and smartphones through the mobile version of WQData LIVE and can be instantly downloaded or graphed.

That's more than other rain alert systems on the market can boast. Stevens notes the G2-RAIN consistently beats competitors on price, design and usability. And the WQData LIVE web datacenter is far and away the best out there.

"There are very few similar competitors," said Stevens. "The others are loggers that you have to configure yourself and they're more costly to set up and maintain."

NexSens Technology will host and manage each web datacenter for customers. Depending on project needs, portions of the G2-RAIN Alert System, including just its data logger and base, may be purchased separately. And a number of accessories are available to suit most projects. ☒

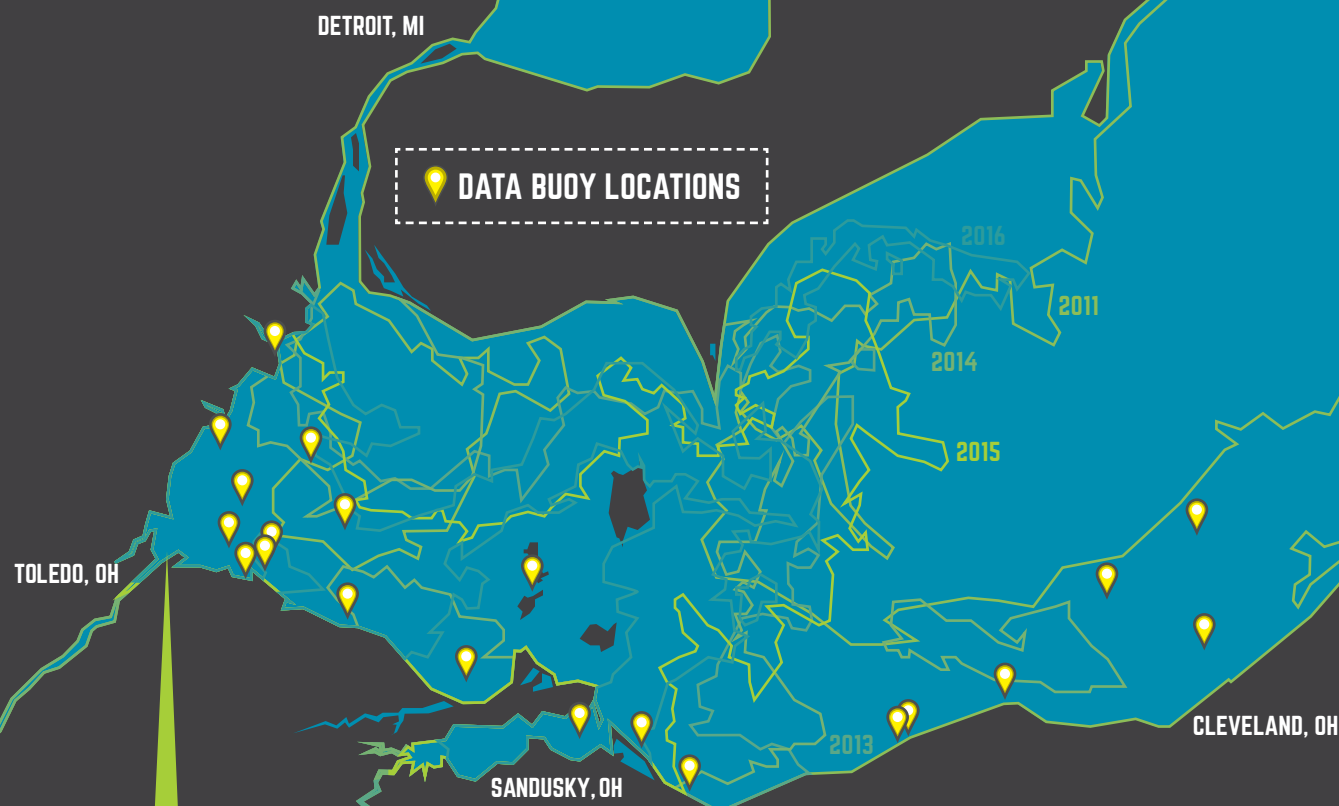
Photos: NexSens Technology



# LAKE ERIE

This isn't the first time that Lake Erie has had algae troubles. Back in the 1960s and '70s, the lake was actually considered "dead" because of increased nutrient loads.

But then, like now, researchers and government agencies came together to tackle the problems and bring it back from the brink. Brush up on some Lake Erie facts with this infographic and then flip ahead to a series of stories that detail present-day efforts to save it.



## TOLEDO WATER CRISIS

On August 2, 2014 residents of Toledo, Ohio were told not to drink or bathe in their tap water because it carried dangerous levels of algal toxins. This left **500,000 PEOPLE** without water for two days.



This extreme situation led to an expanded monitoring network to provide advance warning of changing water conditions.

## NOTABLE ALGAL BLOOMS

**2016** saw a relatively mild summer for harmful algal blooms in Lake Erie, but researchers acknowledge there is still a problem.

**2015** broke the record for the largest HAB in Lake Erie and rated a 10.5 on the severity index based on biomass.

**2014** shut down water supplies for residents in Toledo, Ohio due to the toxicity of the bloom.

**2011** had an immense bloom covering 2,000 square miles of Lake Erie after heavy spring rains and runoff.

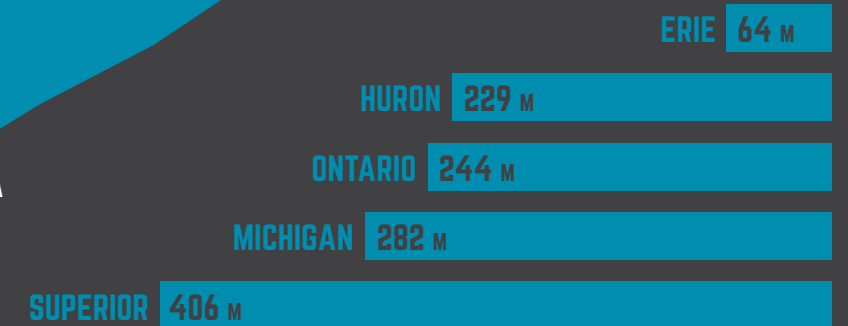
## ERIE POPULATION

**11.6 MILLION** people reside in the Lake Erie watershed, making it the most populated region of the Great Lakes basin.



- U.S. RESIDENTS ( 11 MILLION )
- CANADIAN RESIDENTS ( 1.6 MILLION )

## GREAT LAKES MAX DEPTH



**LAKE ERIE** is the shallowest of the five Great Lakes and is the smallest by volume. The small size makes Erie more affected by changes in temperature and nutrient loads, but also more biologically productive.

Although Lake Erie only holds roughly 2% of the water in the Great Lakes, it contains roughly 50% of the fish. The large number of walleye have made the lake the **WALLEYE CAPITAL OF THE WORLD.**



## ERIE INFLOW



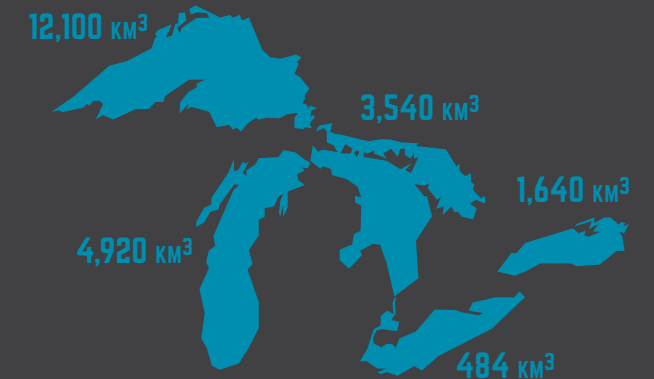
- DETROIT RIVER ( 80% )
- PRECIPITATION ( 11% )
- OTHER TRIBUTARIES ( 9% )

All Graphics: Nate Christopher / Fondriest Environmental

Information from:

Environmental Protection Agency — [epa.gov/greatlakes](http://epa.gov/greatlakes)  
 National Oceanic and Atmospheric Administration — [coastalscience.noaa.gov](http://coastalscience.noaa.gov)  
 Great Lakes Environmental Research Laboratory — [glerl.noaa.gov](http://glerl.noaa.gov)  
 Great Lakes Information Network — [great-lakes.net](http://great-lakes.net)  
 Ohio Sea Grant — [ohioseagrant.osu.edu](http://ohioseagrant.osu.edu)

## GREAT LAKES VOLUME



See more of our infographics at [fondriest.com/news/tag/infographic](http://fondriest.com/news/tag/infographic)



# LAKE ERIE PHOSPHORUS IN SEDIMENTS

An effort led by a consortium of Lake Erie researchers answers long-standing questions to the issue of phosphorus in Lake Erie sediments and its effect on algal blooms.

BY DANIEL KELLY

What happens to algae-feeding phosphorus in Lake Erie that isn't used up by microbes but instead stays in the sediments? Does it have impacts on the algal blooms that hit the lake the following year? These questions have intrigued Great Lakes researchers for some time and have recently been answered thanks to an investigation by a consortium of Lake Erie researchers.

Findings of the work were shared during an Ohio Sea Grant webinar. Numerous updates were given to the media by Lake Erie scientists, covering tributary nutrient monitoring, the Lake Erie algal bloom forecast for 2016 and predicted climate change impacts on the lake's recurring blooms.

Tom Bridgeman, associate professor at U. of Toledo's Lake Erie Center, discussed the study in which he and numerous collaborators dissected the issue of sedimentary phosphorus over a two-year period. A large goal at the outset of the effort was to pinpoint just how much that phosphorus retained by sediments was contributing to blooms in the following year. A high figure would mean management strategies needed an update.

The U.S. and Canada have agreed to reduce the amount of phosphorus going into the lake by 40 percent in a bid to minimize algal blooms and their detrimental effects.

"This leads to some serious questions. One is the question of, 'What about all the phosphorus that's already in Lake Erie?'" said Bridgeman. "We've got all the external loading coming from the Maumee and other tributaries. But what about internal loading, or internal recycling, of phosphorus from the sediments, so all

this phosphorus already in Lake Erie sitting in the sediments? What is that going to do?"

The next question scientists sought to answer from that point was, even if that 40 percent reduction can be achieved, will algal blooms go down as hoped? And, much farther down the road, researchers looked to gauge whether climate change would increase or decrease phosphorus loading.

In 2012, Bridgeman noted, there was a very dry year that resulted in a small algal bloom in Lake Erie. This followed the massive 2011 bloom, helping to inform a guess that the sedimentary contribution to blooms was pretty low. If there had been a lot of carryover, then that 2012 bloom would have been much larger.

"Maybe that small bloom that we got in 2012 was due to a little bit of hangover. Or it was due to waste from the plants or dredging or other things, but that clue shows us how internal cycling of sediments probably is not going to be such a big problem," said Bridgeman. "But we don't know that. That's just kind of looking at that and it's probably what we'd think, but we really need to measure that."

To tackle the issues, he and others involved needed updated sediment data from western Lake Erie because those available at the outset were about 30 years old. Sites throughout the area were sampled to gather sediment cores, including some that were also surveyed with the help of plexiglass bottom chambers. These were placed by scuba divers who dived to them to gather water samples over the course of several days.

One issue that researchers encountered in the effort was the fact that there are many different methods for assessing phosphorus flux from sediments. To get around that, they approached testing it with as many as they could. Scientists used aerobic and anaerobic incubations, phosphorus electrodes and pore water expression, among others.

"We wanted to do it a lot of different ways to see if we could get a consensus of methods, whether they agree ... We tried all of these different methods," said Bridgeman. "The bottom line is that they all agree. Whatever method that we used to measure phosphorus, how phosphorus was coming up off the bottom, pretty much gave us the same answer."

Which was that around 1.4 milligrams of phosphorus per square meter each day comes off the sediments in the western basin. Over the course of a summer, that equals about 3 to 7 percent of the targeted nutrient load coming in from tributaries.

"So really, that's not very much. Under normal conditions when the lake is oxygenated, the sediments are oxygenated, we don't think that there's much phosphorus diffusing up from the bottom," said Bridgeman. "The impact of external phosphorus load reductions will not be substantially delayed by internal recycling. That was our main conclusion there."

As for what may happen in a future of predicted climate change, researchers used Soil and Water Assessment Tool (SWAT) models to forecast impacts. They considered four different scenarios ranging from mild to severe changes.


## “WHAT ABOUT THE PHOSPHORUS THAT'S ALREADY IN LAKE ERIE?”

-Tom Bridgeman  
University of Toledo's Lake Erie Center

Under a mild scenario, researchers modeled that winter loading would go down, while spring loading stayed fairly typical and summer and fall loadings went down. In all scenarios, loads for summer and fall dropped.

"But if we get the most severe climate change scenario, we're going to get a lot more winter loading and more spring loading," said Bridgeman. "So the effect of climate change is going to depend on how severe it is. If we get moderate warming, it could actually be good for us. It could decrease Maumee River loads. But if we get extreme warming scenarios, then it's going to increase Maumee phosphorus loads."

Western basin loading simulations also proved that the 40-percent reduction target was a good one. These showed that reducing loads from its tributaries would decrease algal bloom biomass considerably from a baseline representing the 2014 bloom.

Additional contributors to the work included Case Western Reserve University, LimnoTech, the National Center for Water Quality Research, Ohio Lake Erie Commission and Ohio Sea Grant. Funding was provided by the U.S. Environmental Protection Agency's Great Lakes Restoration Initiative. 

A rosette of niskin bottles and other scientific instruments to sample Lake Erie's water in a profile.

Photo: NASA Earth Observatory

Photo: University of Toledo

# LAKE ERIE A 40 PERCENT REDUCTION

A modeling effort led partly by The Nature Conservancy assesses what needs to be done to achieve a 40 percent reduction in Lake Erie phosphorus.

BY DANIEL KELLY

Results of new modeling research led in part by The Nature Conservancy and Ohio Sea Grant outline some of the steps that will be needed to reduce phosphorus entering Lake Erie by 40 percent. The findings underscore some difficulties, as well as positive effects that could be achieved for fish in streams flowing into the lake's western basin.

The Western Lake Erie Basin Conservation Effects Assessment Project (CEAP) was in the making for around three to five years, says Amy Brennan, Lake Erie conservation director with the Conservancy.

The CEAP sought to answer a few questions. One, what is it going to cost to reach the reduction goal? Also, how are streams in the region going to improve as work is done? And where does work need to be undertaken to both help fish and wildlife in streams while at the same time benefiting Lake Erie downstream?

Thanks to the folks at Heidelberg University's National Center for Water Quality Research, Brennan says that the effort had plenty of stream nutrient data to begin.

"First we had to look at where all those nutrients are coming from," said Brennan. We used the data and extrapolated based on soil type and based on watershed characteristics. We were able to extrapolate some of that into areas where we didn't have detailed monitoring to know exactly what was going on."

The team looked at things like total nitrogen, total phosphorus and suspended sediment concentrations. Another important consideration, which hadn't always been looked at in the past, included what was coming out of tile drains.

"Because 10 years ago, 15 years ago, we thought it was all just what was flowing off the top of the land, that the soil filtered all that through and that we weren't having any of these nutrients coming out of the tile," said Brennan. "Well now we know we're getting about half the phosphorus coming out of that tile. So that was something that we had to do a lot of calibrations throughout the modeling activity to make sure that was getting accurately reflected."

She and others then simulated the impacts of different erosion treatment options, like filter strips, cover crops or buffers to see how they'd affect the model. Nutrient management practices like fertilizer type or application rates were also considered. The group assessed how the practices would impact streams of most concern to those that were relatively in better shape.

Brennan called the worst of these "hotspots" and the next worst the "lukewarm" areas. Investigators considered the effects of treating just the hotspots; treating both hotspots and lukewarm regions; and lastly treating the whole Western Lake Erie Basin, which is a vast 5.2 million acres in size.



**“ THEY DON'T WANT TO FERTILIZE LAKE ERIE, NEITHER DO WE.”**  
-Amy Brennan  
The Nature Conservancy

"We get a lot of improvement when we start doing nutrient management," said Brennan. "And I had a farmer on Monday tell me, 'I want my phosphorus in my field. I don't want it in Lake Erie.' So it's nice because the nutrient management meets the farmer's goals as well."

When it comes to total phosphorus, even if treatment is only done on the smallest number of acres, the hotspots, scientists found that we're getting nowhere close to a 40 percent reduction. By ramping that up to include lukewarm areas, the target still gets missed. But if the entire basin gets addressed, the most unlikely scenario, the target can be reached.

The picture with dissolved reactive phosphorus is a bit different.

"We're looking at so much dissolved reactive phosphorus that we're not sure we can get there just by doing these practices, period. Whether — again, we're seeing that big difference especially with dissolved reactive phosphorus," said Brennan. "If we're putting that fertilizer down the way it should go down, we're putting the right amount, we can make an impact. But we may still not hit that 40 percent."

Further complicating things is the hefty price tag that it would take to cover all of the treatments needed. Brennan says that \$260 million every year would be required to pay for farm bill programs, contributions from farmers, staff time, etc., to get it done. The number is simply too high. And if focus were to go on just the hotspots, that would still require around \$8 million.

"What we got from this analysis is that nutrient management is critically important," said Brennan, segueing into an update on The Nature Conservancy's 4R Nutrient Stewardship Certification Program that aims to encourage agricultural retailers and service providers to adopt best practices to improve long-term water quality of Lake Erie. The four Rs are: Right Source of Nutrients at the Right Rate and Right Time in the Right Place.

The program is just three years old, but has seen a great deal of success. At this point, Brennan says the Conservancy only expected around 20 percent of farmers in the Western Lake Erie Basin to be working with certified retailers. The number, instead, is around 40 percent. Its goal is 80 percent participation.

It has been so successful that folks in other states are taking a look at implementing it. These include Illinois, Indiana, Iowa, Kentucky and Michigan. Some are also looking at using it in southern Ohio, whose runoff has implications for the Ohio River, Mississippi River and ultimately the Gulf of Mexico dead zone.

"This program has taken off because, again, I think it makes sense for the farmers' bottom line," said Brennan. "They don't want to fertilize Lake Erie. Neither do we."

But what about the fish? Brennan says that management strategies meant to help Lake Erie can also result in better stream quality for fish.

"I think it was a little bit surprising to us that the Sandusky (River) really jumped out at us as some place that if you can be able to reduce the nutrient loading by 20 to 30 percent, maybe not even getting all the way to hitting that 40 percent, you're going to see a big change in those streams getting higher quality," said Brennan, noting much of the data for that portion of the work came from the Ohio Environmental Protection Agency and the Michigan Department of Environmental Quality. "Same thing in the St. Marys ... and up in the River Raisin."

A full report on the Western Lake Erie Basin Conservation Effects Assessment Project is still being compiled. Partners in the work include the U.S. Department of Agriculture, Natural Resources Conservation Service, Agricultural Research Service, Ohio Sea Grant, Ohio State University and Texas A&M University.

Photos: Jeff Reutter / Ohio Sea Grant

# LAKE ERIE NUTRIENT LOAD TARGET

Ohio State University scientists help to lead a modeling study finding that the western Lake Erie phosphorus reduction target can be met with more farmers onboard.

BY DANIEL KELLY

Though achieving the 40 percent reduction target for phosphorus going into western Lake Erie is a daunting task, the results of new modeling research has found that getting there is possible. But it's not going to be easy.

The modeling work, led in part by scientists at Ohio State University, dissected different treatment options for the Western Lake Erie Watershed. Its findings help to show the reduction target can be achieved without drastically altering the region's farmland.

Noel Aloysius, a postdoctoral research scientist in the Department of Food, Agricultural and Biological Engineering at Ohio State, recently discussed the project during a meeting of Great Lakes reporters hosted by Ohio State University's Stone Laboratory on Lake Erie's Gibraltar Island. In addition to those from Ohio State, the modeling project involved researchers from Heidelberg University, LimnoTech, University of Michigan, University of Toledo, the U.S. Department of Agriculture and the U.S. Geological Survey.

He presented some encouraging news for tackling the target, which is aimed to be reached by 2025.

"What we did was bring together all these groups with the specific goal of finding different ways to achieve this goal of reducing the load by 40 percent," said Aloysius. "How can we achieve this?"

To begin, the modeling groups decided to focus on a period between 2005 and 2014. Using a common historical period helped them to validate their models, and the period was also ideal because it included a good mix of watershed changes such as drought years and the rainy season in 2011 that spurred a record bloom.

They considered the sources for nutrients, like septic systems, wastewater treatment plants and runoff as well as how fertilizers are applied. The group found that around 85 percent of the nutrients that make it into western Lake Erie from the Maumee River basin come from fertilizers, regardless if they're organic or of chemical origin.

Their efforts showed that removing all the point sources of pollution from the watershed, those from treatment plants for example, would only temper the nutrients going in by about 5 percent.

"If you remove all the point-source discharges, how much reduction? And then we started looking at the extreme cases," said Aloysius. "For example, if we ... reduce or convert agricultural land by 10 percent, 25 percent, 50 percent to grassland — what will happen?"

Aloysius says some of those are extreme scenarios because they're highly unlikely to happen. But modeling them is valuable considering the mix of treatment schemes possible. The

**“FOR EXAMPLE, IF WE ... REDUCE OR CONVERT AGRICULTURAL LAND BY 10 PERCENT, 25 PERCENT, 50 PERCENT TO GRASSLAND - WHAT WILL HAPPEN?”**

**-Noel Aloysius**  
Ohio State University

50 percent grassland scenario would achieve the reduction, researchers found.

Modelers considered how installing cover crops and filter strips would help. Or targeting the application of fertilizers as well as converting large areas to grassland. In all, there were around 15 different methods or treatments considered.

They then sought to learn whether a random or targeted scheme of treatments would have better results. Being more selective won out.

"What we see is, out of these scenarios we looked at, the targeted, across the 50 percent of the land, results as the most plausible scenario," said Aloysius. "... How are we going to target it, who is going to pay for it? Those kinds of things we have not looked at."

So what needs to happen to reach the target? Aloysius says that it will take a lot of farmers stepping up to apply treatments on their lands.

"In the Maumee watershed, we want to have at least 78 percent of the farmers adopt buffer strips and nearly 50 percent of the farmers include placement of fertilizer application (in their planting methods)," said Aloysius. "And nearly 60 percent of the farmers, we want them to have a cover crop."

Many farmers are already doing those things, he says, and trends year over year have shown that more are adopting better practices. We just need to get the pace of their adoption to increase.

Programs like The Nature Conservancy's 4R Nutrient Stewardship Program have helped. Another, the Tri-State Western Lake Erie Basin Phosphorus Reduction Initiative, has too.

"We see things happening, but what we suggest is that we need to accelerate the adoption of these practices in order to achieve the target by 2025," said Aloysius. "What I want to emphasize is that there are multiple pathways. There are extreme cases, like we convert half the land to grassland ... but there are alternate pathways to get there. ... It is possible without compromising the farm productivity. We can achieve this target."

Funding for the work was provided in part by the National Science Foundation. 

Photo: Nate Christopher / Fondriest Environmental

Photo: Lisa Rice / Ohio Sea Grant



# LAKE ERIE PORT OF TOLEDO SEDIMENTS

A riverside project holds promise for reducing sediment in the Port of Toledo, but that is just one area of focus for officials working to better Lake Erie.

BY DANIEL KELLY

The Port of Toledo, Ohio, receives more sediment each year than any other harbor in the Great Lakes. That number is somewhere around 800,000 cubic yards of sediment in the most recent year, say officials with the Ohio Department of Natural Resources (DNR) who are working to find new ways to use the loads to benefit the people living nearby as well as Lake Erie overall.

Scudder Mackey, chief of the agency's Office of Coastal Management, discussed some of the initiatives underway to reduce sediments in the port while also helping farmers seeking healthy crop yields. Mackey also shared some other projects that are on the agency's docket in the years ahead.

Mackey says that the State of Ohio has done a lot to address nutrient and sediment loading in Lake Erie through the Healthy Lake Erie fund. The fund is run through the Ohio DNR but managed jointly with the Ohio Environmental Protection Agency.

He points to the Riverside Park project, for which \$7.3 million was awarded to the Port of Toledo in 2014. Another \$2.6 million went to the Port of Cleveland.

Much of the monies went to Toledo due to its heavy sediment loads, and Mackey discussed some of the ways that the funding is being used.

"What are we doing to address some of the issues we have? Specifically nutrient and sediment loading," said Mackey. "To address several issues, the HABs (harmful algal blooms) issue. And secondly, can we deal with the dredging issue along the coast of Ohio?"

By July 1, 2020, there will be no more open-lake sediment dumping, he says, per an Ohio law change. And so projects underway currently are helping to get things ready for managing where sediments can go in the future.

One is at Toledo's Riverside Park, where Mackey and others have built a series of cells that are designed to mimic an agricultural field.

"Because one of the things we're thinking. If you can pump this material back onto agricultural fields, the material that's dredged out — you should understand that the material in Toledo is pretty much contaminant-free, it's very clean sediment," said Mackey. "You pump this back onto agricultural fields, you can probably grow crops on it and get better yields but we need to demonstrate that. That's what this site is all about."

The four cells sit on a site very near to an area set up to recycle Toledo's yard waste, so there is a possible partnership there for developing soils. Four cells have been constructed, and were loaded with dredged sediment in early August.

**"YOU PUMP THIS BACK ONTO AGRICULTURAL FIELDS, YOU CAN PROBABLY GROW CROPS ON IT, AND GET BETTER YIELDS BUT WE NEED TO DEMONSTRATE THAT. THAT'S WHAT THIS SITE IS ALL ABOUT."**

**-Scudder Mackey**  
Ohio DNR Office of Coastal Management



"This is not a small area. The site is designed to receive, at least initially, 40,000 cubic yards of dredged material," said Mackey. "We are, I think as of Tuesday (Aug. 16), we had 18,700 cubic yards pumped into cell 2 and they were just starting to pump into cell 4."

After the dredged slurry material goes in, it essentially sits there while the water is filtered out through underdrains, weirs and a fine mesh. The sediment remains.

In their states currently, sediments in the cells are still firming up, so there's not much use for the final product yet. But give it some time, Mackey says, and the results could be quite positive.

"Next spring, we will do some tests and will look at compaction and geotechnical properties. But then we're also going to go ahead and we're actually going to do plantings in these cells for various types of crops and then we'll see how they actually grow," said Mackey. "And we'll have a control area as well and over time what we want to do is to evaluate: Can we grow crops here? What are the yields that come off this? And how does that compare to the native soils that we have? And see if this is indeed as good or better (than typical agricultural land)."

The cells can capture quite a bit of the sediments from the Port of Toledo, perhaps around 10 percent, but Mackey cautions they will come nowhere close to capturing it all. Still, the demonstration project is a positive indicator of things that could come.

"It's amazing," said Mackey. "We actually have clear water coming out of these underdrains, and then it drains into this area that will collect the water and then we'll do edge-of-field treatment before it goes back into (the lake)."


Mackey discussed other projects around the lake, including a bed load interceptor in the Cuyahoga River that is used to

collect sand that comes off the river. It can remove up to 40,000 cubic yards of sand per year, he says, that then don't need to be dredged out of the river. A confined disposal facility in Cleveland is doing something similar.

Mackey's office also has some projects going on near Sandusky Bay, a highly turbid bay that sees high wave activity. What's more, the bay is separated by bridges and other structures that can cause different conditions depending on which side of the structures you're on. And so his team is looking at constructed wetlands that could trap sediments, including nitrogen and phosphorus.

"We're talking about maybe some construction of islands out in the inner Sandusky Bay, because it's only 5 to 8 feet deep. And you reduce wave energy, you break up the waves," said Mackey. "Because the reason that Sandusky Bay is a really dark brown, other than the material coming out of the Sandusky River, is because these waves continually re-suspend sediment. So we'd be creating habitat there, but we'd also be breaking up the wave energy a bit."

Doing that could also trap more sediment in the inner bay, which would significantly reduce the amount that has to be dredged in the turning basin. Long-term dredging costs could go down as well, he says, noting that as one of his office's goals for 2025. There might also be some public-private partnerships come to bear for wetland creation near Sandusky Bay.

"The idea is to look at this and design a series of projects where the benefits from one feed into the next and into the next," said Mackey. "It's sort of like a giant stormwater treatment train but at the scale of Sandusky Bay. It just makes sense to try something like this." 

Photos: Scudder Mackey / Ohio DNR Office of Coastal Management



# LAKE ERIE EYES ON STREAMS

Photo: Daniel Kelly / Fondriest Environmental

We had the chance to visit the National Center for Water Quality Research at Heidelberg University, home to long-term stream data used by Lake Erie modelers near and far.

BY DANIEL KELLY

What started as a simple biology project for a class at Heidelberg University is today the National Center for Water Quality Research (NCWQR). It's a beautiful example of how far small actions of the past can ripple into the future.

"It was actually an outgrowth of an educational drive," said Ellen Ewing, laboratory manager at the NCWQR who was working at the Center at its beginning. "Dave Baker, who is our director emeritus, was a professor here at Heidelberg and he wanted to introduce some new concepts to the introductory biology classes. And so he put together a program for a National Science Foundation grant and started with some sample collection on the Sandusky River."

We caught up with Ewing and Jake Boehler, a research assistant at the Center, on a recent visit to Heidelberg University in Tiffin, Ohio. The two are part of the team that goes out every week throughout the year to gather water samples collected by automated monitoring stations on many of Ohio's waterways, helping to assess their nutrient loads, which affect water quality downstream and, for one of the stations, forms the basis of Lake Erie algal bloom forecasting.

The purpose of the biology project that started it all, Ewing says, was to introduce inexperienced biology students to the processes of sampling. It focused on the Sandusky River and incorporated taking water samples from the river and then analyzing them in a series of lab experiments focused on bacteria, phosphorus and nitrogen loads.

That first project generated a lot of interest into the issue of tributary nutrient loads, Ewing says. And from there, more advanced summer research projects, driven by undergraduate students, would follow. Slowly but surely, the projects began to yield interesting and useful data that would become the foundation of important discoveries, including one on the influences that different flow regimes have on the movement of nutrients to Lake Erie.

"In 1969, this area sustained a 100-year flood and the student project that was written up was to study the Sandusky (River) during low flow. Well, in a 100-year flood, you kind of don't have low flow. So, like all good researchers, they persevered and started to generate some interesting numbers," said Ewing. "About that time, the federal agencies were getting involved. Lake Erie was dead, all those kinds of scenarios — the Cuyahoga River caught on fire. And so what Dr. Baker discovered — and his actual PhD background was in transport systems in plants and he sort of transplanted that to transport systems in rivers — and realized that about 90 percent of what's delivered down our rivers happens during about 10 percent of the year, on average, during high flow."

From there, the NCWQR and its staff would begin to specialize in monitoring the transport of nutrients through streams. And a rich history would start to take shape, one resulting in what researchers all around the Great Lakes know and value as the Heidelberg Tributary Loading Program, an incredibly useful tool in the fight to fix the current Lake Erie algal bloom problem.

But that is not all that the Center's staff work toward. There are many other initiatives they support, including the Cooperative Private Well Testing Program that provides low-cost water quality tests for anyone in the United States with a well. The Center also runs a website, lakeeriealgae.com, to educate people about the issues faced there and what's being done. Other works include studies looking at the health of macroinvertebrate communities in Ohio streams and Lake Erie, as well as large efforts to model watersheds throughout the state to determine different methods that farmers can take to clean up runoff flowing off their lands.

### STREAM MONITORING

During our visit to the NCWQR, we had a chance to tour a sampling station located on Rock Creek, which flows right by the university. From there, we got a behind-the-scenes look into how all the samples moving through the Center get analyzed.

The Rock Creek station is much like the many other stations that the Center helps to manage throughout the state of Ohio. According to the most recent total, there were 18 stations in all, with one located in Michigan.

And not all are created equal: Some are bigger or smaller than others, including the tiniest site, which sits on an unnamed tributary of Lost Creek near Farmer, Ohio.



Jake Boehler services an automated sampler.

## “BACK IN THE DAY, STUDENTS COLLECTED SAMPLES WITH A BUCKET AND A BOTTLE AND WE LOWERED IT DOWN FROM A BRIDGE.”

-Ellen Ewing  
Laboratory manager at NCWQR

“Just a little, tiny creek they put a little weir in to be able to get flow measurements that we need to go with the concentrations that we get,” said Boehler. “And this one is slightly special in that we have two samplers set up in here so that the data logger, when the stage gets above 1.75 (feet), it trips this sampler to kick on and it takes samples every two hours. So when it's really raining, we get more samples.”

As Boehler describes the setup at the Rock Creek station, he notes that many of the others in the network are set up the same way, with ISCO automatic samplers at their core. Within each, there are plates to hold plastic sampling bottles. As a water tube spins around, bottles get filled up one by one.

“So that's where we are now. Back in the day, students collected samples with a bucket and a bottle and we lowered it down from a bridge,” said Ewing. “(They) brought it back to the lab, we did manual chemistries where everything was colorimetrically analyzed but it was all done by hand.” That type of processing began to change in 1974, she says, when work in the lab began to be automated with the help of machines like colorimetric analyzers and ion chromatographs.

Of course, before the samples can be analyzed, they have to be collected. That's where Boehler and Ewing, who makes sampling runs with Research Assistant Barbara Merryfield, focus a lot of their efforts. And there isn't a break — they are out collecting samples no matter the season or the weather.

Boehler's route, like the other, is every Monday. Gathering samples essentially involves driving to a station and swapping a new, empty base of bottles into a sampler and retrieving the base containing the previous week's samples. The two routes cover the stations within reach, but there are two sites that rely on the help of volunteers who gather samples every day and send them in. Unlike the automated collection at most sites, the work in these streams is done using old-fashioned buckets lowered off of bridges.

“The Cuyahoga, Muskingum, Scioto and Great Miami (Rivers) are all that same way where someone actually goes to our site, whether it be grabbing a sample with a bucket or automatically like one of our stations and they just ship them to us then in coolers,” said Boehler.

The volunteer who helps out on the Muskingum River has been doing it since the 1990s and takes the duties seriously. He has gotten into his eighties, but sends in samples reliably for the Center.

“He was very apologetic because he had to miss a little bit because he had a knee replacement,” said Ewing. “And even then he had his wife go out and do it for him.”

But similar care goes into processing all the samples, as well as keeping stringent quality control checks to ensure that the data produced are accurate and useful.

“If you read any protocol for doing dissolved reactive phosphorus, you're supposed to analyze it within 48 hours. That's impossible to do and do the type of intensive sampling that we do,” said Ewing. “So within the base, there's this special bottle (that we leave). And so bottle No. 24 and bottle 'SX10' are going to be filled at the same time on Monday. Bottle No. 24 is going to come back here and be analyzed immediately or within 48 hours. That SX(10) bottle in the middle is going to stay out there for a week. And we will then compare the values we got for the fresh sample versus the values that we got for the stored sample so that we can then back up the quality control on our data and try to assuage some of those people who tell us that we can't do this because we're beating, or exceeding, holding time.”

### DATA ANALYSIS

Back in the lab, analyzing samples is such a big job requiring so many machines that viewing the processes to someone unfamiliar (certainly us that day) is like taking a tour of a fast-moving industrial factory. But instead of the crew you'd expect, all the workers are well-trained scientists and produce data instead of goods.

Walking through the third-floor lab housed in Gillmor Science Hall on Heidelberg's campus, there are big machines and small machines. Contraptions on long tables feature circulating glass tubes, filled with liquids colored blue (for total phosphorus) and orange (for total Kjeldahl nitrogen). Some rooms are filled with sampling bottles, while others hold more machines. These are used for the tributary monitoring program while others support the well testing program.

Common equipment includes colorimetric analyzers, ion chromatographs, filters and balances for weighing, which we're told was one of the first things to get automated in the lab.

“We literally send the weight into a program that takes care of keeping track of all of that information in addition to sample location, sample bottle, volume filtered and all of the assorted pieces of information that we need for this,” says Ewing. Thousands of weighings are done each year, she says, given the magnitude of the sampling operation.

One of the machines used is a Seal AA3 analysis system. It evaluates ammonia, dissolved reactive phosphorus and silica. From there, we moved on to a large area dominated by ion chromatographs where Merryfield demonstrated a typical sample run.

“The idea behind this is we have our sample. It's been prepared in whatever fashion it needs to be prepared, and we then add sample and reagent,” said Ewing, pointing out the spinning glass coils pushing through colorful blue and orange. “Wherever there's a fitting, there's either a reagent or sample that comes into the system. The glass coils, you can see them still tumbling, because this was actually finishing running. That's acting as a mixing chamber and so the idea here is that we have the two meet, mix, may heat it may not, depending on the chemistry.”

From that point, scientists take a look at the color that is produced. The darker the color, or the more intense that a color



Sampling bottles from a stream monitoring site.

is, the higher the concentration. Merryfield shows us on a computer screen how one of the peaks in a line graph is edging upward. The peak moves higher, indicating the strength of the concentration. This process is repeated for hundreds of samples, Ewing says.

“The idea behind these chemistries is steady state. So we add reagent and mix until we get no further color production,” said Ewing. “So this is a very classic peak. You want to see that peak flatten off and maintain.”

We venture down the hall to a solutions prep room and from there to a trace metals room containing a big, boxy machine called an Inductively Coupled Plasma Mass Spectrometer. It is an important piece of equipment for the well testing program, which has processed more than 90,000 samples for private well owners around the United States over the years.

“In the late '80s, we started a well-testing program through funding with the (Ohio) Farm Bureau where they actually would, basically, pay most of the cost for people around the area and turned it into the whole statewide program,” said Boehler. “And now I think we've done 37 or more states, well samples from different states where they send us a sample and we process them for metals and these are things like arsenic, calcium, magnesium, things you can use to figure out your water hardness.” The total number of metals they screen for is about 20.

The program has yielded some useful information for well owners. Roughly 10 percent of the wells that come through the program have been found to have some sort of structural deficit. What that means, typically, is that problems people find with their wells, and water, are due to poor construction or the integrity of the well's structure. Examples of this include ruptured casing

Photos: Laura Johnson / National Center for Water Quality Research

from a lightning strike, or fractured bedrock nearby that lets surface water penetrate.

In addition to the regular chemistries on the well water, the Heidelberg crew also does a couple pesticide screens. These cover the water-soluble forms that are most commonly used today, like atrazine and alachlor.

#### HOW DATA ARE USED

Data from the Heidelberg tributary monitoring network are used in a lot of ways. They have been a primary source of conclusions drawn by researchers studying Lake Erie's western basin and its algal blooms for some time, but that is not the only purpose they serve.

For insight into some of the ways that all the findings get used, we talked with Ken Krieger and Laura Johnson. Krieger has recently retired as the Center's director and Johnson has assumed the role beginning in 2016.

Our conversation was wide-ranging and we learned about prominent trends reflected in datasets collected by the Center over the course of the previous year. We dug into some of the implications the numbers have for the years ahead as well as continued monitoring in the Great Lakes region.

"We've found lots of things in our long-term dataset. The biggest finding has been that dissolved phosphorus, dissolved reactive phosphorus, has been increasing pretty drastically since the mid '90s. It's increased and then it's sort of leveled off," said Johnson. "And because we see them in the Maumee River, which is one of the main inputs into Lake Erie, we're attributing that increase to the recurrence of algal blooms that we've been seeing since about 2003."



Rock Creek stream monitoring station.

## “THE BIGGEST FINDING HAS BEEN THAT DISSOLVED PHOSPHORUS... HAS BEEN INCREASING PRETTY DRASTICALLY SINCE THE MID '90S.”

-Laura Johnson  
NCWQR Director

There are nuances there, Johnson says, and notes that most of the metrics that they show are reported on an annual basis, including yearly loads and concentrations. But when trying to relate the size of the blooms that are seen in Lake Erie to what's coming out of the Maumee River, the most important time of year to focus on is the spring.

More specifically, nutrients that make it into the lake from the beginning of March through the end of July seem to have the most impact on the size of the algal blooms. This knowledge has helped scientists at the Center to contribute to a forecasting system, which was created by the National Oceanic and Atmospheric Administration, for the size of the bloom each summer.

Timing is important for that, but so are the nutrient loads. And when it comes to dissecting those, you can parse them out in different ways. Those from point sources have not gone up to coincide with the recent return of algal blooms from the mid-1990s, while non-point sources seem high depending on the year that you look at.

"Sometimes they're more equivalent, but what you're really missing when we look at total phosphorus is we don't have a good explanation for why algal blooms have returned," said Johnson. "And so it's not until you actually look at the dissolved phosphorus component."

There is a downward trend in particulate phosphorus, Johnson says, while there is an increasing one for dissolved phosphorus and that makes total phosphorus appear to have little change. Still, only a little more than 20 percent of total phosphorus is dissolved, while the rest is mostly particulates that algae can't use. Much of that settles out before it can make it to Lake Erie anyway, so the details of all the figures are important in knowing what factors are at play in algal blooms.

"Our founders decided to measure dissolved phosphorus even though the water quality measure for phosphorus is usually total phosphorus," said Johnson. "They added that in since the very beginning. It's always been there."

But what about nitrates? That's been monitored by scientists at the NCWQR from its beginning too. Krieger tells us that nitrates coming from the watersheds they monitor in, particularly agricultural ones, are down from what they were in the early 2000s.

"There was a general increase until about 2000, 2002, and since then, there's been a general decline," said Johnson. The average for the Maumee River has gone from 7 milligrams per liter in 2001 down to 4.5 milligrams per liter in 2014. And that's not huge, but it is substantial. "They're (farmers) getting higher yields because of new varieties of corn and, which is what they needed nitrogen for, and they're more efficiently using nitrogen. So they're not applying that much more but they're getting a



A staff gauge tracks Rock Creek's water levels in Tiffin, Ohio.

lot more yield, and so it seems like there's a possibility we're seeing this response in terms of nitrogen just in advances in crop technology."

For all rivers across the state with agricultural land use, there is a reliable period on which to bet that a nitrate surge will appear in the data and that is right around the planting season's first big rain event. In that way, nitrate spikes can almost be used as a tracer for agricultural activity.

Other researchers are studying nitrogen's role in the toxicity of algal blooms. The decreasing trends that the Center's data show may very well support the idea that there's more to it than just nitrogen. It's well established that phosphorus drives the size of the blooms, Johnson says. And so toxicity isn't something that could solely be associated with nitrogen loads, but the levels are high enough that they could influence toxicity. The concentrations could also have effects on the future composition of algal species in Lake Erie.

"If nitrate keeps going down and phosphorus keeps staying up, that might have a big effect on what we see in the future," said Johnson.

Beyond nitrogen and phosphorus, a lot of work is done to monitor suspended sediments in tributaries. These efforts date back to a time prior to the second phase of the Great Lakes Water Quality Agreement wherein farmers and land managers were trying to turn soil over less often, put in buffer strips and promote conservation tillage as ways to reduce the sediments that made it into Lake Erie.

The idea for those actions was also benefited by the fact that they would probably help to reduce the loss of particulate

phosphorus, which they did. Seeing the patterns is a little more difficult, Krieger says. But he notes that the quantity of water that's flowing through rivers like the Maumee and the Sandusky has increased quite a bit since the 2000s and there are much higher average flows than there were back in the 1980s.

So if you're considering something like suspended sediments or particulate phosphorus, the erosive capacity of rain events can push those higher. But add in the effects of good management practices, and something else comes to light: There can still be high flows that push sediment concentrations higher, but those concentrations are still lower than they were for a similar flow event back in the 1980s.

"But then we see something else in terms of dissolved phosphorus. Everywhere we look (in agricultural watersheds), the dissolved phosphorus has gone up," said Krieger. "The proportion of dissolved phosphorus to all the phosphorus, what we call total phosphorus, has increased." These changes have come about since 1995, and they're owed to changes in the sizes of farms, how fertilizer gets applied and increases to the intensity of precipitation in the area.

And there are still other things that the Center's staff have tracked over the decades. One you might not expect is silica, something that we confused with sand.

"Silica is a component of sand, at least the type of sand in non-volcanic regions," said Krieger. "And so it's a component of glass and diatoms basically have glass shells, which is what makes them heavy and they tend to sink."

But why would you want to monitor something like that? Well, think back to the decision to track dissolved reactive phosphorus

Photos: Daniel Kelly / Fondriest Environmental

even though it wasn't a typical thing to track. There is always a good reason for collecting data, or at least a good scientist can give you one.

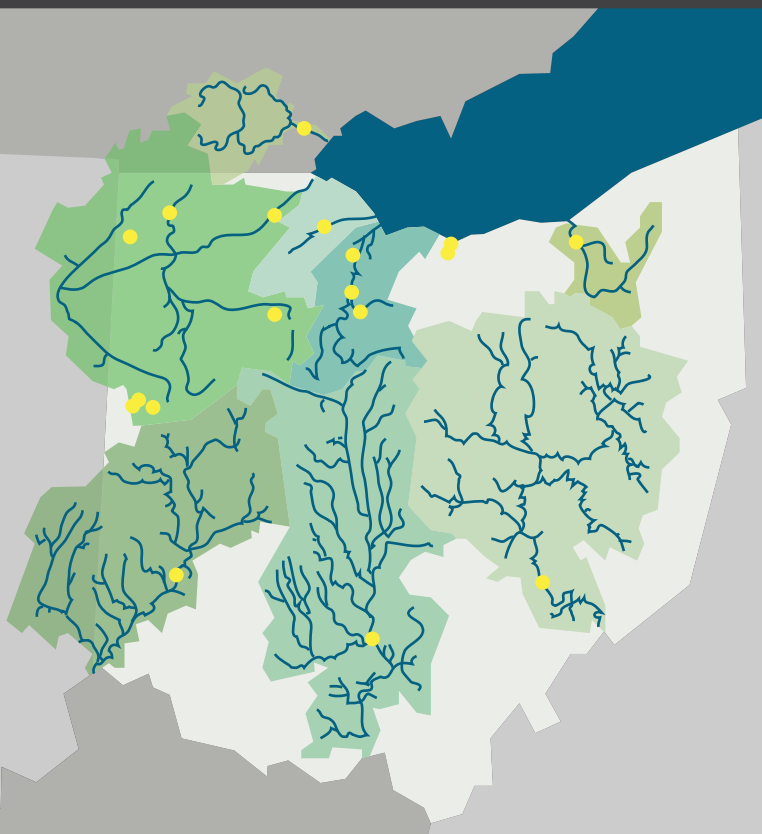
"Of course the diatoms are taking all that (silica) up," said Krieger. This is because they use it to form their shells. He adds that diatoms grow like crazy in colder temperatures and cites a Bowling Green State University study that is looking into how they behave in the winter. "They have to be playing a big role in the dead zone in the central basin because they're going to settle out, go to the bottom and decay just like the bloomers, cyanobacteria, do too. So there's a winter, maybe fall through spring, component of the algal cycle nobody's really paying much attention to which is not causing a problem in the western part of the lake but might be causing part of the big problem in the central basin. There's just a lot of dynamics going on."

The insights that researchers at the Center have gained over the years are considerable. And all of them are proof of the worth of their efforts and the tributary loading network because there's no way that one or two stations would provide all the information resource managers need to know.

"We get the question: 'Why do you need to keep monitoring year after year? You've done this for 30 years already,'" said Krieger. "Well, it's because we've done it for 30 years that we can see these things."

## WATERSHED MODELING

So far, we've talked about a lot of data collection. But an important question is how the data actually get used in attempting to solve the problems that they help to quantify.



NCWQR Station locations.

To get some insight into that side of things, we talked with Rem Confesor, senior research scientist at the National Center for Water Quality Research who is heading up efforts to model the hydrology of watersheds that impact water quality in Lake Erie. In addition, he is working with other modelers around the state to launch a new program to compensate farmers for the nutrient runoff reductions they achieve.

Confesor's work applies much of the understanding that the Center has gained over the years in a modeling approach to make improvements in the real world.

"We're basically trying to understand the problem, trying to understand the processes for what causes the problem. So the purpose of the modeling actually is, given all the limited understanding of the problem, what can we do?" said Confesor. "So this is the solution side really, so we're not just identifying the problem and just analyzing the trends or the cause but I think my task is to test implementing the solutions at this time with the limited knowledge that we have."

What most watershed models do is take into account conditions like terrain, slope and elevations along with those relating to properties of the soil throughout the region being considered. So things like soil type, depth, its chemical properties and its bulk density (soil weight in a given volume key to its ability to support root growth) get plugged in.

Weather is another important consideration, as the model can't really move without it. Inputs like falling rain and snow are forces that drive the model's behavior, Confesor says. The movements of nutrients like phosphorus are impacted by those flows, as well as other things like crop cover. From there, things get even more detailed.

"It can actually identify if it's urban or if it's forested and if it's agriculture," said Confesor. "If it's agriculture, it can ... identify if it's corn, soybean or wheat." For each crop, the model considers the cover, when it is planted each year and the different agricultural practices used in the process.

As an example of modeling capability, Confesor pulls up the Nutrient Tracking Tool online, a computer program developed by scientists at Tarleton State University and in part by the U.S. Department of Agriculture's Natural Resources Conservation Service. It is a useful platform for farmers who want to consider changing up their farming practices to get different results. What's great about it is that it can zero in on specific land parcels across the country. Just enter an address and you're ready to go.

From that point, users can enter the sort of treatments that they currently apply to their lands, like choice of fertilizer, the crops

**“ WE’RE BASICALLY TRYING TO UNDERSTAND THE PROBLEM, TRYING TO UNDERSTAND THE PROCESSES FOR WHAT CAUSES THE PROBLEM.”**

**-Rem Confesor**  
Senior research scientist at NCWQR



Stream monitoring station.

planted and land management approaches used, like crop rotation. And then it's possible to consider what might happen if they adjusted things by inputting that info too.

"For example, this is your actual fertilizer, or tillage management system. So you just don't plow, you don't apply fertilizer," said Confesor, pointing out fillable information boxes in the tracking tool. "This is a type of planter or something like that. And then you plow again for soybeans (as an example). So you're using conventional tillage. And what if you copied that alternative but this time changed it so there's no tillage? So what's going to be the difference?"

Though using the tool can be difficult for some, Confesor says that it at least provides an easy way to compare the effects of different approaches, like tilling or not tilling.

But looking at actions taken at the field scale is fairly simple when compared to considering those over a larger land surface, such as an entire watershed. So that is where most of the difficulties come in, like accounting for activities of all the tiny farms existing in a much bigger region.

"So that's the main problem with scaling up from the field scale to the watershed scale," said Confesor. "It's still the challenge of what's going on in between the small farms as it flows to the outlet of the watershed."

But the end goal, of course, is better management approaches that can help land managers while also helping farmers who are growing food for all of us on limited budgets. Toward that end, Confesor is working on a project that would push a pay-for-performance approach that could reduce nutrient runoff while keeping farmers' crop yields steady.

He is working with an international nonprofit and local soil and water conservation districts to set up the new kind of program.

"For example, instead of the government subsidizing the farm as to implement the BMP (best management practice), it's not sustainable because if the money's gone the farmers will not stick to it. That's always the case," said Confesor. "So what we do is that for several farmers in a small watershed, we can identify, using the help of the soil and water conservation district people, a small watershed and identify the farmers and ask them to participate in that program where we will use this field-scale model to calculate what's going on in their farm."

The next move is to set up an alternative management scenario that the farmers could use on their land. One key, though, is that farmers would keep the freedom to choose how they want to implement the best management practice. Once the BMP is put in place, Confesor and others can rely on edge-of-field monitoring devices, in-stream samplers and modeling to assess how well each practice is doing.

"We will just estimate with the model the reduction. So based from that reduction in pollutants and the actual year of the farm, we will have some kind of a rule or calculations that we would pay the farmer, whatever the reduction is," said Confesor. "And the more reduction we have, it could be possible that they have reduced the exports and they have at the same time increased their yield — we're still going to pay them. It's based on their performance actually, not on what the government tells them to do. And I think that's what they want."

Map: Nate Christopher / Fondriest Environmental  
Photo: Jakob Boehler / National Center for Water Quality Research



# ICELANDIC GLACIERS

Scientists at Western Kentucky University lead an investigation of Icelandic glaciers, dynamic ice sheets that are largely understudied.

BY DANIEL KELLY

There are lots of glaciers out there that contribute to sea level rise, but those are surprisingly less dynamic than many in Iceland. There is also a sizeable information gap on Icelandic glaciers, as they are much less studied than their more famous melting counterparts.

An investigation led by scientists at Western Kentucky University is trying to change that. The exploratory study is sampling 12 glaciers throughout the country every few months to try and get a handle on the changes that the sheets experience throughout the year. It involves students from the university, the Iceland Meteorological Office and other researchers from the University of Akureyri.

Work there has only just begun, with researchers hoping to return later this year to gather more data.

"We have 12 glaciers and 25 different sites that we're sampling over a year," said Jason Polk, associate professor of geoscience at Western Kentucky University. "We want to see how things change from the summer melt to the peak of winter."

To gauge the water situation in the field, he and others are measuring temperature, pH, conductivity, dissolved oxygen, total dissolved solids, turbidity and nitrates with a YSI ProDSS water quality meter. The variety of data they're gathering will help to clue them in to where the water is coming from.

"When you're out in the field, the challenge is to get equipment that will stay together," said Polk of the ProDSS. "But the calibrations have held wonderfully and we've gotten some great data."

In addition to those direct measurements, researchers are collecting discrete water samples for analysis back in the lab.



Glacier sampling site in Iceland. The black substance coating the glacier is volcanic ash.

Things of interest there include radiocarbon and tritium within, which are used to figure out how old the water is.

"A lot are young — less than 1,000 years old. Not a lot has been done to measure the dynamics of the substrate meltwater," said Polk. "We're also doing a texture analysis, trying to characterize the chemical and physical parts of samples."


Polk says he and others are also capturing meltwater samples at the glacial surface and then downstream where they feed the ocean. The idea there is to see how conditions can change over distance.

The Meteorological Office, which is chipping in some of its monitoring data, is interested in learning more about flooding that sometimes occurs near the glaciers. This can take place due to glacial lakes that burst through the ice and submerge areas below.

Complicating that further is a healthy tourism sector that brings more than 1 million people to Iceland each year. The country itself only has 300,000 in population.

"People were out there on the roads when we went out to sample in June. There was a nice glacial foot bridge that we took a hike over," said Polk. "We came back about two weeks later and it was blown out by a flood. The bridge is lost."

The entire effort is just getting its start at this point, Polk says, noting that there is still much more work to be done. In the future, he'd like to set up long-term monitoring stations that can gather data with an eye toward broader timescales.

The investigation is a thesis project for Anisha Tuladhar, a masters student in Polk's department. She was intrigued by the Icelandic glaciers after studying similar ones in Nepal. 



Photos: Jason Polk / Western Kentucky University

# LAKE MENDOTA GREENHOUSE GASES

Scientists at University of Wisconsin – Madison use an eddy covariance approach to study greenhouse gas movement around Lake Mendota.

BY DANIEL KELLY



An anemometer and other sensors on a tower overlooking Lake Mendota help to measure its greenhouse gas flux.

Lake Mendota is known as one of the most heavily studied lakes in the world. And there is no doubt that the lake, which sits by the University of Wisconsin's Center for Limnology, has seen its share of sampling. But the atmospheric conditions around the lake haven't been researched quite as much.

Learning more about those conditions is important, as they impact greenhouse gases surrounding Lake Mendota. On a broader scale, the lake's emissions also chip in their own contributions to global warming.

"While the scientific community has studied the role of various organisms on land and in oceans for some time, we know less about lakes and rivers. And even among lakes, urban lake settings have been less studied," said Ankur Desai, professor of atmospheric and oceanic sciences at University of Wisconsin – Madison. "Lake Mendota, which has had world-class research on it for decades, seemed like an ideal place to contribute improved understanding of where lakes fit in the global climate system."

To dissect the gas flux surrounding the lake, he and other investigators at the university have deployed a few sensors on a tower

overlooking the lake. The idea is to capture gusts and eddies of wind as they carry greenhouse gases like carbon dioxide in and out of the lake's surface as well as the organisms that call it home. The approach is commonly known as eddy covariance.

"If we can measure how strong each gust is and how much carbon dioxide or other gases are in that gust, we can back out the net amount of greenhouse gas emission or uptake by the organisms at the surface," said Desai.

Two instruments make measuring those things possible. Wind gusts get tracked by a sonic anemometer, a device that precisely measures vertical wind speed at nearly 60 times a second from variations in the relative speed of sound. Gas concentrations are measured at a similar frequency using fast-response infrared spectroscopy.

Desai says that the tower and sensors are situated on a peninsula in Lake Mendota that provides the station a prime spot for observing gases coming off the lake. It was a result of some luck: The pole had been recently installed as a landmark so boaters could avoid hitting the peninsula, so researchers took advantage by seeking permission to place the sensors there.

**“ WITH MULTIPLE YEARS OF DATA ... WE CAN ESTIMATE HOW FUTURE CHANGES IN CLIMATE OR LAND USE WILL AFFECT THE LAKE CARBON BALANCE.”**

**-Ankur Desai**  
University of Wisconsin – Madison

The high location helps scientists to sample a larger area of the lake, adding a little more precision to their findings. Those, as well as some expectations, are partly informed by the long-term set of data available on Lake Mendota.

"We have a similar system set up on campus and from that, we know that this particular lake can take up or release carbon dioxide on net over a year. This amount seems to vary with how long the growing seasons is, which is set by when ice breaks up and when fall storms set in to mix the lake up," said Desai. "With multiple years of data, and coordinated measurements of lake organisms, nutrients and ice thickness, we can estimate

how future changes in climate or land use will affect the lake carbon balance."

A larger goal of the work is to add the data gathered at Lake Mendota to a database on the cycling of carbon in lakes and rivers around the world, Desai says.

"With that, we can provide a more definitive estimate of how much lakes emit or take up. Currently, all ecosystems globally on land and ocean take up nearly half as much carbon as we emit in fossil fuels each year," said Desai. "This tremendous service keeps the rate of ongoing climate change slower than it would be otherwise. Should this rate of carbon uptake in the future change, it has large implications for the future rate of climate change even for the same amount of fossil fuel emissions."

All the data, he says, will be shared openly and hopes are that they will help inform important decisions on carbon emissions both locally and globally.


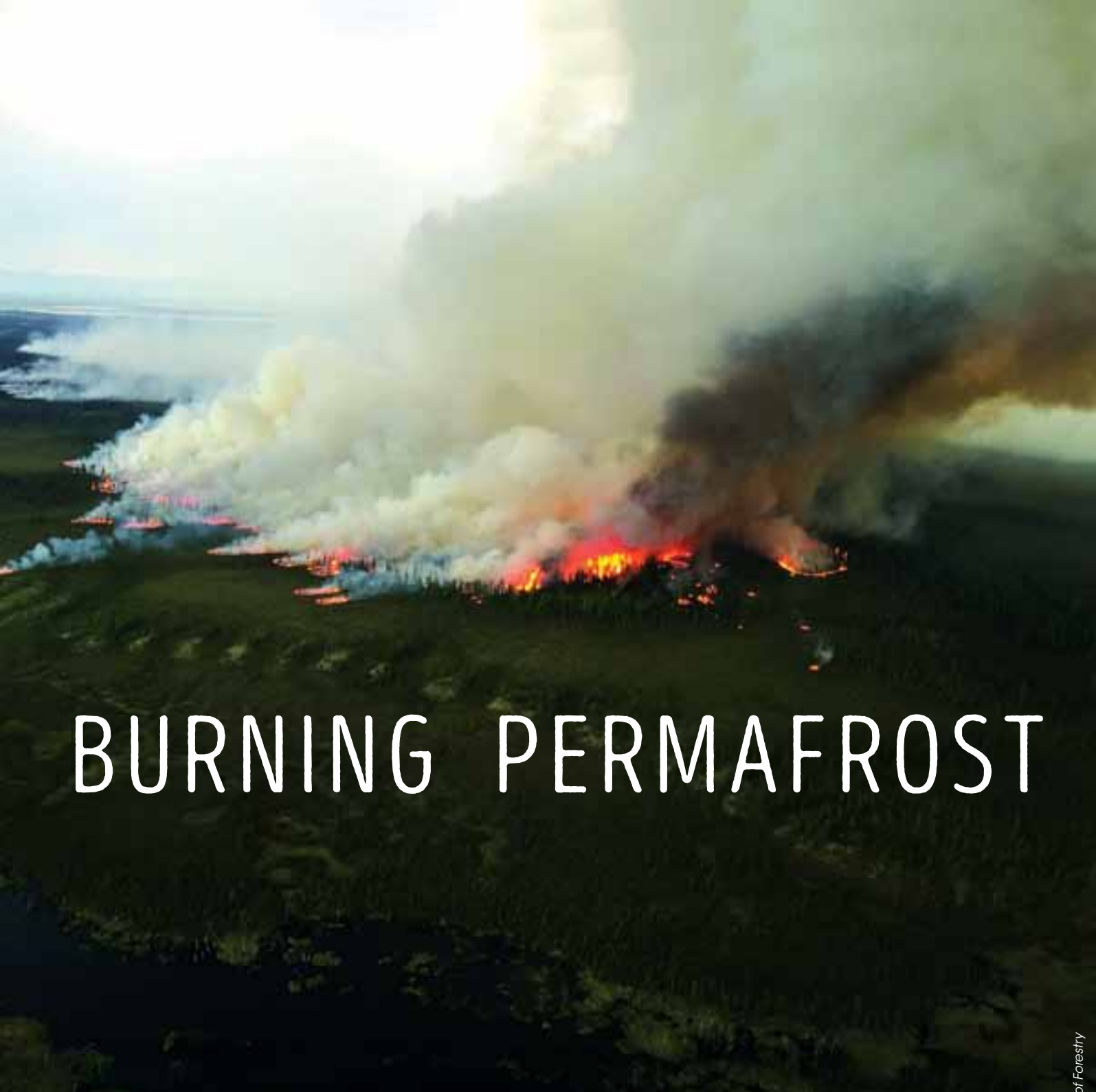
Desai credits the University of Wisconsin campus community and the Long Term Ecological Research program led by the National Science Foundation for making the work possible. 

Photo: Richard Hurd / CC BY 2.0

Photos: Jonathan Thom / University of Wisconsin



# BURNING PERMAFROST

**“MORE AREA BURNED LAST YEAR IN THE YUKON RIVER DELTA THAN IN THE LAST 67 YEARS.”**

**-Max Holmes**  
Woods Hole Research Center

Photo: Matt Snyder / Alaska Division of Forestry

## Peristaltic pumps and handheld water quality meters aid Woods Hole Research Center scientists studying impacts of fire to Yukon River Delta permafrost.

BY DANIEL KELLY

Climate change appears to be raising fire risk in the Arctic tundra, as a recent uptick in blazes have scorched permafrost there. And the impacts of the burning on permafrost are not yet fully understood.

Many scientists are interested in learning more about the effects, among them those at Woods Hole Research Center who are embarking on an expedition to the region in fall 2016. Armed with handheld water quality meters, peristaltic pumps and other tech, they're in for a whirlwind of sampling to log conditions in 25 different aquatic bodies in the Yukon River Delta over the course of just three days.

Their main interest lies in determining how the water bodies have changed following 2015's Kuka River Fire. The blaze came after a warmer winter meant less snow for the area. The precipitation dried up quickly and a thunderstrike is believed to have sparked the fire.

"Last summer was a crazy fire year for the area," said Max Holmes, senior scientist at Woods Hole. He has a lot of experience in tundra regions, having worked in parts of Siberia and participated in many investigations to aid the Arctic Great Rivers Observatory. "More area burned last year in the Yukon River Delta than in the last 67 years."

Early in June 2016, he and others visited the delta to study the active layer of permafrost there. Essentially, that layer is the portion of the frost that fluctuates each year between thawing and freezing.

During the time out in the field, Holmes and around eight other colleagues camped out to study the active layer's fluctuations. It was a remarkable place to sample following the fire.

"One thing about the fire that was interesting, it was just so patchy," said Holmes. "The lower-lying areas of the tundra was like a patchwork of burned to unburned areas. That helped us compare the areas easily."

Along the way, Holmes and others made a key find about the Kuka River Fire's impacts.

"In the active layer, the permafrost thaws each year. But it was considerably deeper in areas that burned," said Holmes, cautioning that findings are preliminary and that more analysis of the expedition's samples is yet to be done. "And there was a big pH difference. The aquatic bodies in burned areas have higher pH levels, which was an interesting result."

The fall trip looks to build on those insights by measuring a slew of terrestrial and aquatic conditions. Scientists have an eye

Photo: Melissa Gabrielson / U.S. Geological Survey




U.S. Geological Survey scientists study conditions in a pond in the Yukon River Delta.

toward gauging changes in the Yukon River Delta's permafrost as well as the gases that its thaw may be helping to release.

Fluctuations of methane and carbon dioxide over the tundra are going to be tracked. And parameters like pH, temperature, conductivity and dissolved oxygen will be gauged with YSI ProDSS handheld water quality meters in each of the 25 bodies of water under study.

"It's an ambitious trip. Three people for three days, in a helicopter each day, going from site to site. We'll see how it goes," said Holmes. "... But there's a huge amount of carbon in the delta and we're trying to find out the impacts on permafrost. That's a big climate question."

Results of the effort will be used in published scientific papers, he says, adding that Woods Hole's Polaris Project will also benefit. The project, in some of its programming, engages around 12 undergraduate students to develop their own research and share it with the public at large. Polaris had for some time been focused on work in Siberia but is shifting efforts to the Yukon River Delta starting in 2017.

Funding for all of the projects is being provided by the National Science Foundation. 

# RESTORING THE EVERGLADES

With the Everglades restoration plan underway, University of Alabama scientists continue a long-term study of the wetlands' greenhouse gases and more.

BY DANIEL KELLY

The Everglades is a special ecosystem, comprising the largest subtropical wetland system in North America. But beyond its size, it is also home to an astounding array of plant and animal life, including the American Alligator, American Crocodile and 73 threatened or endangered species, according to the Everglades Foundation. What does the future hold for the crucial region as an ambitious Everglades restoration plan gets underway?

It's hard to say, but investigators at the University of Alabama are at work trying to learn more about the Everglades and its changes over time. The scientists have already been studying for nearly a decade gathering data at two sites in the wetlands, but have recently received a grant from the National Science Foundation to deploy two more. By expanding their data collection, the researchers are hopeful that they can continue gathering information key to predicting changes the Everglades may see in the future.

One of the older sites is set up in the park's Taylor Slough, while the other sits nearby in the Shark River area. They were installed in 2008. The two new sites, still to be deployed in the fall, are planned to launch so as to form a transect across the Everglades. They'll hit four key areas: coastal mangroves, freshwater marshes that have standing water six months of the year, freshwater marshes with standing water the whole year and the brackish ecotone. That is an area where freshwater mixes with saltwater and grassy marsh gives way to mangrove forests.

"We're looking at how changes in the hydrology, associated with hurricane management, affects species composition," said Greg Starr, associate professor of biological sciences at the

university. "Or how these ecosystems are respiring. Are they sequestering or are they a sink to the atmosphere?"

To get at those and other questions, the researchers are relying on an array of sensors. Some of these — infrared gas analyzers and anemometers — capture eddy covariance, essentially the movement of gases and their fluctuations. These sample every 10 seconds.

"We look at the balance, the whole system respiration, including the methane reduction and release," said Starr. "By doing that, we can determine the changes, what's giving off greenhouse gases and understand the drivers."

But there are also meteorological sensors to gauge weather, light sensors to record radiation from the sun and soil sensors that keep tabs on the movement of moisture through the surrounding wetland.

The grant his team just received will keep the project moving for another three years, but Starr would like to continue gathering

**“WE LOOK AT THE BALANCE, THE WHOLE SYSTEM RESPIRATION, INCLUDING THE METHANE REDUCTION AND RELEASE.”**

**-Greg Starr**  
University of Alabama

data with the systems for as long as possible. More understanding is needed, he says, in light of ongoing changes in the region. These include high use of the area's aquifer and sea level rise that is spurring the intrusion of saltwater as well as the Everglades restoration plan that has just begun implementation.

"We're just getting long-term datasets, unique datasets, and we hope to continue for as long as funding will allow," said Starr. "There's a substantial restoration effort going on — a multibillion-dollar effort."

Over the coming years, plans are to reintroduce freshwater inputs once diverted from the Everglades to bring back some of the historical flows that pulsed through it. Work has already begun on the Tamiami River just last year, Starr says, where a trail has been removed and a major roadway has been raised to make room for water passage.

"We're at the forefront of those changes. Within four to five years, following the hydrological changes, you can have substantial impacts for plant communities, major impacts to carbon cycling in the system," said Starr.

Studying the Everglades' gas emissions is also important in a future of predicted climate change. But researchers all around the world depend on the data as well. Starr says that information from the existing sites is downloaded, on average, 200 times per year by other scientists. They typically plug the data into models and simulations that are used to study global dynamics and land-surface change. Measurements are also shared with the Ameriflux Network, which connects research on field sites representing major climate and ecological biomes.

Photo: Fondriest Environmental

Photo: Pedro Lasira / Public Domain



# ENDANGERED PALLID STURGEON



By tracing rhodamine dye and larvae movement, U.S. Geological Survey scientists look to understand why pallid sturgeon recruit poorly in the Missouri River.

BY DANIEL KELLY

Along the Missouri River, researchers with the U.S. Geological Survey (USGS) have used a dye typically used to study the flows of contaminants in an effort to help endangered pallid sturgeon. Results of their efforts may clear up questions on the fish's poor recruitment rates in the waterway.

It's estimated that there are currently only 100 to 125 pallid sturgeon in the Upper Missouri River and its Yellowstone River tributary. In the mid 1960s, following their last successful recruitment, there were around 1,000.

"It's unknown why they're not recruiting," said Susannah Erwin, research hydrologist with the USGS' Columbia Environmental

Research Center. "They live at the bottom of turbid waters and we call the Missouri River the 'big muddy,' but we don't know what is affecting recruitment."

To get a better idea of the dynamics at play, Erwin and a team of scientists from the agency recently sampled down a stretch of the river between the Fort Pack Dam, managed by the U.S. Army Corps of Engineers (USACE), and Lake Sakakawea upstream. They used massive bottles of rhodamine dye to color the river a bright red and tracked its movement downstream, where the color dissipates, with a network of fluorometers placed along shore.

The idea was to study particle movement and dispersion as a proxy for sturgeon larval transport.

"We were trying to better understand the dynamics of drifting larvae," said Erwin of the fieldwork effort that lasted from June to July 2016. "When they've just hatched ... they're relying on a yolk sac for sustenance and eventually develop into an organism that is feeding and eating invertebrates. We're concerned that there may not be adequate drift distance available to make that development possible."

There isn't a set distance that the larvae need to transition, she says. More important is the flow rate of the section under study. If the waters are moving too fast, then the young sturgeon may just not have the time they need to mature.

Alongside the dye-tracking effort, a separate team of USGS researchers worked to complete an experiment charting the movements of actual sturgeon larvae. They released larvae and fished them out of the river using nets over days and nights.

"In all, they released 700,000 pallid sturgeon larvae into the river," said Erwin. "So we'll be able to compare results with a passive tracer (the dye) and the actual biological organisms."

Both of the efforts were part of the Comprehensive Sturgeon Research Project, which has recently wrapped up. Erwin and others are now busy sifting through all the data they've collected.

Hopes after that are to plug the data into models that the USACE already has on particle transport in the river to make them more accurate. Results so far are looking good.

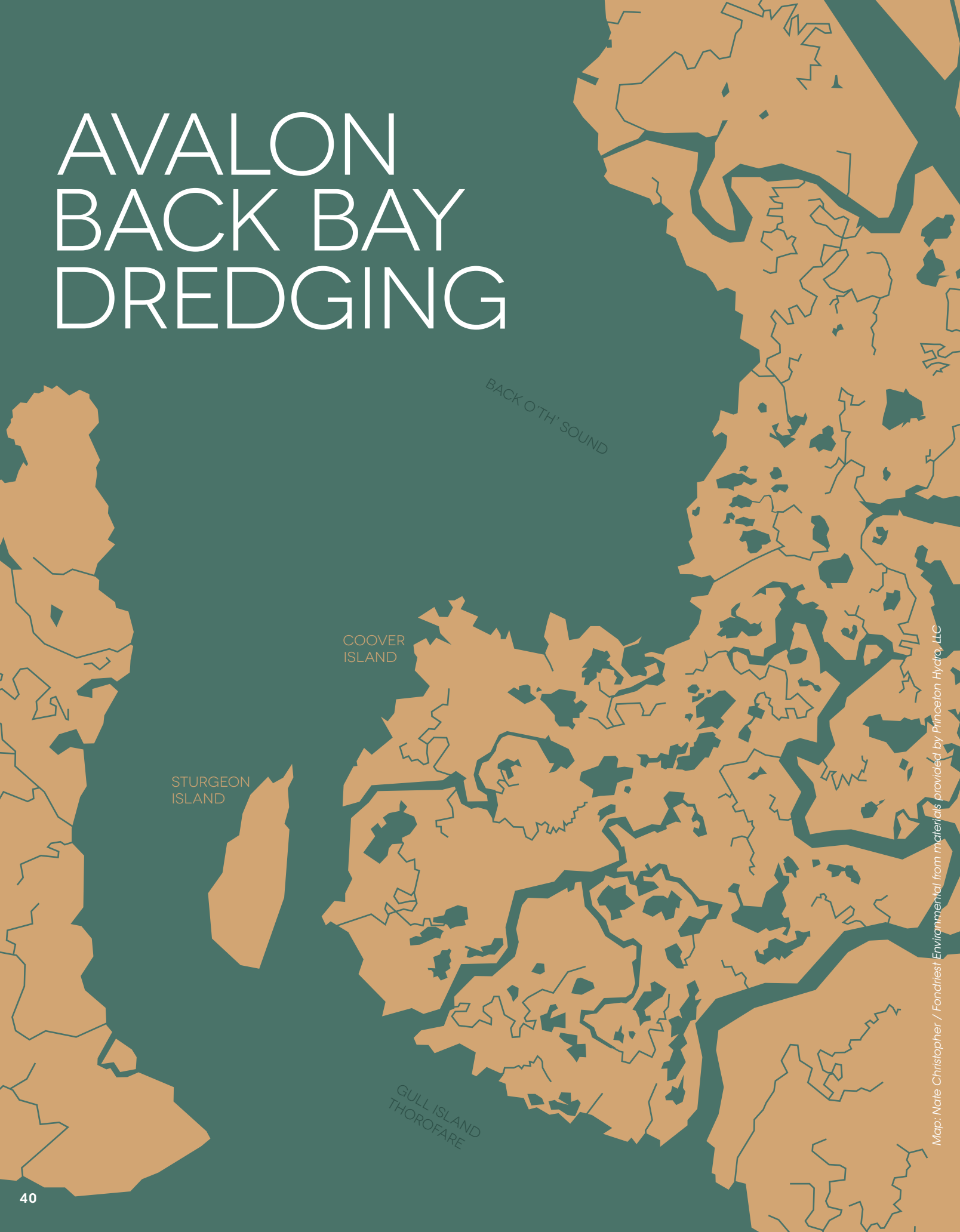
Photo: U.S. Geological Survey

"From an early analysis, what we can see is that the injection-dispersion model performs reasonably well, surprisingly well in terms of matching travel times, matching the dye trace," said Erwin. "The data will allow us to further refine it from there."

Several other institutions helped in the work in addition to the USACE, which controlled flows from the dam during sampling. The U.S. Fish and Wildlife Service and the State of Montana were also involved as well as the U.S. Bureau of Reclamation and the Western Power Administration.

Findings from the work will help to inform the Missouri River Recovery Program, an effort to try and mitigate harm that's been done to three threatened species along the river: pallid sturgeon, least tern and piping plover. [DK](#)

# AVALON BACK BAY DREDGING



Tetra Tech engineers use a cellular data logger and water quality sonde to automate tracking discharge from a confined disposal facility during a New Jersey dredging project.

BY DANIEL KELLY

Getting things in place to monitor total suspended solids (TSS) around a dredging operation sometimes takes a quick turn-around. Just ask engineers at Tetra Tech who had short notice to get ready for tracking discharge out of a confined disposal facility (CDF) during the Avalon Back Bay Dredging Project. It's entering what looks to be its final stage in 2016.

Back in November 2014, they got approval to monitor during one of the early stages of the dredge work. But by the time they secured it, there was barely more than a week to get preparations underway.

Luckily, they were able to rent the gear they needed just as dredging of areas in and around New Jersey's Princeton Harbor began. This included a YSI EXO2 Multi-Parameter Water Quality Sonde outfitted to track temperature, conductivity, turbidity and depth as well as a central wiper to minimize maintenance. The sonde connected to a NexSens 3100-MAST Cellular Telemetry System, which logged data and transmitted back to stakeholders in real time.

It was really the only way that the project could move forward, crews tell us. The area being dredged was so remote that traveling to and from it to obtain water samples would have wasted a lot of time. Plus, lab results would take a few days to get back, which simply wouldn't accommodate reporting requirements for the state. If the crew went over exceedance limits just twice, the project would have been in jeopardy.

"Once you register an exceedance, you're close to getting shut down," said John Gee, principal engineer at Tetra Tech, a global environmental consulting firm. He described the CDF where dredge material was being deposited by an operator. "This approach was the way to go. It's really remote, it took us a half hour just to get there. And it's a wetland marsh, so at high tide you can't get to it. You can take a boat or just wait till low tide."

After they got the gear in and installed, it took about a week for the holding basin to fill up with dredged matter and begin overflowing. That's when they began tracking discharge from the CDF, hoping to keep things below a 30 parts-per-million limit.

Data from the sonde were recorded every hour by the logger, which transmitted them to project engineers, officials at the local township and even the captain of the dredging boat in real time through a NexSens WQData web datacenter. Managers were also able to set up an alarm that would alert them automatically if TSS levels went too high throughout the nearly two-month project, including work through Christmas Day.




The monitoring system included a YSI EXO2 multi-parameter sonde and a NexSens 3100-MAST data logger with cellular telemetry.

"It worked really well. We had data every hour instead of every day," said Gee. "The township engineer was thrilled."

But the project did have a few hiccups, Gee tells us. The crew got close to one exceedance because the sonde would occasionally be out of the water due to variations in dredge flow. When out of the water, measurements of TSS were elevated.

"We should have put in a water level meter because we got an alarm on a Sunday," said Gee, noting that no one was really in the mood for a site visit on the weekend. "We had some discussions. About half of us thought the unit was out of the water but no one was 100 percent sure. So we go down there, and it was out of the water. The basin had drained. When that happened, the unit read high values. It had nothing to do with the water."

The addition of a water level sensor to the sonde would have been a big help. Getting such a sensor or a standalone water level logger wouldn't have been too much of a stretch, as the cost of renting gear helped the Tetra Tech team to manage its budget really well. And tracking discharge in an automated way just made the work simpler on everyone.

"We probably saw a 50 percent savings in cost and it exceeded expectations for the state," said Gee. "I've automated a lot of stuff and this is one of the easiest setups I've ever done ... Any time you get the chance to automate, it's better for the environment, it's cheaper and it's better for the client." 

Map: Nate Christopher / Fonclrest Environmental from materials provided by Princeton Hyatt, LLC

Photo: John Gee / Tetra Tech



MONITORING  
GEAR



### Geneq SXPad 800H

Named for its 800 MHz processor, the SXPad 800H can handle high-accuracy GIS data mapping in less time than other rugged handheld computers. The 800H runs Windows Mobile 6.5 and has an integrated cellular modem, offering wireless connectivity for internet access and data exchange. With Bluetooth connectivity, the handheld can also link up with Geneq SXBlue GPS/GNSS receivers and compatible laser rangefinders.



### PME miniDOT

The miniDOT logger is a completely submersible instrument that logs dissolved oxygen and temperature measurements. It includes an optical DO sensor, a temperature sensor, batteries and a microSD memory card. Data are recorded internally with a sample interval from once per minute to once per hour and can be offloaded to a computer via USB cable. Its sensor computes oxygen concentration in mg/L and records all measurements internally. Each logger is factory-calibrated at 12 oxygen concentrations, each at 8 temperatures, for a total of 96 calibration points.



### Rickly Rain Gauge

The Model 3510 Tipping Bucket Rain Gauge is ideal for measuring rainfall and precipitation in remote and unattended locations. The bucket consists of a collector funnel, a stainless steel filter screen and a tipping bucket mechanism that can be programmed to tip at precipitation levels from 0.1 millimeters to 0.1 inch. A siphon keeps rain flowing at a steady rate, no matter the intensity of the rainfall, and the gauge supports measurements up to 27 inches per hour. Rain data can be recorded by data logger and transmitted remotely via cellular, radio or satellite telemetry.



### Heron dipper-Temp

This new meter from Heron profiles water temperatures while also tracking levels in groundwater wells, boreholes and inland water bodies. Its tape is made of high-tensile steel and wrapped in either polyethylene or heat-resistant Kynar depending on the model. The Kynar-wrapped tape is capable of withstanding temperatures up to 110 degrees Celsius and immersion in solvents and harsh substances while the polyethylene version can sample up to 80 degrees. Tapes come up to 300 feet in length.

### Juniper Geode

The Geode is a simple GPS/GNSS receiver with sub-meter accuracy and easy, one-button operation. It can be mounted on a pole or carried in a pack and works seamlessly with almost any handheld computer running Windows, Windows Mobile or Android operating software. The Geode receives GPS and SBAS with optional GLONASS reception. It also features all-day battery life with 4-hour charge time to help ensure uninterrupted data collection in the field.



### YSI EcoSense ODO200

The ODO200 handheld provides accurate dissolved oxygen data in an affordable format. It features an easy-to-use interface, one-hand operation, IP67 waterproof case and low cost of ownership over the life of the product. The ODO200 simultaneously measures temperature and DO through an optical sensor. This means no stirring requirement for dissolved oxygen readings and no sensor warm-up time.



### Geotech Geopump

Geopump Peristaltic Pumps offer single-stage pressure or vacuum pumping of liquids to depths of 27 feet at sea level. They are ideally suited for sample removal from shallow wells and surface water sources. Because the pumps operate by mechanical peristalsis, the sample comes in contact only with the tubing. This allows for sample integrity as well as easy cleaning and replacement. With optional stainless steel tubing weights, tubing can be lowered to specific depths without curling or floating occurring on the water's surface.

### Van Essen TD-Diver

Van Essen's new TD-Diver features a design built from the ground up after incorporating years of customer feedback. This groundwater level and temperature logger is housed in stainless steel and features a novel backup memory system not available in other loggers. Its 144,000-record capacity is split into two, allowing for backup space, and memory is flash-based so data can be retrieved through any condition. The TD-Diver features the latest hardware and firmware upgrades, 8-year battery life and is compatible with all existing Van Essen accessories as well as third-party data loggers.



# DIY DIVERS

Creative thinking and do-it-yourself tech helps divers with the Coral Reef Ecosystem Program gather data in the North Pacific without breaking the bank.

BY DANIEL KELLY



You can spend just about as much as you want on the latest environmental sensing system. Or if you've got an inventive streak like a group of divers with the National Oceanic and Atmospheric Administration (NOAA), you could just make your own.

The work that the team does is fascinating, as they get to dive through waters around remote Hawaiian islands surveying anything from fish to corals, algae outbreaks, sea turtles and more. Through the years, since about 2000, the group that dives under the Coral Reef Ecosystem Program has spotted shipwrecks, marine debris and even sunken fishing gear, all while relying on simple gear that they've largely devised themselves.

"Offentimes people say that we fly the boards underwater," said Kevin Lino, marine ecosystem research coordinator at NOAA's Inouye Regional Center, describing boards that the divers use to carry out marine surveys around Hawaii and other areas of the North Pacific Ocean.

The boards represent just one piece of equipment used during the dives, which are carried out with two divers. One does a

benthic survey, while the other keeps tabs on a region's fish. Boards attach to tow lines that pull the holders through the water at a speed of about 2 knots, but also double as underwater tables.

Attached to each board is a slice of PVC so thin that it's possible to write on. The PVC sheets have different sections carved into them to mark space for certain information. That could be on habitat, the extent of algae, fish in an area or other things. But how divers write on the sheets is pretty neat in itself, if just for its sheer simplicity. We asked for the secret, expecting talk of water-proof paper or hydrophobic ink.

"It's just a regular pencil, Ticonderoga No. 2," said Lino. "It's tied on with string."

The divers also carry a few other, more sophisticated, items on their boards. Each is equipped with a Seabird 39 that records temperature and pressure, while the board used for benthic surveys also carries an underwater camera that takes images during tows. The shots that it collects are broken down into five-minute segments for analysis later.

In addition, the crew also swims with stopwatches set to alarm every five minutes to alert divers to check in with their dive buddies. A sound-signal device on a battery-powered cable along the towline also allows those swimming underwater to communicate via Morse code with crew members piloting the ship. To send messages to the divers, boat drivers rev the engine. A GPS unit aboard the boat is used to georeference their findings.

Lino says that his group has looked into purchasing an acoustic system to replace the manual means of communicating through Morse code, but that its cost hit around \$40,000, which was prohibitive.

"Versus our simple wire system, sometimes simplicity is the best means," said Lino.

All of the tech helps Lino and other members of the dive team to gather valuable data on areas in the North Pacific. They mostly serve as independent data-gatherers, acquiring the information needed for policymakers and others to make the best management decisions.


Photos: Kevin Lino / NOAA

**“...SOMETIMES SIMPLICITY IS THE BEST MEANS.”**

**-Kevin Lino**  
National Oceanic and Atmospheric Administration

"Our goal is to look at the broad-scale changes, on the island scale or archipelago scale as well," said Lino. "... We try to be as non-invasive as possible, just get the data and allow local managers and stakeholders to make the decisions."

In looking at changes in fish communities, he says that his crew has found populations in some areas are stable whereas those in other regions are decreasing. The investigators are still sifting through the benthic data they've collected, as analyzing images adds some time to the turnaround.

The information divers have gathered has been gleaned from all over the Hawaiian Islands, the Mariana Islands and areas near Guam, some of which is difficult to obtain by other means. But the crew's small footprint often makes it possible for surveying in hard-to-reach areas, like coastlines. 





# SUTTLE LAKE SALMON

A new data buoy deployed in Oregon's Suttle Lake is revealing key insights into its food web and helping officials better manage salmon stocks there.

BY DANIEL KELLY

Oregon's Suttle Lake is home to populations of kokanee salmon, best described as the landlocked version of sockeye salmon. In 2003, kokanee salmon there were anywhere from 12 to 18 inches long. Nowadays, their average size is around a mere nine inches according to the U.S. Forest Service (USFS).

Clearly something is going on with kokanee salmon in Suttle Lake. But there has also been a recent resurgence of sockeye using the lake as well, thanks to dam removal projects and stream modifications by USFS fisheries biologists that have helped reduce difficulty for fish passage.

To help improve understanding of both types of salmon that live in Suttle Lake, officials at the High Lakes Aquatic Alliance Foundation (HLAAF) have launched a water quality monitoring buoy in the water body. It took its spot in the eastern portion of the lake in July 2016, and will likely provide insight into more than just fish.

"The lake was once the home of a strain of sockeye salmon that had disappeared," said Frank Conte, a retired professor of limnology at Oregon State University and board member at the foundation. "In the past three or four months, they've had

ancient salmon re-appearing in the Columbia River and the Deschutes River."

There is interest in figuring out where those salmon are going, Conte says. They could be heading from the Deschutes through the Metolius River and then on into Suttle Lake. The Confederated Tribes of Warm Springs, a longtime partner of the HLAAF, is keen to figure that out.

Another question remains as to the ability of Suttle Lake, with its shrinking kokanee, to sustain populations of hungry sockeye salmon as they spawn.

"How might the spawning affect the fish that are already there?" said Conte.

To get at those questions, the NexSens CB-450 data buoy is equipped with a number of sensors that gather measurements on conditions directly affecting Suttle Lake's food web. These include a Lufft WS501 weather sensor, Hydrolab DS5 sonde and two LI-COR sensors tracking photosynthetically active radiation (PAR).

The weather sensor logs data on air temperature, humidity, barometric pressure, wind and global solar radiation. The sonde is outfitted to track temperature, conductivity, pH, dissolved oxygen and pigments. An LI-190R measures PAR above water, while an LI-192 tracks it below the surface to a depth of 5 feet.

All of the sensors are powered by three 10-watt solar panels and send measurements to a data logger housed within the buoy.



The logger is equipped with cellular telemetry to broadcast measurements to managers at the foundation in real time.

"We need to have the buoy to give us the chemistry of the lake," said Conte. "It puts us in comparison with some of the Arctic limnology going on. It's a vital thing for our lake, which is a freshwater lake."

In the future, he and others with the HLAAF would like to take the buoy system to other high lakes nearby that are important for the migration of waterfowl. Lake Abert, a saline lake to the south of Suttle Lake, is one possible water body.

Abert is an important resting point for birds moving from Canada down to lakes in Mexico and Peru, says Conte. They love to stop at Lake Abert — Oregon's only saltwater lake — because of its brine shrimp, which have been threatened in recent years by receding waters.

"The Pacific Flyway (major waterfowl migration route), we haven't touched it yet," said Conte. "Suttle Lake is a defining work. We have the buoy for three years to use there, and then we might go to putting it into Lake Abert. We could then go to the national bird associations and join the studies they have." 

## FOOD WEB BUOY SYSTEM

A NexSens CB-450 data buoy supports a number of sensors. A Lufft WS501 multi-parameter weather sensor sits atop the buoy gathering data on air temperature, humidity, barometric pressure, wind and global solar radiation. Near this is a LI-COR LI-190R sensor that tracks photosynthetically active radiation (PAR) above water. It sits securely on its own NexSens-designed sensor mount, which doubles as a support for the buoy's solar marine light. Underwater, a deployment pipe holds a Hydrolab DS5 water quality sonde equipped with sensors to measure Suttle Lake's temperature, conductivity, pH, dissolved oxygen and pigments. A LI-COR LI-192 underwater PAR sensor, mounted on a NexSens instrument cage, dissects light penetration from the lake's surface to 5 feet deep. All data are recorded by a NexSens data logger within the buoy and transmitted via cellular to officials at High Lakes Aquatic Alliance Foundation.



Photo: Roger Tabor / U.S. Fish and Wildlife Service

System Diagram: Tyler Fondriest and Nate Christopher / Fondriest Environmental

# SALT FLAT PRESERVATION

Chile's Salar de Atacama gets most of its water from outside its watershed, according to a study led by University of Massachusetts scientists.

BY DANIEL KELLY



Photo: David Boutt / University of Massachusetts - Amherst

Photos: (left) David Boutt / University of Massachusetts - Amherst; (right) Lee Ann Munk / University of Alaska - Anchorage

A great deal of the world's lithium comes from one place: Salar de Atacama, also known as the Chilean salt flat. In 2008, it alone provided 30 percent of the planet's supply of lithium carbonate.

Companies that sell the element, as well as the Chilean government and locals living nearby, wish to make sure that the region stays properly managed. After all, the dry area known best for its brine needs water like anywhere else.

In a recent investigation, scientists led by researchers at the University of Massachusetts - Amherst have visited the region to study how it drains. The question is an important one for the future management of Salar de Atacama. Its answer may also prove useful in caring for other dry regions around the world, including parts of the U.S. West.

"The water budget there is a source of contention. People use the brine as a resource, and they want to know how much brine is taken out. There are lots of protected lagoons, brackish lagoons. They're not very salty, but flamingoes use them as mating grounds," said David Boutt, associate professor of hydrogeology at the university. "We were trying to understand sources of salt to the basin and where moisture was coming in, to get a better handle of the water budget."

This part of Chile is very dry, he says, noting the difficulty that came when even trying to locate springs for sampling. The locals are pretty good at finding them though, as they have built around them. Some companies working in the Salar de Atacama have also installed monitoring wells but they are sparse.

And so Boutt and others on the team simply sampled everywhere that they could find water, hitting streams, springs and groundwater around the salt flat. In all, they gathered 300 samples of freshwater and brine to analyze all the sodium entering into the basin.

"We used a combination of isotope and elemental analysis — a chloride mass balance, which tries to figure out how much



Lilly Corenthal, former graduate student in Boutt's lab, takes measurements at monitoring wells in the Southern Transition Zone.



Gypsum crystals precipitated on a natural fracture in the Tucucaro ignimbrite at around 100 meters depth.

chloride comes through and accumulates in the groundwater, as well as remote sensing analysis," said Boutt. The investigators relied on data from the Tropical Rainfall Measuring Mission satellite system, using satellite estimates of precipitation to understand water recharge in the modern record for comparison to data from water samples. "On projects like this, we combine remote sensing with on-the-ground measurements and integrate those two."


Satellite data used in the investigation covered a period from 2000 to 2010, which was a relatively short time range for understanding the region's discharge rate over time. To get around that, investigators compared geological estimates of the discharge rate to what they were seeing in their samples.

The modern discharge rate was close to those estimated over time, Boutt says, and the region is draining an area nearly five times as large as its watershed. But perhaps the bigger find is that most of the water within Salar de Atacama is originating from outside its watershed on the Andean Plateau.

"The watershed is importing water from outside its topographic boundaries. With a lot of watersheds in dry areas, you can't simply ignore water crossing the topographic divide," said Boutt. Otherwise, underestimating discharge is pretty much guaranteed. "This has important implications for regions like this being managed."

Areas like the U.S. West and the Great Basin, where Boutt and members of his lab are embarking on a new research project in Nevada.

"A lot of people are interested in the (Chilean salt flat's) water for various reasons, and these are limited resources," said Boutt, noting its lithium supply and local copper mining. "We're trying to understand how to manage these systems and, in some cases, draw lines on a map to say where the water is coming from."

Full results of the work are published in the journal *Geophysical Research Letters*. 

# 6 SMARTPHONE APPS EVERY ANGLER SHOULD HAVE

No matter what you need to do, there is probably an app for it out there somewhere.

BY BRANDON CARD



The SondeCAM mobile app records video and takes still photos directly on smartphones.

When it comes to fishing, smartphone apps have changed the way that I pre-fish for tournaments and approach areas while I am on the water. These apps are what I use and are something that all anglers should try. You don't even need to have a boat to see the benefits.

## Navionics App

Just about everyone I know has the Navionics app on their phone or tablet. It is a great way to instantly check out the bottom contours of the lake you are fishing or one that you plan to go to. It is really accurate and helps me find depth changes, humps, underwater points and much more. I highly recommend it if you don't already have it.

I also have a pretty funny story about this app. A few years ago while I was pre-practicing for an Elite Series event on Lake Seminole, I was following my charts to fish an offshore contour that had a deep weedline. I was moving along and came across two teenagers in an old, beat up aluminum boat with no electronics whatsoever. They were crushing the fish on lipless crankbaits and even showed me pictures of bigger ones they had caught earlier. They were following the contour on their Navionics smartphone app and doing way better than I was in my much more decked-out boat. It works and these kids figured it out.

## YouTube

This may seem like an easy one, but the YouTube app on my phone really helps me with fishing. There are so many videos out there that no matter what lake you are headed to, there is probably some footage out there. I use this to gauge how the fishing will be and what size and species of fish are biting in that body of water before I head to somewhere new.

The videos out there are also a great way to learn about a new product or technique. Pros and amateurs alike are always showing new tricks to make us all better anglers.

## Weather.com App

There are many great apps for getting weather reports. I like the weather.com app as it seems to be the most accurate. Weather is unpredictable as we all know, but I like to track the temperatures, wind speed and direction as well as the chance of rain. All of this factors into my fishing.

There are also some great wind apps out there that will show you wind speed and also direction. I have used these on some bigger lakes like the Great Lakes as well as on Lake Champlain. Wind up there can decide if you can even go out on the water that day and it is helpful to see which direction it is blowing.

Photo: Ray Gardner

## FishSens SondeCAM App

This one may be my favorite and I have used it quite a bit this year. The SondeCAM is a fun way to get video of fish and habitat underwater and the new app makes it even better. The app allows me to easily start and stop my recording right from my phone.

You can easily edit your videos and it makes it convenient to do it right away. Before I would have to take out my SD card, put it into my computer and then edit it. It removes a few steps for me and makes it much faster when I am away from my computer.

Another thing I like about it is the photo feature. Before I would take screenshots of video and it worked OK, but this makes it much easier to get a clear picture of my underwater footage.

All of the photos and video you take while using the app go straight to your photo gallery on your phone. This makes it convenient to share them right away to your social media pages or as a text to one of your buddies.

This app allows anyone to use the camera without even needing a boat. You can drop it down under a dock or pier and see what is down there while looking at your phone. I have even heard of people attaching the camera to a telescopic pole and sticking it into laydowns and other cover as they walk the bank.

Photo: FishSens Technology

## Google Earth

Like the Navionics app, Google Earth helps me locate good fishing areas. I really like to use this in the spring to locate backwaters that other people may have missed. It really helps to find these areas, but it is also great for seeing underwater points, humps and grass lines. This is another must-have app for anglers.

## Lowrance GoFree Hooked Fishing App

This is another relatively new one and something I think is really cool. This app allows you to record your fish catches to create a log. It saves the time, location and exact GPS location of your catch. This is a cool way to track your trips and reference them later.

Like the SondeCAM app, you can easily share pictures of your fish to social media. Another cool feature is the contest feature. You can start your own competition with friends in a MLF format for total fish caught. I haven't used this feature yet, but plan to this season with my buddies back home.

# IN THE GREAT LAKES

RESEARCH FROM AROUND THE BASIN

## SUPERIOR

In the Straits of Mackinac, where Lake Superior and Lake Michigan meet, eurasian watermilfoil has spread. There's a similar situation in the Les Cheneaux Islands, where the invasive species has advanced enough to choke local waterways and hurt tourism. To help with those problems, researchers at Michigan Technological University are using an unmanned aerial vehicle to do airborne surveys. Equipped with an advanced camera, the hexacopter is used to map areas affected by eurasian watermilfoil for high-resolution, scalable imagery. Investigators are comparing the images gathered to satellite data in hopes of one day being able to see the invasive species from space. But getting there requires drone imagery that can refine knowledge of what satellites pick up.

*Michigan Technological University (2016). Fighting Invasive Species in Michigan (Press Release). Retrieved from [www.mtu.edu/news/stories/2016/august/fighting-invasive-species-michigan.html](http://www.mtu.edu/news/stories/2016/august/fighting-invasive-species-michigan.html)*



## MICHIGAN

Unstudied for decades, Lake Michigan's Morgan Shoal has been surveyed for the first time by researchers at Shedd Aquarium. The 32-acre limestone sheet rests in shallow waters about 300 feet off the Chicago shoreline. To document the shoal's biodiversity, scientists used underwater cameras and buoyed nets. They also made scuba dives to visually document what lifeforms lurk beneath the surface. Their survey, completed in spring 2016, revealed a surprising amount of biodiversity in Morgan Shoal. Quagga mussels cover what was once open rock and native fishes like sculpin and darters weren't found, but 15 other species of fish were documented swimming around the area in the winter. Researchers were stumped to find a large number of longnose suckers, a threatened fish in Illinois that is increasingly rare. They netted nine on just one day.

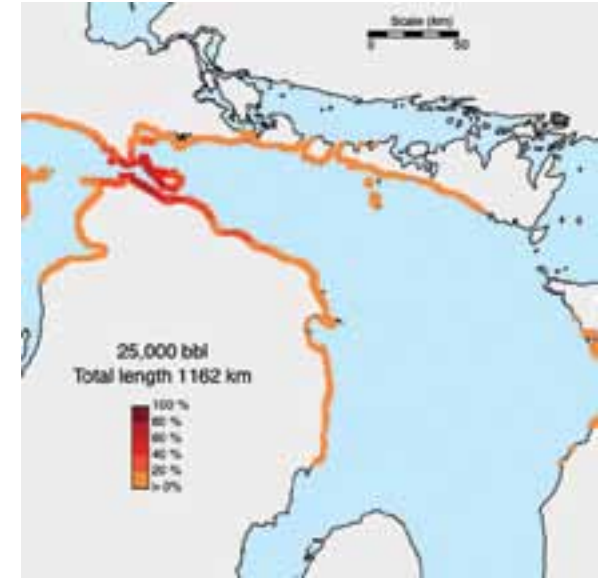
*Chicago Tribune (2016). Just off Chicago in Lake Michigan sits an oasis of diversity — Morgan Shoal (News Article). Retrieved from [www.chicagotribune.com/news/local/breaking/ct-morgan-shoal-reef-met-20160703-story.html](http://www.chicagotribune.com/news/local/breaking/ct-morgan-shoal-reef-met-20160703-story.html)*



## HURON

In 2014, researchers at the University of Michigan Water Center ran two simulations to project what could happen if an oil spill occurred in the Straits of Mackinac, home to an aging oil pipeline owned by Enbridge. But in a recently released study, the scientists have upped the number of disaster simulations to 840, providing a much clearer image of the impacts that such a spill could bring. The simulations were made with computer models predicting how far and fast an oil spill could spread from the Straits. Using data on weather and water currents gathered in the Straits of Mackinac during the ice-free season, researchers found that just one spill in the area could affect 152 miles of coastline along the shores of Lakes Michigan and Huron. When all 840 simulations were considered, scientists added up 720 miles of vulnerable shoreline in the U.S. and Canada.

*University of Michigan (2016). More than 700 miles of Great Lakes shoreline potentially vulnerable to Straits of Mackinac oil spills (Press Release). Retrieved from [ns.umich.edu/new/multimedia/videos/23638-more-than-700-miles-of-great-lakes-shoreline-potentially-vulnerable-to-straits-of-mackinac-oil-spills](http://ns.umich.edu/new/multimedia/videos/23638-more-than-700-miles-of-great-lakes-shoreline-potentially-vulnerable-to-straits-of-mackinac-oil-spills)*



## ONTARIO

A recently completed survey of tributaries to Lake Ontario has found that fishing in the waterways has increased. But that clashes with fishing in the open lake, which has gone down. The Ontario Ministry of Natural Resources and Forestry (OMNRF) and New York State Department of Environmental Conservation (NYSDEC) have regularly surveyed the amount of fishing activity on the open waters of Lake Ontario for more than 30 years. The NYSDEC surveyed the amount of fishing activity in New York's Lake Ontario tributaries from 2005 to 2007 and 2011 to 2012. OMNRF just completed the first-ever comprehensive survey of fishing activity on the lake's Canadian tributaries. Considering all the data gathered, scientists note that the amount of annual fishing activity on Lake Ontario's tributaries is two times greater than the amount of fishing activity on the lake itself.

*Lake Ontario Partnership (2016). Lake Ontario Lakewide Action and Management Plan Annual Report 2015. Retrieved from [binational.net/wp-content/uploads/2016/01/LO-2015-Annual-Report-FINAL\\_20151214.pdf](http://binational.net/wp-content/uploads/2016/01/LO-2015-Annual-Report-FINAL_20151214.pdf)*



## ERIE

Summer of 2016 saw a surge in water temperatures throughout the Great Lakes. As the most shallow of the five, Lake Erie was especially impacted by the rises. According to data from the Great Lakes Environmental Research Lab, 2015 Lake Erie summer temperatures were closer to the mid 70s Fahrenheit, on average. This year, that figure was closer to 79 degrees. Experts believe that a warmer than normal winter helped to spur the surge in Great Lakes water temperatures. High air temperatures during the summer have likewise helped to continue the trend around the basin. And this year is clearly in contrast with lake temperatures from 2013 to 2015, which plunged against averages.

*Michigan State University Extension (2016). Great Lakes offering warmer water for summer pleasure. Retrieved from [msue.anr.msu.edu/news/great\\_lakes\\_offering\\_warmer\\_water\\_for\\_summer\\_pleasure\\_breederland16](http://msue.anr.msu.edu/news/great_lakes_offering_warmer_water_for_summer_pleasure_breederland16)*

Photo: (Superior) Michigan Tech; (Michigan) Bernd Rostad / CC BY 2.0

Photo: (Huron) David Schwab / University of Michigan Water Center; (Ontario) SYSS Mouse / CC BY-SA 3.0; (Erie) Ken Lund / CC BY-SA 2.0

# WINTER TUNE-UP SPECIAL

PREPARE YOUR EQUIPMENT  
FOR THE  
2017 MONITORING SEASON



FONDRIEST ENVIRONMENTAL  
FACTORY-AUTHORIZED SERVICE & REPAIR CENTER

GO TO [FONDRIEST.COM/WINTER-TUNE-UP](http://FONDRIEST.COM/WINTER-TUNE-UP)  
FOR MORE INFORMATION

TRADE IN  
OLD BENCHTOP METERS  
SAVE 20%  
ON A BRAND NEW ONE!\*

Contact a Fondriest  
Environmental applications  
specialist for more details

FONDRIEST  
ENVIRONMENTAL  
888.426.2151



**Thermo**  
SCIENTIFIC  
\*Offer expires 12/31/2016

# LAKE TAHOE RECORD WARMING

BY DANIEL KELLY



In 2015, Lake Tahoe went through a flurry of extreme changes, according to an annual report released by the Tahoe Environmental Research Center. Those include record changes in temperature, as well as shifts in mixing and the types of precipitation the lake receives.

In the recently released Tahoe: State of the Lake Report, scientists at the University of California, Davis, detail how natural forces, human actions and long-term change have impacted the water body over 2015. Notable effects have been registered on the lake's average temperature and clarity.

The average surface temperature for Lake Tahoe was 53.3 degrees Fahrenheit, the warmest on record. Not only that, but the pace of its warming has quickened, surging from an average increase of just 0.018 degrees each year to 0.3 degrees Fahrenheit in the last four years alone. That is 15 times faster.

"The occurrence of rising air temperatures at Lake Tahoe has been known about for many years now, and with it the warming of the lake," said Geoff Schladow, director of the Tahoe Environmental Research Center. "What is different this year is that we are seeing more aspects of the lake's internal physics changing, and that is bound to alter the ecology."

Like dynamics of the lake's mixing, which has certainly changed. Lake Tahoe failed to mix at its full depth for the fourth year in a row, setting up conditions ideal for low oxygen at deep levels.

The lack of mixing also led to the highest average nitrate levels ever recorded in the lake, 20.6 micrograms per liter. This marked a recent shift from the relatively constant nitrate concentrations that have persisted for much of the 35-year record.

Despite the higher nitrate levels, Lake Tahoe registered record-low levels of attached algae around the lake's margins. Researchers believe that is due to a lower lake level, which

dropped by 9 inches in 2015. Lake Tahoe was below the natural rim for all but one day in 2015, so no water could flow into the Truckee River, the sole outlet for the lake.

The lake's average annual clarity also went down 4.8 feet to 73.1 feet. The measurement marks the depth at which a 10-inch Secchi disk remains visible when lowered into the water. The average is lower than the previous year but still not as cloudy as in 1997, when Lake Tahoe's clarity was just 64.1 feet. In 2013, its clarity averaged 70.1 feet.

The biggest culprit for the clarity loss appears to be a shift in the type of dominant precipitation that the lake received in 2015 — there was less snowfall. Only 6.5 percent of the precipitation that fell came down as snow, investigators found, the lowest amount ever recorded. Warmer inflowing water also contributed to the decline.

Lake Tahoe is the largest alpine lake in North America. Every year, the report released by the Tahoe Environmental Research Center informs the public about some of the most important factors affecting its health. The big one for 2015 was a rise in temperatures that came as somewhat of a surprise to scientists.

"That is a huge amount of water," said Schladow, referring to Lake Tahoe's depth that reaches more than 1,600 feet. All that water spread out is enough to cover California 15 inches deep. "It takes a lot of energy to raise that a half degree."

The report was funded by the California Tahoe Conservancy, the Lahontan Regional Water Quality Control Board, the Tahoe Fund, the Tahoe Lakefront Owners Association, the Tahoe Regional Planning Agency, the Nevada Division of Environmental Protection, the Tahoe Water Suppliers Association, the League to Save Lake Tahoe and the Incline Village Waste Not Program, as well as individual donations.

Photo: the\_tahoe\_guy / CC BY 2.0



INDUSTRY  
PROFILE

# Q&A

## Chris Winslow

Chris Winslow is the interim director of the Ohio Sea Grant. The Environmental Monitor recently caught up with him during a meeting of science reporters at Ohio State University's Stone Lab on Lake Erie's Gibraltar Island. Winslow told us about some of the projects going on under Ohio Sea Grant to help address harmful algal blooms (HABs) in the lake.



### Environmental Monitor: Can you tell us a little about your work on the Field to Faucet Initiative?

**Chris Winslow:** Field to Faucet is all Ohio State (OSU) awardees because it's a College of Food, Agricultural and Environmental Sciences initiative. These are OSU projects, but the co-PIs are coming from Heidelberg University, University of Toledo, Bowling Green State University, but you'll see the state — there's (Ohio) EPA, Department of Natural Resources, the U.S. Geological Survey is in on some of these projects. So it is a very collaborative effort going forward.

### EM: We heard there's a project looking to extract nutrients directly from manure — How does that work?

**CW:** So basically there's a series of centrifuges and hydrated lime on the back of a semi truck and they are pulling through filtered water. That comes out the back at about 1 milligram per liter. So you can irrigate your fields in that area and not have to worry about increasing your soil phosphorus and runoff. The cool thing about this is that the separated lime's solid, so after this whole coagulation process goes through, the lime solids are held in what we're calling lime or phosphorus cakes. These are the concentrated phosphorus that's pulled out of the process. And those cakes now no longer have the volume of water associated with them, so they can be shipped out of that distressed watershed and sold to other farmers to use as fertilizer.

Right now, it's running. They're using the Quasar digesters and they're not actually running manure through this yet but they're testing it on what actually comes out of these digesters, removing the phosphorus and nitrogen from that material. They will then

actually move it to a farm and do it with that material. ... With the manure, it's an unproven concept. They're going to do it with manure and see if there's anything that needs to be tweaked or changed. So that's what will happen over the next five to six months is to do manure trials instead of digester material.

### EM: How is your team working to leverage smartphone technology to help farmers?

**CW:** We're making an app that farmers can use when they're on their fields. So they can use this app to record what is my crop? Am I doing corn, soybean or wheat? And what kind of tillage did I do on my acreage? How much fertilizer did I add this year? What was the rainfall this year? Or how much did I irrigate? So they can type all of this into the app while they're on their field doing the work so they can track it. There is currently an app out by the Ohio Farm Bureau Federation, but that app is different. The Farm Bureau app is to keep farmers in compliance with 4Rs. Two separate apps, but the one that's being developed by John Fulton (associate professor in the Department of Food, Agricultural and Environmental Science at OSU), basically it's this idea of nutrient stewardship. So letting farmers know, when I do this with this amount of crop rotation and fertilizer application, it resulted in this yield. So really giving tools to farmers so they can kind of know how their fields are producing.

### EM: What about drones?

**CW:** There are drones now that are fitted with cameras that are actually looking at the spectra coming back off the water source, being able to look at what organisms are living in there. One of our investigators has a drone that has been using optical images to look at those wave spectrums. It has actually been outfitted with

a water collection device, so it can actually go out to the stream, collect a water sample and then take a photograph of where that water was taken from and bring it back to the researcher. So the researcher can actually analyze the organisms in the water, like which zooplankton or chlorophyll or cyanobacteria are in there, and correlate that with the wavelengths that are coming back off the water.

This is not new stuff as far as the wavelengths go. This is what the satellites have been doing for Dr. (Rick) Stumpf (scientist at the National Oceanic and Atmospheric Administration) for the HABs forecasts. But the problems with the satellites, if you have a cloudy day or the satellite's not passing over when you wanted it to, you're missing data. So this allows you to do it at very specific locations. This also allows us to get inland because the satellites have a certain grid size, like 1-kilometer resolution. These have much finer resolution, you can take these to smaller inland lakes.

### EM: There is also talk of developing a sensor that can measure cyanobacteria toxins in real time. Can you give us an update on that?

**CW:** As you guys know, right now the ELISA (enzyme-linked immunosorbent assay) kit that wastewater treatment plants are using takes anywhere from four to six hours to get results back. Well if you're a water treatment plant, that water is already in your plant and going through. So in many of the water treatment plants, when they see cyanobacteria in the water, they have to assume it's producing toxins and they have to assume it's producing at pretty high levels. They treat worst-case scenarios because they don't know what the concentration is and they won't know for four or five hours. So what Wu Lu (professor in the Department of Electrical and Chemical

Engineering at OSU) is doing will give them the time so they can say, "Hey, cyanobacteria is in the water but this time it's not producing toxins, we don't have to ramp up our efforts." We can also see that the toxins are there, but at this part per million, so they don't have to treat as much. It's going to help the wastewater treatment plants treat that waste in a very targeted way.

### EM: Phosphorus fingerprinting, or pinpointing in water samples exactly where the nutrient originates, is an exciting possibility that some of your colleagues are working on. Are we getting close to it becoming a reality?

**CW:** A sample that you take from a pile of chicken waste might have 1,500 unique molecules in it, or compounds. Of those 1,500, maybe 200 have a phosphorus in it. Of those 200, how many would be also found in chicken, cow, pig? Of those, how many of those are unique to chicken? So we're already at that stage. We have that suite of characters for wastewater treatment plants, pigs, chickens, cows, that are unique phosphorus molecules for each one of those. Now we think we will have the capability of doing that.

The ideal — we're not there yet — is to be able to take a sample of water. Here's the concentration of phosphorus but of that amount of phosphorus, 30 percent of it can be attributed to this, 20 percent can be attributed to this, 50 percent can be attributed to this. And it's not always going to be that straightforward. There's some gray areas there but that is the idea to be able to say, "That phosphorus is in the water, where did it come from?" It could allow us as researchers to recognize phosphorus hotspots and where that phosphorus is coming from.

Photos: Nate Christopher / Fondriest Environmental



NEW  
TECHNOLOGY



## OpenCTD Ready To Build

A few years back, the OpenCTD was just an idea. At that time, the device's developers were talking in terms of its first blueprints and were still trying to achieve a conductivity measurement using a custom-built sensor made with two flat washers relying on Ohm's law.

But it's been three years since that conceptual phase. Where is the OpenCTD now? Is it ready for more widespread use?

We can gladly report that its design is complete and thoroughly improved over what it used to be. And anyone who would like to build their own can easily do so by downloading instructions and a bill of materials from Oceanography for Everyone's GitHub.

The OpenCTD has progressed by bounds since its inception. One of its developers, Andrew Thaler, a visiting scientist at the Virginia Institute of Marine Science, tells us that the device has made it through its first phase. He developed the OpenCTD with Kersey Sturdivant, a visiting scholar at Duke University's Nicholas School of the Environment.

"We have officially completed what we're calling Phase One. We have a working device that is simple enough for any oceanography group to use," said Thaler. He described a get-together that he and Sturdivant had with a few other scientists to flesh out

the sensor's design. They called it 'Hack the Ocean' and promoted it on social media using the name as a hashtag. "It was a four-day build cycle where we built the units and put together intense documentation."

The conductivity measurement, though difficult, has been solved.

"We built a conductivity circuit that worked, but it took 24 volts to run it," said Thaler. "And we didn't want people using that in the ocean."

So they instead sourced a conductivity circuit from Atlas Scientific. The price for that is around \$50, and performs better than anything Thaler and Sturdivant could put together on their own. In addition, the part is easier for those with little to no experience to use.

Keeping things simple is something that the crew takes pride in. Just check out the bill of materials. They are all things easily sourced through Amazon's web store or a hardware store. And one of the items they jokingly list is a coffee maker.

"We like to inject a little humor into building the instrument. We're having fun with this too," said Thaler. "We want this to be something people won't see as intimidating." ☺

Photo: Andrew Thaler / Oceanography for Everyone



NEW  
TECHNOLOGY



## Son-O-Mermaid

Earthquakes have never been easy to study in the oceans, but documenting their processes is important as scientists continue to conquer the data-poor seas. Ocean-bottom seismometers are relatively commonly used to gauge quakes undersea, and moored hydrophone systems pick up the odd earthquake as well. But those tools are expensive and difficult to deploy, sometimes requiring diving or travel on large research vessels. Enter the Son-O-Mermaid, a platform developed over the course of decades to make things simpler and much less costly.

The system is an amazing tool and has proven its utility in earthquake sensing through deployments recently completed in the Atlantic Ocean. Its main developer, Frederik Simons, associate professor of geosciences at Princeton University, looked to a few global ocean networks for inspiration, including the Argo network of floats. Another relative is the Southern Ocean Carbon and Climate Observations and Modeling (SOCCOM) program. The Argo network currently has 3,918 floats in the ocean measuring basic conditions like temperature and salinity. SOCCOM is using similar tech to sample for biogeochemical parameters in the Southern Ocean.

"But we are physical scientists of the solid Earth and we want to listen," said Simons. To do that, he and others involved in the effort use the Son-O-Mermaid. It is a second-generation plat-

Photo: Frederik Simons / Princeton University

form following the MERMAID, which stands for Mobile Earthquake Recording in Marine Areas by Independent Divers.

The first-gen MERMAID, as similar to what Argo floats do today, collected sound wave data with sonar and then floated to the water's surface to broadcast data back to researchers via satellite. It was powered with batteries. The Son-O-Mermaid, named in homage to sonobuoys — expendable sonar systems typically dropped from airplanes — and because it is a design update, improves on the original by adding solar power and complete operation at the surface. No more surfacing needed.

Hydrophones hanging beneath the Son-O-Mermaid, on cables up to 1,000 meters (3,281 feet), listen closely to all the sounds in the ocean. These can come from whales and other marine life, but also oil exploration operations, submarine movements, underwater volcanic eruptions and many other disturbances.

The big question for many years was how to filter out all that noise and only report earthquakes that occur in the ocean. Thankfully, a lot of time and effort yielded a solution.

"That's a scientific, engineering problem. We've found appropriate algorithmic formulas that we know work very well," said Simons. "It was a challenge at the beginning, but it's no longer difficult." ☺



# Versa Star Pro



## VERSATILE BENCHTOP METER

The Thermo Orion Versa Star Pro is an advanced benchtop meter that works with pH, conductivity, DO, pH/ISE and pH/LogR interchangeable modules to provide the most versatile performance of any Star-series meter.

[fondriest.com/featured-product](http://fondriest.com/featured-product)

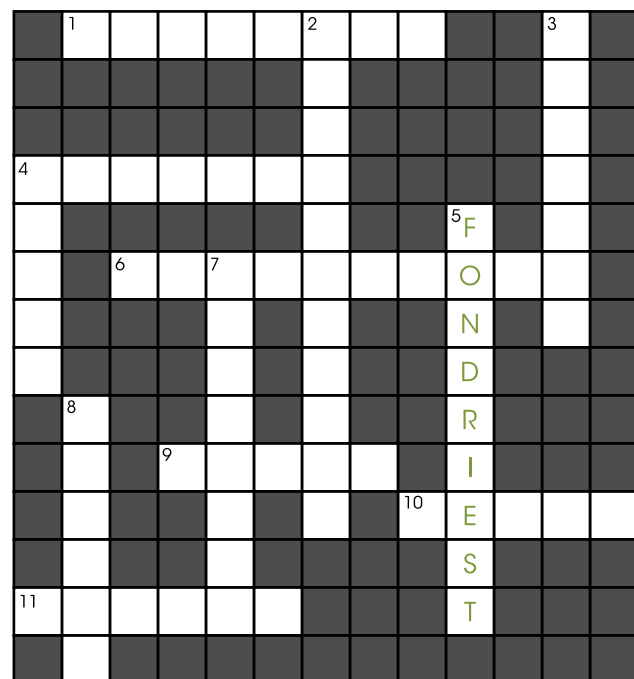
## In the Lab

### Across

- Process multiple samples at a time with this type of meter.
- Typically rubber, used to plug flasks or test tubes.
- Makes specimens appear larger for detailed inspection.
- Measure small amounts of liquid, from milliliters to microliters.
- Dish for growing cultures and observing specimens.
- Commonly made of glass. Used to hold, measure and heat liquids.

### Down

- Tracks how hot or cold things are.
- Protect your eyes with these.
- This weighing device can prove especially useful.
- Buy scientific equipment here.
- Extremely durable container for heating matter to high temperatures.
- Put these on your hands when handling hazardous material.



Visit [fondriest.com/news/crossword-puzzles](http://fondriest.com/news/crossword-puzzles) to find more puzzles and answers!

# RENTAL EQUIPMENT FOR ANY PROJECT

FAST DELIVERY · RELIABLE PERFORMANCE · QUALITY DATA



**FONDRIEST**  
R · E · N · T · A · L

[fondriest.com/rental](http://fondriest.com/rental) 888.426.2151



# FONDRIEST ENVIRONMENTAL

Fondriest Environmental, Inc.  
2091 Exchange Court  
Fairborn, OH 45324

**P** 888.426.2151

**F** 937.426.1125

**E** [customercare@fondriest.com](mailto:customercare@fondriest.com)

when your  
**research**  
demands  
**quality data**

PRSR STD  
US POSTAGE  
**PAID**  
DAYTON, OH  
PERMIT# 860

## Ohio State University's Stone Laboratory

Read the full story in the next edition  
Subscribe at [fondriest.com/news/subscribe](http://fondriest.com/news/subscribe)

**NEXSENS**  
technology