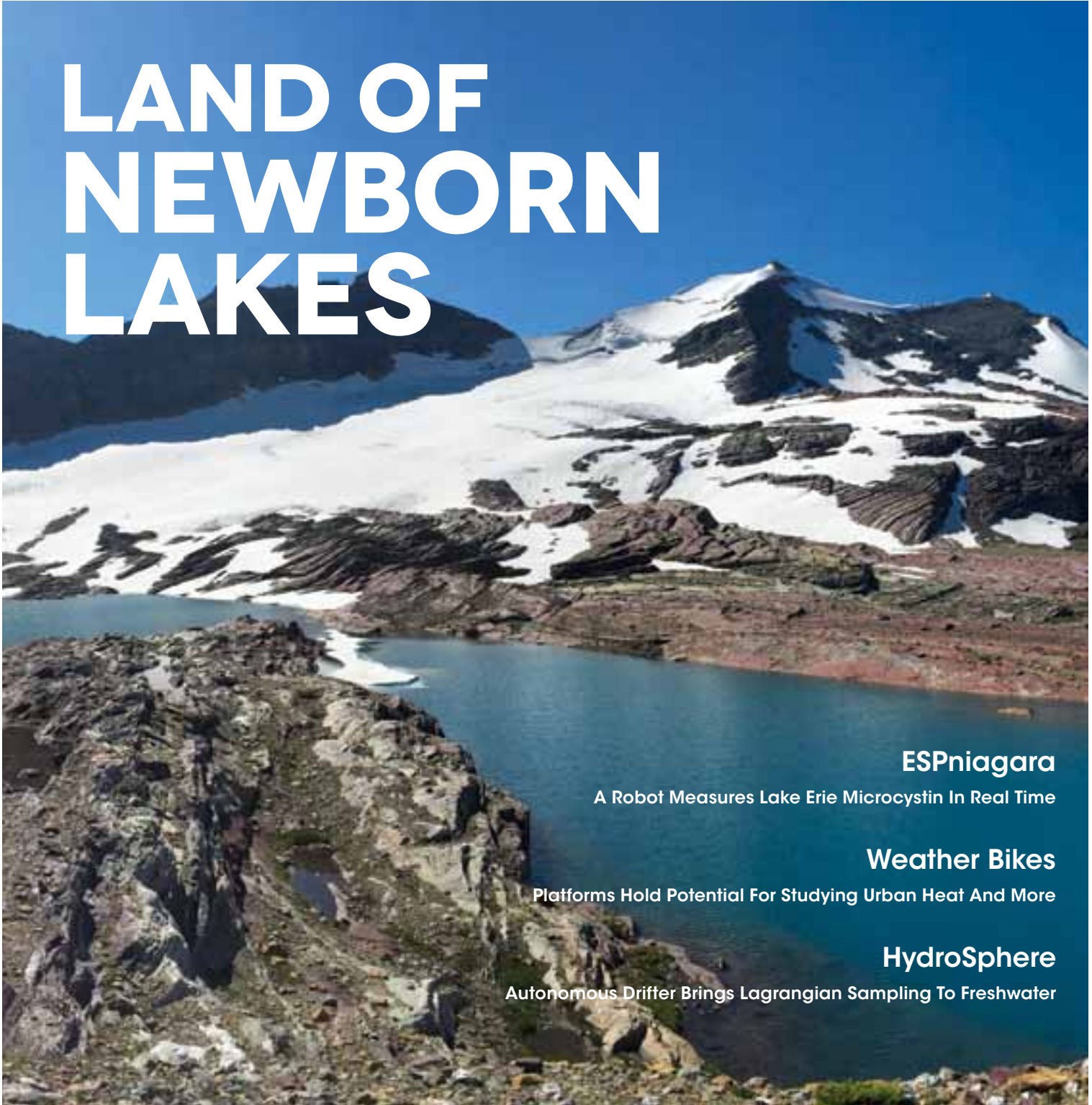


ENVIRONMENTAL monitor

SPRING 2017

APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS

LAND OF NEWBORN LAKES



ESPniagara

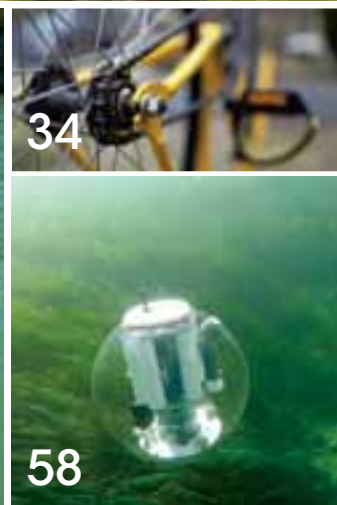
A Robot Measures Lake Erie Microcystin In Real Time

Weather Bikes

Platforms Hold Potential For Studying Urban Heat And More

HydroSphere

Autonomous Drifter Brings Lagrangian Sampling To Freshwater



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IN THE NEXT EDITION

The Fondriest Center for Environmental Studies launches as a resource for training and research, complete with constructed wetland, pond and lab space.

Photo: Jim Elser / University of Montana

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WELCOME...

Welcome to the Spring 2017 edition of the Environmental Monitor, a quarterly collection of the best of our online news publication. In this edition, we showcase a number of projects that are truly advancing the way data are gathered in the environmental monitoring field.

This includes a look at the first-ever deployment of the ESPniagara in Lake Erie, a device for real-time microcystin measurements that is so advanced its makers say it is essentially a robot. We also go for a ride with researchers using regular bicycles as mobile data-collection platforms to study urban heat, air pollution and more. From there, we float down several rivers with the HydroSphere, a new kind of autonomous drifter built for freshwater.

You'll also read about limnologists at the University of Montana leading the charge to learn how freshwater food webs form by surveying pristine lakes in Glacier National Park. And don't miss our coverage of a Lake Erie data buoy advancing education and research into the toxicity of algal blooms.

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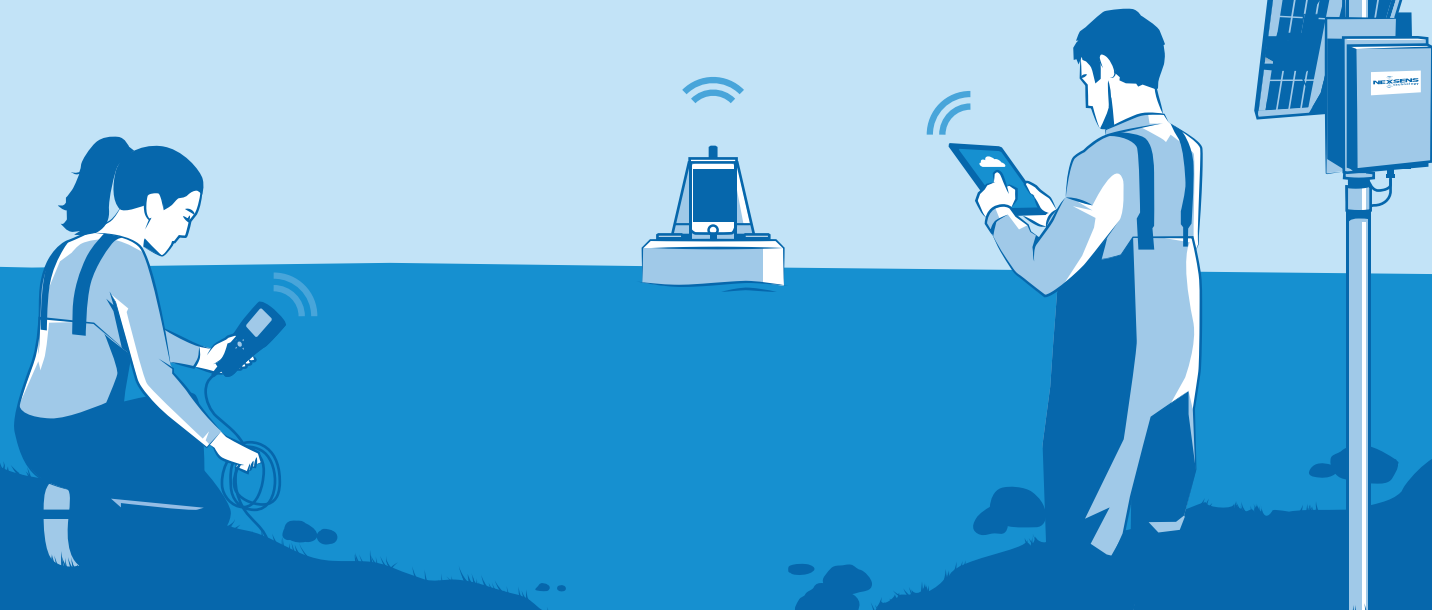
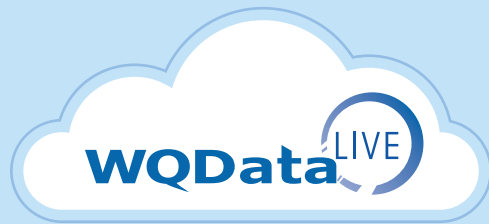
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Photo: (top) Woods Hole Oceanographic Institution; (center) Pete McBride / U.S. Geological Survey; (bottom) U.S. Army Corps of Engineers

WEB EXCLUSIVES

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Underwater Cameras And Autonomous Vehicles Track Leatherback Turtles



In 2012 and 2013, researchers at the Woods Hole Oceanographic Institution (WHOI) successfully used an autonomous vehicle equipped with an underwater camera, in conjunction with transponders mounted to sharks, to monitor the creatures' behaviors in deep water. The effort had great success, even capturing never-before-seen ambush tactics.

Following up on that and other achievements of the work, scientists at the institution were interested in using the same approach to study leatherback turtles. In New England's coastal waters, as in others around the country, the life patterns of these turtles are still largely understudied.

After a successful crowdfunding campaign, scientists have been using what they're calling a TurtleCam to study leatherbacks. The name harkens back to the previous work wherein a Remote Environmental Monitoring UnitS (REMUS) vehicle equipped with an underwater camera, nicknamed SharkCam, captured the behaviors of sharks with incredible detail.

Pulse Flow Brings Colorado River Delta Big Benefits

A few years ago, a pulse flow was released into the Colorado River Delta per Minute 319 of the U.S.-Mexico Water Treaty of 1944. The flow began March 23, 2014 and ended on May 18, 2014, pushing around 130 million cubic meters of water downstream. A few months after that, this magazine checked in with some of the scientists involved in monitoring the effects of the pulse flow.

Investigators told us they had deployed more than 100 piezometers to study groundwater levels. Flow trackers were giving them discharge data and measurements on salinity were being gathered with conductivity probes. For gauging the impacts to waterfowl, the researchers were using stereos to send out mating calls while listening for responses.

But there was so much more data collection underway than we knew. In a new report, released by the International Boundary and Water Commission, those involved with the pulse flow effort document other monitoring efforts used over the two-year study period.



First Environmental Monitoring System For Baltimore's Inner Harbor



Baltimore's Inner Harbor and the rivers that flow into it are important sources of water to Chesapeake Bay, popular recreation sites and the targets of an ambitious clean-up plan. But the city has for some time lacked an environmental monitoring system for tracking water quality in the harbor continuously.

That is about to change, thanks to a collaboration between the U.S. Geological Survey (USGS) and Environmental Protection Agency (EPA). It will lead to the new installation of a suite of sensors that will provide the public and scientists with the first comprehensive, real-time look at water quality in the harbor. The environmental monitoring system will be mounted near a pedestrian bridge across the mouth of Jones Falls, overlooking the Baltimore Harbor Water Wheel.

"Everyone deserves clean water and the sensors will provide the local community a real-time look at water quality in the harbor, informing efforts to improve it," said Don Cline, the USGS' associate director for water.

IN THE NEWS



Few Coral Reef Ecosystems Likely To Escape Rising Temperatures

With levels of atmospheric carbon dioxide continuing to rise, scientists from Duke University and France's Université de Bretagne Occidentale have found that very few coral reef ecosystems will escape the effects of rising seas and ocean temperatures. What's more, the damage that is felt will very likely hit areas of human dependence the most.

Their study suggests that reefs near Australia, Indonesia, Micronesia, Southeast Asia and Western Mexico will bear the brunt of rising temperatures. By the year 2050, reef damage will result in more lost fish habitats and shoreline protection, jeopardizing the lives and economic prosperity of people who depend on coral reefs for tourism and food.

The authors mapped human dependence at the country level, scoring for two indicators: shoreline protection and coral reef fisheries. At the same time, they mapped the unavoidable impacts of increased sea surface temperatures and ocean acidification. Investigators predict that the countries of Oceania will be among the first to face great environmental stresses from climate change and ocean acidification.



As Smallmouth Bass Move In, Walleye In Ontario Lakes At Risk

Researchers at York University have found that native walleye in Ontario lakes are at the risk of disappearing with the rise of smallmouth bass. Populations of walleye are diminishing as warmer waters allow the bass to push into more northern lakes.

Encroaching smallmouth bass mean more competition for food resources in Ontario's lakes. Adult bass will also chow down on younger and smaller walleye, affecting development of the fish's stocks in the future.

In the past, cold and northern water bodies had served to deter bass from edging in. But that is changing, scientists say, as temperatures are getting warmer. Similar impacts from warming have been noted in lakes in Wisconsin, a U.S. state that sits just south of the Canadian province.

To make the find, investigators used a database that included the abundance and occurrence of over 130 fish species, lake chemistry and lake morphology for 722 lakes. In lakes in which both types of fish were found, scientists saw there were about three times fewer walleye than bass.

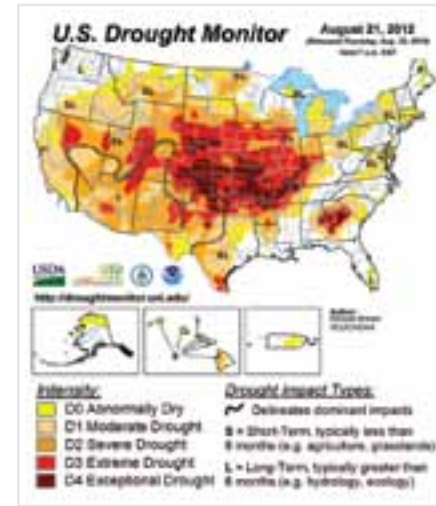


Carbon In Everglades National Park Mangroves Valued At Billions

Scientists at Florida International University have put a price tag on the value of mangroves in Everglades National Park. They estimate that the stored carbon is worth somewhere between \$2 billion and \$3.4 billion. Though a large figure, investigators say the costs are low compared to the damage society could experience if the carbon stored in the mangroves were released into the atmosphere.

The mangrove forests of the Everglades National Park are the largest in the continental United States. Although protected, the Everglades is affected by sea level rise, hurricanes, changes in water flow and other environmental events. In addition to removing excess carbon dioxide from the air, mangroves provide a variety of other benefits, including flood control, storm protection and better water quality.

The billion-dollar price tag reflects the costs to preserve the park's mangroves and their ability to hold organic carbon intact by restoring freshwater flow to the areas that need it the most. Decreased funding for Everglades restoration was also a consideration.



Major Drought Could Have Been Predicted Sooner

In 2012, great areas of the Midwest and the Rocky Mountains were under drought. It was one of the most extreme dry periods the region has ever experienced. But those living in the region could have had more warning before the drought hit, according to research published by scientists at the National Center for Atmospheric Research (NCAR) focusing on soil moisture and snowpack.

Seasonal drought forecasts issued in May 2012 for the upcoming summer did not foresee a drought forming in the country's midsection. But by the end of August, a drought that had started in the Southern Rockies had spread across the Midwest, parching Kansas, Missouri, Nebraska and Oklahoma.

Researchers analyzed data collected between 1980 and 2012. To supplement those observations, they also explored connections using a new NCAR-based community Weather Research and Forecasting model dataset comprising 24 simulations from 1990 to 2000 as well as for 2012. Researchers found that a full four months of warning could've been realized had data on snowpack and soil moisture been considered earlier.



Method Emerges For Estimating Biodiversity With Tree Cover

Scientists at Stanford University have developed a method for estimating biodiversity based on tree cover. The approach took around a decade to form, as researchers ventured to field sites in Costa Rica to gather data to support the method.

Each stint in the field lasted from three to six months, and saw scientists hiking across hilly landscapes of Coto Brus. They made passes in gradients going from protected forests to treeless pastures, racking up more than 67,000 observations of 908 species.

Those spotted included understory plants, bats, birds and more. The scientists then plotted plant and animal observations on detailed, fine-scale maps from Google Earth aerial photographs. When they analyzed the results, the importance of tree cover became clear. For four of the six species groups (plants, non-flying mammals, bats and birds), scientists saw a significant increase in the number of species with increasing tree cover visible through Google Earth.



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Photo: (left) Catlin Seaview Survey; (center) Riandi / CC BY-SA 3.0; (right) Liam Quinn / CC BY-SA 2.0

Photo: (left) National Drought Mitigation Center / University of Nebraska - Lincoln (right) David Spangenburg / Stanford University

Microbial Lifeforms

Oddly enough, rocks don't always need heat and pressure to metamorphose. In the process of serpentinization, rocks actually change with a reduction in both heat and pressure. Researchers at the University of Utah are working to better understand this process as well as the extremophile lifeforms that reside in the water bodies nearby.

In one investigation, scientists at the university are sampling along the Tablelands Ophiolite in Canada's Gros Morne National Park. There, researchers gather samples of water from streams and groundwater in a bid to further document the conditions that support microbial lifeforms in some of the surrounding springs. Gear commonly used in this effort include a YSI Pro Plus water quality meter and a flow cell.

Some of his helpers in the work include students at the Memorial University of Newfoundland as well as U. of Utah. One interesting question that they are trying to tackle covers how lifeforms in the pools are living given the extreme, basic pH levels recorded there.

Photo: William Brazelton / University of Utah



Limno Loan

The Limno Loan program, overseen by the Illinois-Indiana Sea Grant, is making it easier for educators around the Great Lakes to teach their students about freshwater science. Not only that, but it's also inspiring youngsters who have never gotten to use real scientific gear.

The program, which launched in the 2011-2012 school year, began after suggestions from teachers taking part in a science workshop on the Lake Guardian Research Vessel. The workshop on the U.S. Environmental Protection Agency ship led them to think that it'd be a great idea to get some of the same gear into the hands of their students.

The Limno Loan program of today is pushing the boundaries of success, providing four Hydrolab DS5 water quality sondes to high school and middle school teachers around the Great Lakes. Each gets the sondes for about two weeks, including shipping time to and from the Sea Grant, to use in their lesson plans.

That first year, the program only had about five teachers who checked out sondes. This year, more than 20 have already signed up and the pace signals to program managers that nearly 40 could use them by the end of the school year.

"High school and middle school students use them the most. That's the most appropriate age for this type of equipment," said Kristin TePas, community outreach specialist with the Sea Grant. She says the youngest who have used the Hydrolabs were fifth graders. "Most I'd say probably just deploy them in a river or small water body but some have rented boats to take their students out onto lakes."

When that's the case, it's common that the educator secures some sort of grant to cover the cost. And there are usually educational discounts that can help.

"That is one of the hurdles to getting them out there," said TePas. "You need to have money to do those field trips."

Loaning the sondes out to teachers provides a substantial cost savings over purchasing. Each one records a standard set of parameters, including temperature, conductivity, pH, dissolved oxygen, chlorophyll a, turbidity and depth.

The measurements are incredibly intriguing to students, who can see how their local water body is doing in real time. But since most of the sampling trips hit ponds on campus or streams nearby, depth is not as important as the other data coming in.

"For some, the lesson is just doing a pond day. ... Some are just doing a snapshot in time. Others have a monitoring program and they're comparing the data that they're getting," said TePas. "They might compare between two sites or between different areas. It's more of a comparison spatially than temporally."



TePas points out that the sondes have a lot of advantages over other methods the kids may have used in the past. Water quality testing kits often use tablets or strips that can introduce complexity. And the projects sometimes take longer because of that.

One big advantage that the Limno Loan program provides to school kids is that they actually get to use real scientific gear.

"For some reason, just using equipment that's used by real scientists gets them more excited. It's instantaneous," said TePas. "They're able to see right away what the status of the particular lake is."

The teachers benefit as well. Long before students get their hands on the sondes, Sea Grant officials give them hands-on training to use the gear.

The training is provided during workshops, TePas says, typically during other activities in partnership with local groups. Because of that, they can take various formats, but the training is consistent throughout.

"First and foremost, I want to increase water quality literacy. ... I hope at least they (students) take away a better understanding of water quality. So why do we care, why do we measure this stuff?" said TePas. "And if we had some budding scientists come out of this, that would be awesome."

Photo: Cindy Byers

Photo: Britta Anderson / University of Rhode Island

Stream Health Survey

A sampling project led by University of Rhode Island researchers and funded by the National Science Foundation is helping to reveal the dynamics of aquatic health in three streams while supporting undergraduate education and local drinking water. The effort, relying on dip nets and handheld water quality meters, also gave students the chance to connect with Rhode Island's hydrology.

For Britta Anderson, graduate student in the department of geosciences at the university, the project offered something else.

"Last summer was my first summer, so I had experience and the knowledge from that," said Anderson, who oversaw undergraduate students who assisted during this year's leg of the project. "I was able to continue this summer as more of a mentor."

Anderson, who did her undergraduate studies at the University of Minnesota, says that the sampling effort has also helped her to learn more about Rhode Island. It gave her the chance to jump in and get involved as soon as she hit the ground.

The project focuses on three streams. There is Cork Brook, near Scituate, R.I., which is the least affected by human development than the other two. These include Bailey's Brook and the Mairford River, both of which are nearer to Middletown.

Bailey's Brook is around 55 percent urban and 30 percent agricultural, Anderson says. The Mairford River is nearly the opposite, at 30 percent urban and 40 percent agricultural.

"The goal was to monitor two streams and compare what we're finding in those urban areas to Cork Brook," said Anderson.

To get there, she and others sampled up and down the streams using a YSI handheld water quality meter recording temperature, conductivity and pH at multiple sites. They used test kits to sample for phosphorus and nitrates every week. And dip nets helped them to sample populations of macroinvertebrates, markers of pollution.

"We'd go out into the stream and sample ripples and pools. We'd kick the substrate upstream a few times while sampling them downstream," said Anderson. "We chose to do 100 organisms in our samples. Other methods count what's in the whole bucket, but we chose to go with 100. At some spots, it was easy to go with that. At others, the streambed was dry or it had just rained and washed everything out."

Investigators sorted the macroinvertebrates based on their scientific orders in an effort to show relationships with the chemical data collected. They used the EPT index (sum of Ephemeroptera, Plecoptera and Trichoptera divided by the total number of midges) to say which orders dominated in certain streams. By gauging if more or less pollutant-tolerant species won out, researchers had a clear marker of water quality.



Most of the macroinvertebrates that were collected turned out to be mosquitoes, midges and blackflies. But there were a few outliers in that effort.

"At one site on Bailey's Brook, it had a very high EPT score compared to sites upstream and downstream and it was in the very middle of the stream right by a parking lot," said Anderson. "Everything else was pretty predictable."

Scores throughout the streams are being compared to surrounding vegetation to gauge the relationship between that and macroinvertebrate populations. Doing that is helping researchers to make more sense of the data.

Full findings on the streams' health aren't yet available, as investigators are continuing to sift through their datasets. There is hope that they can reveal some trends. The biggest difference that Anderson saw between the streams from this year and last were most likely due to drought.

"We have data for 2014, 2015 and 2016. We're looking for correlations but also how the information varies over the three years that we have data for," said Anderson. "If there are changes, what are they coming from?"

G2-MET Weather Station

NexSens Technology's cellular weather station features real-time wind speed and direction, barometric pressure, air temperature and relative humidity measurements in a fully integrated and easy to install package.

BY KEVIN STEVENS



Environmental professionals rely on powerful remote monitoring systems to record and transmit data from a variety of sensors in real time. In many applications, a complex data recorder is unnecessary and only adds to purchase, setup, and maintenance costs. For those looking to track reliable weather data, the new NexSens G2-MET Weather Station provides an innovative solution that lies at the crossroads of powerful and useable.

NexSens' innovative G2-Series redefines data collection by offering a lineup of easy-to-use products designed for specific applications, and the G2-MET is the latest addition to the rapidly growing G2 family. Designed and manufactured in the United States, the G2-MET delivers on its promise of durability and reliability.

The weather monitoring system vertically integrates the entire data collection process from sensor setup to online data viewing. Configured with an Airmar 110WX Ultrasonic Weather Station, the system records and transmits reliable wind speed, wind direction, air temperature, barometric pressure and relative humidity values directly to NexSens' WQData LIVE cloud-based data storage platform. This datacenter provides a mobile-friendly design and central location for data storage, analysis, project management, remote device configuration and automated alert notification.

A competitive price point and streamlined design that includes a pre-mounted solar power pack and cellular connected logger make the G2-MET

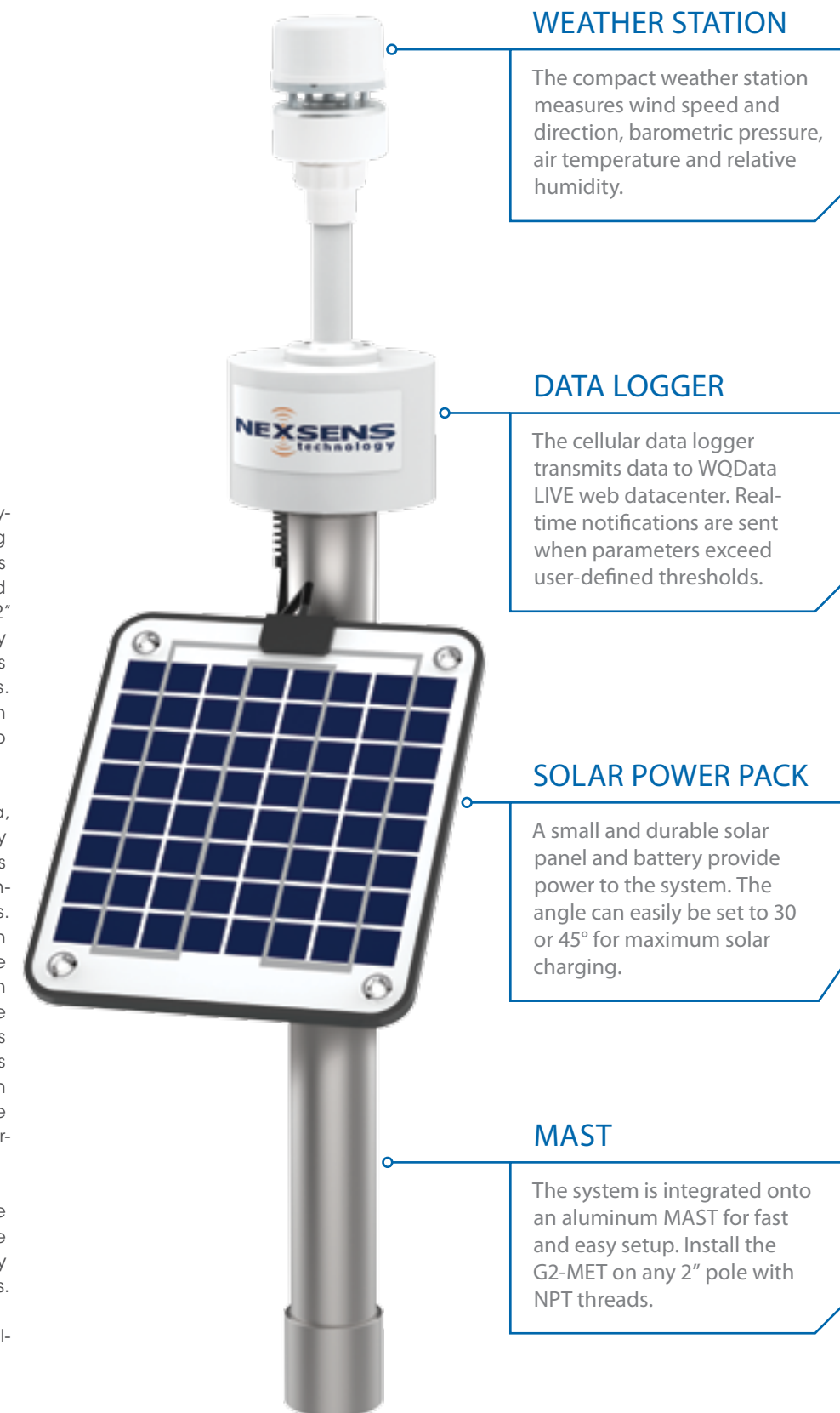
ideal for portable and long-term deployments. NexSens' Chief Engineer Doug Nguyen said, "Setting up the system is as easy as making two connections and threading the included MAST onto a 2" NPT pole. The device does not require any programming or setup, and data begins streaming to WQData LIVE in minutes. Application-specific adjustments can be made from a mobile phone or laptop after returning from the field."

Once the G2-MET is collecting data, WQData LIVE can be used to remotely change device setup and check its status. User-configurable alarm thresholds can be set to send data and alerts. This capability ensures quick notification of important weather events without the need for power-demanding connection intervals that drive up system price, size and complexity. "By designing in various power saving and innovative features such as this, the G2-MET is able to remain extremely easy to setup and operate while providing a fully-featured monitoring system for the user," said Nguyen.

With a simple interface, powerful feature set, and extreme duty housing, the G2-MET has the ability to deliver quality data in challenging monitoring situations.

Pricing and additional information available at fondriest.com/G2-MET.

All photos: NexSens Technology



WEATHER STATION

The compact weather station measures wind speed and direction, barometric pressure, air temperature and relative humidity.

DATA LOGGER

The cellular data logger transmits data to WQData LIVE web datacenter. Real-time notifications are sent when parameters exceed user-defined thresholds.

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A small and durable solar panel and battery provide power to the system. The angle can easily be set to 30 or 45° for maximum solar charging.

MAST

The system is integrated onto an aluminum MAST for fast and easy setup. Install the G2-MET on any 2" pole with NPT threads.

TOXINS IN REAL TIME

The National Oceanic and Atmospheric Administration has completed the first long-term deployment of ESPniagara, a robot measuring microcystin in real time.

BY DANIEL KELLY

It may have taken 20 years and \$20 million to develop, but Lake Erie researchers working to fight harmful algal blooms (HABs) now have a new tool to safeguard drinking water: ESPniagara. The advanced sampler has been called a "lab in a can" for its ability to sample microcystins, the most common algal toxin these days, in almost real time.

The big gadget's name is a mashup between "ESP," for environmental sample processor, and the name of Admiral Oliver Hazard Perry's ship during the War of 1812.

"We wanted to name it something that was significant to Lake Erie," said Tim Davis, molecular biologist and lead HABs researcher at the National Oceanic and Atmospheric Administration's Great Lakes Environmental Research Lab (NOAA GLERL) in Ann Arbor, Mich. "Niagara was the flagship that Admiral Perry used in our winning battle near Bass Island and we kept the Great Lakes through the rest of the war."

As the first ESP to be deployed in Lake Erie, the name is apt because it is in effect leading a charge that Davis and others are hopeful could one day lead to a network of the devices there. The lake's western basin is the target, as that's where the blooms are of greatest threat. Davis says that four ESPs, deployed in tandem with the lab's real-time monitoring stations in the basin, could provide enough data.

More measurements can surely help western Lake Erie researchers, but the real benefits are for those who manage drinking water withdrawn from the basin. With ESPniagara's ability to sample at the surface and at depth, it's possible to get data on microcystin no matter the conditions.

Davis told us how it all works following ESPniagara's very first deployment in Lake Erie. It began in early September and wrapped up in mid-October 2016.

You might expect that the device has to hover somewhere near the surface to sample algae, but it's a little too large for that. Instead it is mounted on a lander developed by scientists at the University of Washington that lets it sit on the lake's bottom. The lander has a three-way valve permitting samples to be taken at depth if winds near the surface are too great.

"That's important because most of the drinking water intakes around Lake Erie are at the bottom," said Davis. "It's really important to be able to look at both."

But given good conditions, sampling at the surface is achieved through a tube that runs from the ESPniagara to a buoy. This small platform holds a cellular modem, connected to the ESP via a communication cable, that relays microcystin measurements back to scientists at the lab.

"It's fully automated. It's essentially a robot," said Davis, describing some of the science at work inside the ESP. "It will analyze with the ELISA method, which is the same method we use in our labs and that drinking water systems use for raw and unfiltered water."

Compared to going out, grabbing a discrete sample and then taking it back to analyze, the ESPniagara saves an incredible amount of time. Davis estimates about two hours' turnaround time with more conventional approaches. What's more, it can stay deployed for more than two months, transmitting data at pre-defined intervals the whole time.

"We can sample every day," said Davis. "We can program it to sample as frequently or as infrequently as we need."

For its first long-term deployment, researchers set it to sample every morning at 10 a.m. The time just happened to coincide with regular runs to grab water samples from the same area. Davis and others are still going through the data collected, but the two sets are matching up well.



All Photos: National Oceanic and Atmospheric Administration

Tim Davis inspects the ESPniagara.




A topside buoy relays data from ESPniagara through a cellular modem and also supports a tube sampling 1 meter below the surface.

"Late in the summer, we see toxicity decline. A lot of our samples are below the detection limit," said Davis. "The preliminary data (from the ESP) have shown a good relationship between what we're seeing at our western Lake Erie sampling site on Mondays. Both sample sets have been below detection."

Up next for investigators at NOAA GLERL is to continue work to improve their microcystin assay. They are also partnering with scientists from the Woods Hole Oceanographic Institution to develop an assay to detect cells of microcystis. And hopes are to come up with a dual-assay in the future that can measure multiple toxins, including saxitoxins.

Much more further down the road, Davis is looking to take toxin data and use them to form models similar to those currently available for HABs.

"The one thing that we want to make clear is that there's no silver bullet. The ESP is a very powerful tool that we're using in concert with our HAB tracker and HAB bulletin," said Davis. "Right now we have models to predict blooms and if they'll be growing, but not toxicity. With this, we can get an idea of what the toxicity is at the surface or depth and let managers know. ... It also allows us to monitor at a frequency where we will be able to monitor microcystin."

Funding for ESPniagara was provided by the Great Lakes Restoration Initiative with monies made available following the Toledo Water Crisis. It is a second-generation device following in the footsteps of the first ESP developed at the Monterey Bay Aquarium Research Institute. The University of Michigan's Cooperative Institute for Limnology and Ecosystem Research is also assisting. Greg Doucette, a research oceanographer at NOAA's Center for Coastal Environmental Health and Biomolecular Research in South Carolina, developed the ESPniagara's microcystin assay. 

MARSHES AND RISING SEAS

North Carolina State University researchers use an unmanned surface vehicle to study organic matter and carbon flux in coastal marshes.

BY DANIEL KELLY



For centuries, coastal marshes have been steady storehouses of organic matter and the carbon it holds. But predicted shifts in sea levels and rising global temperatures signal a change is on the way.

"With sea level rise, the loss of marsh is meaning the loss of carbon," said Chris Osburn, associate professor of Marine, Earth and Atmospheric Sciences at North Carolina State University. "That carbon is on the verge of being released."

Osburn and others at the university, in partnership with the Bald Head Island Conservancy, are working to understand what such a shift will mean. In a work that's just begun, they are using an unmanned surface vehicle (USV) equipped with side-scan and swath sonar, a fluorometer and a water quality sonde to document carbon dynamics in Bald Head Creek. The idea is to take

findings and use them to develop a model of coastal marsh carbon flux that can be used for management and research in similar areas around the country.

The creek sits on Bald Head Island and is hemmed in by the Cape Fear River and the Atlantic Ocean. For the investigation, which is serving as a thesis project for master's student Cindy Lebrasse in Osburn's lab, Bald Head Creek is serving as a launch point.

"We're collecting the measurements we need to develop a coupled biogeochemical model of the system," said Osburn. "... For Bald Head Creek, that's one of our reference sites. It's the place where we're starting this work. Once we have the techniques down and a model of the system, we plan to apply it elsewhere."

A lot of data will need to be collected to get to that point, which is where all the tech comes in. The sonar on the USV capture the bathymetry of the creek along its side and bottom while the water quality sonde snags measurements of temperature, conductivity and dissolved oxygen. Data on colored dissolved organic matter (CDOM) and chlorophyll a are recorded by the fluorometer.

A GPS unit is also onboard to help manage the USV's movements. It's possible to program the craft to sample along certain lines based on location data. But that option isn't used much in Bald Head Creek because it's a small and somewhat crowded waterway.

"There's a camera on it so it can be piloted with a forward-looking view," said Osburn, discussing a recent sampling trip. "We were in a boat that served as a chase boat that helped us keep people away from it. There's lots of interested kayakers and paddleboaters around."

For future study sites, the unmanned surface vehicle's routine may be tweaked to best fit the water body it's sampling. One that may be visited is Barataria Bay, along Louisiana's Gulf Coast. It is a much more dynamic area than Bald Head Creek and could yield some interesting comparisons.

Investigators are keen to learn about a number of issues at play between the two marshes as well as others they plan to visit in the future.

"One thing is that the form of organic matter is an important influence on its reactivity. Dissolved organic matter has a wide range of sources and activities. How easy does it turn back to carbon dioxide?" said Osburn. "One thing we'll be doing is tracking how reactive carbon moves into and out of these systems and how that varies with different parameters."

A hope for the work is to figure out a range for that reactivity. Another issue, Osburn says, is that the flux into and out of

"ONCE WE HAVE THE TECHNIQUES DOWN AND A MODEL OF THE SYSTEM, WE PLAN TO APPLY IT ELSEWHERE."

-Chris Osburn
North Carolina State University

adjacent marshes is very poorly understood. He is looking to gather enough data to inform a model that can constrain a better range than other methods.

"One of the questions we've been trying to understand is coastal marshes — do they store or expel organic matter?" said Osburn.

More uncertainty is introduced by the sheer amount of carbon that can be exported from coastal marshes each year, anywhere from 15 to 330 grams per meter squared.

"In terms of the export of dissolved organic carbon, that's a 20-fold range," said Osburn. "Understanding what influences that range is something that we need to do."

At this stage, scientists are mostly still gathering data. But Lebrasse is planning to present some early findings at the next meeting of the American Geophysical Union. And Osburn says efforts to get the USV sensor package into other coastal marshes are ramping up.

"Our plan is to use it around the Gulf of Mexico in a variety of coastal environments. We want to use this technique to quantify carbon moving out of coastal estuaries across gradients of the environment in which sea level rise might be higher or lower," said Osburn. "We also have an ADCP (acoustic doppler current profiler) we intend to deploy to help with water flow, current velocity and direction (data)."


Funding for purchasing the unmanned surface vehicle was provided by the National Science Foundation through a grant to NC State's Center for Marine Sciences and Technology (CMAST). Additional support comes from the North Carolina Sea Grant and an innovation grant from North Carolina State University in partnership with Bald Head Island Conservancy. All data gathered in the effort will be shared with officials at the conservancy for use in advocating for the conservation of coastal estuaries and saltwater marshes. Del Bohnenstiehl, an associate professor in Osburn's department, is also assisting in the work. 

Photo: Cindy Lebrasse / North Carolina State University

MOBILE MICROBES

Yet another mystery of Lake Huron's sinkholes comes to the surface, as scientists find microbial mats that move with startling speed to find light.

BY DANIEL KELLY



No matter how long researchers study them, the mysteries of Lake Huron's sinkholes seem to persist. Case in point: microbial mats that inhabit them can actually move to maximize their photosynthetic potential. What's more, these mats can move together so quickly that it's possible to see their new positions without scientific equipment.

"You don't normally expect microscopic organisms to move a distance you can see with your naked eye in a relatively short amount of time," said Bopi Biddanda, professor of water resources at Grand Valley State University, who has been studying the lake's sinkholes for years. "They move at the same body lengths per minute (around 10 to 20) as a swimming human."

Diving expeditions to the sinkholes, with help from staff at the Thunder Bay National Marine Sanctuary, provide water samples containing the microbes. Analyzing them is achieved with microscopes back in the lab, even though the startling movements can be observed without much difficulty.

With that approach, Biddanda and other researchers have tried out some novel treatments to see how the microbial mats respond to light. In one, dive teams placed pebbles and pieces of broken shells in altered locations within the Middle Island Sinkhole. Within hours, the structures were fully buried as the microbes sought to reclaim their positions.

In another test in the lab, they cut out a question mark in aluminum foil to see if the organisms would migrate into the

shape. After just 30 minutes in normal laboratory light, they got their answer.

If it's not neat enough that these microscopic organisms move as fast as they do, Biddanda notes that they play an important role as carbon buriers in the sinkholes. All their shifts help to move fallen debris down into the anaerobic layers of sediment.

"Our observations suggest that intricately coordinated horizontal and vertical filament motility optimize mat cohesion and dynamics, photosynthetic efficiency and sedimentary carbon burial in modern-day sinkhole habitats that resemble the shallow seas in Earth's early history," said Biddanda.

The findings may also have implications for the present-day understanding of cyanobacteria because they reveal in part how the communities may have come to colonize our planet's waters. Biddanda says that the modern-day motility that the cyanobacteria have may also give them the ability to thrive under low light and bury organic carbon more efficiently. The sinkholes in Lake Huron, he adds, are effective carbon sinks.


More results of the work, as well as some of the additional methods used, are published in *Frontiers in Microbiology*. Continuing research into the microbial mats, Biddanda says, involves micro-profilers that are taking in-situ measurements of the mats' surrounding sedimentary ecosystems. 

Photo: Grand Valley State University

Photos: Bopi Biddanda / Grand Valley State University

NATIONAL FOREST WATER CYCLES

Scientists at the University of Wyoming lead an effort to dissect evaporation and transpiration in the mountains of Medicine Bow National Forest.

BY DANIEL KELLY

For Daniel Beverly, a doctoral student at the University of Wyoming's Center for Environmental Hydrology and Geophysics, researching in the mountains has its perks. Like skiing or riding snowmobiles to monitoring sites when it snows. But when there's not much snow, things are a little different.

It's pretty much always windy near the top of the mountains in Medicine Bow National Forest. Beverly, along with others from the university who are researching the movement of water through the region's trees, know this first hand. The gusts at high elevation are so strong that they can blow monitoring stations completely over.

"At one tower right above that, above the snow field, there's no soil up there," said Beverly, telling us about one of his stations that encountered heavy winds at around 12,000 feet high. "The wind just ripped it out. Our record (measured by their equipment) is 138 miles per hour. Of course, when the tower was down, we measured 600 meters per second (more than 1,340 mph). That was clearly an instrument malfunction."

High wind speeds weren't much of a surprise. But Beverly says that he wasn't prepared for the sheer kinetic energy that wind can produce on mountaintops.

He and other investigators are essentially trying to document the movement of water from the atmosphere through the trees and then on to the groundwater below. They are also looking to see what insights may be gleaned from the impacts that bark beetles have had on trees there.

"Our major objective is to quantify the transpiration and evaporation occurring through different ecosystem types," said Beverly. "Almost all have been impacted by bark beetles and we're trying to determine how they've changed. ... If we can establish how bark beetles have impacted the area, along with climate change impacts, we might be able to estimate available water downstream."

To get there, Beverly and others are using seven monitoring sites throughout the forest equipped with sensors that can gauge solar radiation, vertical wind speed, precipitation, temperature and other parameters. There are also sensors deployed for tracking changes in snowpack, radiation as it comes in and goes out, and soil heat flux. Many of the trees are equipped with sap-flow sensors.

"Sap flow is one of the methods we use to get a transpiration rate, which is separate from evapotranspiration," said Beverly,



Sensors track dynamics of soil, weather and solar radiation in Medicine Bow National Forest.



All Photos: Daniel Beverly / University of Wyoming

"so that we can partition water use in the plants from the total ecosystem."

Beverly says a flux tower downhill, sitting at elevation in the forest, is also helping to capture carbon and water flux. The team is likewise relying on images from NASA MODIS and Landsat satellites to look at changes in vegetation. And there's talk of soon deploying a drone for data collection from the sky.

Data from the flux tower are being compared to measurements from another in Fort Collins, Colo., managed by the Glacier Lakes Ecosystem Experiments Site (GLEES). It has been around since the 1990s, whereas the one in Medicine Bow National Forest began collecting data around 2014.

Bringing all that data together so far, Beverly does have a few insights to share.

"We're observing the same thing that's been observed in Colorado. There's not any actual increase of discharge post bark beetle," said Beverly. "But unfortunately we didn't have any sites up before the bark beetle outbreak, so we can't argue how land and water use has changed. But we are seeing different levels of transpiration as elevation increases."

"... WE ARE SEEING DIFFERENT LEVELS OF TRANSPIRATION AS ELEVATION INCREASES."

-Daniel Beverly
Center for Environmental Hydrology and Geophysics

A lot of that is because there are different species of trees that dominate at different elevations. As you move up the mountains, there's a transition, he says. Still, there isn't a huge contrast in water use between the two zones.

"Trees aren't as stressed in high-elevation conditions, but the growing season is so much shorter that the total water use is not that different," said Beverly.

Plans are to continue the effort for several years to come. All data, along with measurements to be taken in the future, are remotely telemetered and posted on the Center for Environmental Hydrology and Geophysics' Data Discovery Tool online. Beverly's advisor in the work is Brent Ewers, professor and director of Wyoming EPSCoR. Funding is being provided by National Science Foundation Grant EPS #1208909.

LAND OF NEWBORN LAKES



University of Montana scientists embark on an investigation of young lakes in Glacier National Park's Sperry Basin to learn how freshwater food webs form.

BY DANIEL KELLY

Most folks don't question why a lake sits where it is. But at some point in our planet's history, it's safe to assume that the water body didn't exist. Something had to have happened to bring about its creation and stable status as a freshwater ecosystem.

Observing such a transition is incredibly difficult, as we don't live long enough to view planetary timescales as they shift and mold our world to create new terrains and ecosystems. But things are getting easier nowadays, thanks to new technologies and a globally connected world that allows the scientists of today to access more of the Earth's wonders.

Clearly one of those is Glacier National Park, a beautiful place to study with lakes that just may hold answers to questions related to the birth of our freshwater treasures. Interestingly, water bodies in the park, many of which are so untouched that they remain unnamed, are in a developmental sweet spot that may offer scientists the chance to see what happens when a lake begins to shift from giant puddle to bustling ecosystem.

Photo: Jim Elser / University of Montana

In a work that is just beginning, investigators with the University of Montana and U.S. Geological Survey have recently sampled lakes in the Sperry Basin of the national park. Their efforts rely on simple techniques and gear at this point, but with a little luck and funding, they hope to ramp up study of the lakes to learn more about the critical point their food chains begin to develop.

"We're most interested in the colonization of different parts of the food web. When we were there, we couldn't hardly see any (plankton) at all. There's not a lot of zooplankton yet, and some of these lakes are 40 or 50 years old," said Jim Elser, director of U. of Montana's Flathead Lake Biological Station. "The question is how long does it take to amass a pelagic food web."

Elser likes to say that his recent trip to Glacier National Park was like a trip back in time to the Pleistocene when there was no one around to sample lakes. The expedition this past summer was the first to the study site, which holds six shallow water bodies of interest to the crew that includes the U.S. Geological Survey's Joe Giersch and Clint Muhlfeld.

Muhlfeld is a research ecologist with the agency while Giersch is an aquatic entomologist. Both have done extensive studies in the park before. For Giersch, the Sperry Basin lakes are just a stone's throw from other water bodies he's researched to help protect the western glacier stonefly, a rare, endemic insect threatened by glacier loss.

Both were useful guides for Elser's trip — Giersch has some excellent maps showing the lakes going back to 2000 — and each also helped with sampling the lakes. Those efforts involved gathering discrete water samples for chemical analysis back in the lab. Plankton nets were also used, as well as handheld water quality meters that tracked parameters including temperature, pH, dissolved oxygen and conductivity.

"They're pretty dynamic water bodies and there are lots of things to be done here to understand how lakes were like when they first formed," said Elser, noting that some of the glacial flour-filled lakes have shifted color since Giersch's maps captured them. They were once a bright turquoise but are now a clear blue.



"...The only data I've looked at so far is from the meters, and the conductivity is extremely low. That's not surprising because there's nothing in the water. Conductivity is a reflection of all the things dissolved in the water, from rocks, soil substrate, atmospheric deposition, and these waters are extremely fresh."

The levels were about 10 times lower than what he's used to seeing, Elser says, and he is eager to make more discoveries into the lakes' processes. In the future, he'd like to instrument the water bodies with in-situ sensors that can gather data over the long term.

But since the lakes are located in a national park, there are likely restrictions on the gear that researchers can deploy. And tackling the water bodies' food webs is tough because each of the lakes are only about 3 to 5 meters deep. A profiler is pretty much out of the question.

"I wonder if they even stratify. I don't know," said Elser, adding that the crew didn't take a boat along for that first trip.

To answer that and many other questions, he is going to need some help from researchers who are doing similar work. So far those folks have proven hard to find, but Elser has a few lines out with researchers in China and Tibet. There are also some scientists at the University of Maine who have useful expertise.

"Researching these water bodies will advance our understanding of how the history of lakes comes about," said Elser. That will aid understanding of the Sperry Basin lakes and other freshwater bodies in a future of predicted climate changes. "This is the water capital of the western U.S. and the functions of lakes and streams are going to change. What roles do these lakes play in contributing to downstream water quality?"


Elser is also interested in learning more about the lakes' relationships with nutrients like nitrogen and phosphorus, as well as their contributions to carbon dioxide in the atmosphere as the glaciers around them melt. 

Photo: Jim Elser / University of Montana

UNDERSTUDIED LAKE CHAMPLAIN

A lake data buoy recently launched on Lake Champlain by State University of New York scientists is aiding research, education and weather forecasting.

BY DANIEL KELLY



Since the 1990s, manual sampling trips on Lake Champlain have gathered data on its dynamics every few weeks. But the measurements they've gleaned are sparse when you consider faster-paced changes that the lake could see in a future of predicted climate upheaval.

To help fill that gap and meet a host of other needs, scientists at the State University of New York (SUNY) – Plattsburgh have deployed a new lake data buoy on the water body. It is only the second such monitoring platform launched in Lake Champlain, after another that logs in Missisquoi Bay.

The new cellular data buoy, sitting not far from Valcour Island, is providing previously unavailable data on the lake in real time. These are helping research and education at the university, while also helping to improve National Weather Service forecasts and making things a little safer for local fishermen.

"One of the things we're looking at is whether or not the monitoring we're doing on Lake Champlain is adequate enough to pick up climate change," said Eric Leibensperger, assistant professor of environmental science at the university. "... Another aspect is that we don't have that much open-lake buoy data. There was a buoy in Missisquoi Bay, but this one is in the main part."

The location gives investigators a prime spot to track how its thermocline changes, which they're doing with a NexSens TS210 thermistor string. It runs from the water's surface all the way down to the sediments and is a whopping 50 meters long. Additional data on the water's temperature, pH, dissolved oxygen and conductivity are gathered by a Eureka multi-probe.

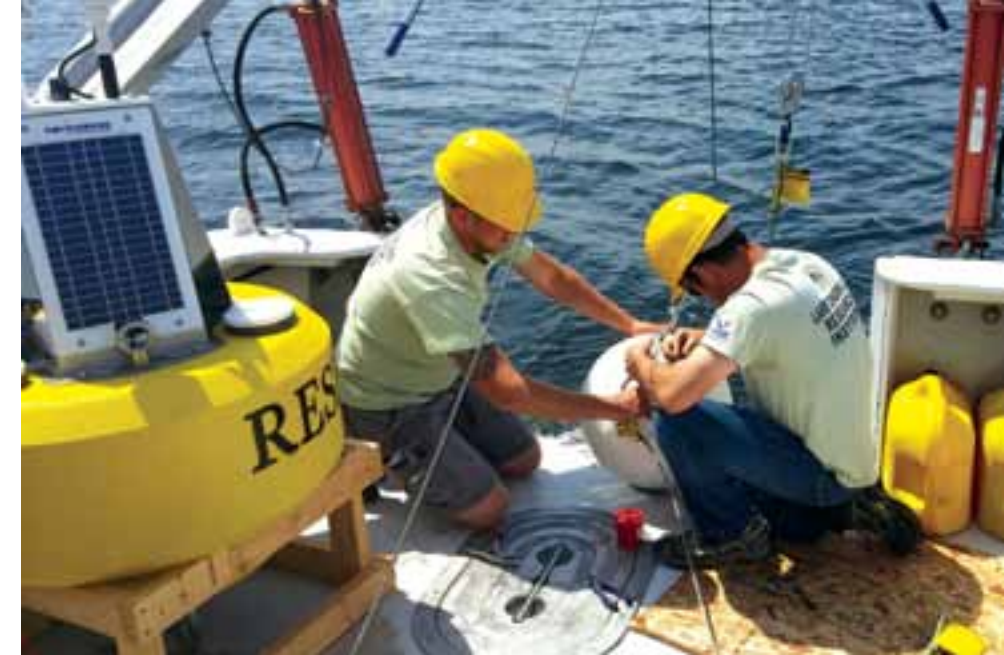
Leibensperger says that previous efforts to document Lake Champlain's thermocline only reached from the sediments to 6 meters below the surface. And the data he shared with us showed in great detail the extreme fluctuations that the lake can experience thanks to wind and an active seiche.

"In a particularly windy storm, the thermocline can mix — right now it's around 13 to 15 meters — but it fluctuates a lot, on the order of 20 to 30 meters," said Leibensperger, comparing what's going on now to the previous effort that relied on a marker buoy and the short thermistor string. "We have the weather measurements, so now we can relate those changes in wind speed to changes in the thermocline depth."

Those wind speed and direction measurements are gathered by an Airmar 200WX weather station that also logs data on air temperature and barometric pressure. They are proving useful in helping an ongoing investigation at the university that's looking to learn more about the dynamics of zooplankton movement.

The work has SUNY – Plattsburgh researchers going out periodically with plankton nets to sample above and below the thermocline.

"This is not my specialty, but they (zooplankton) move up and down to find food and hide from predators. We can look at the depth of the thermocline and relate it to those biological



Preparing the data buoy for deployment.

samples we're extracting," said Leibensperger. "The buoy is also close enough to our boathouse so we can take classes out."

In addition to those research and educational uses, measurements from the NexSens CB-450 lake data buoy are helping National Weather Service forecasters who previously didn't have enough data on air temperatures, water temperatures and wind speed to calibrate their models. The improved forecasts mean that fishermen and boaters who go out on the water don't have to wonder as much about the accuracy of weather estimates.


"I kind of see it as a win-win-win situation. We use it for research purposes as well as lake management. It helps the National Weather Service, but also aids public safety," said Leibensperger. "Data are used a lot by local anglers. Local fishermen regularly visit our website to see conditions on the lake. We've had success in reaching a lot of different people."

Measurements from the lake data buoy are available on Leibensperger's university website. The portal showcases current conditions the buoy is reporting and features graphing tools that make it possible to view historical data.

The open accessibility is a step in the right direction, as it's odd to hear that data are lacking on Lake Champlain. Despite being one of the more famous lakes in the United States, Leibensperger explains that the water body is in a tough spot.

"It's kind of in that region where it's well studied and not well studied at the same time," said Leibensperger. "We could use a lot more data than we have."

In the future, researchers are looking to upgrade the weather sensor to also gather data on solar radiation and humidity. Knowledge of those parameters could permit the development of an energy budget for the lake.

Funding for the cellular data buoy was provided by the Lake Champlain Sea Grant and the Lake Champlain Research Consortium. 

Photos: Chad Hammer / State University of New York – Plattsburgh



Researchers tend to Philadelphia rain garden sites using water level meters and soil probes.

PHILADELPHIA RAIN GARDENS

Villanova University scientists track water movement through rain gardens in Philadelphia in a bid to improve their future design and performance.

BY DANIEL KELLY

Managing stormwater is a concern in cities all across the United States because of its tendency to overflow drains which are linked directly to nearby waterways. This is especially true when the rains come down hard, overloading storm drain systems and sending pollutant-heavy runoff down the line.

Solving the problem isn't easy, but rain gardens have shown to be particularly useful in reducing the amount of runoff that makes it into drains.

Researchers at Villanova University are testing out the potential of rain gardens in an ongoing partnership with the Philadelphia Water Department. Their efforts are part of the Villanova Urban Stormwater Partnership and are being funded by a U.S. EPA Science To Achieve Results (STAR) grant.

"We are assessing the performance of green stormwater infrastructure sites which have been built in Philadelphia over the past five years as part of the Green City, Clean Waters initiative," said Cara Albright, doctoral candidate in the department of civil and environmental engineering at the university. "We are looking at these from a volume reduction perspective and using our findings to make recommendations for the next generation of designs."

Albright says there is instrumentation at four different sites in Philadelphia to record rainfall as well as other meteorological conditions. She and other researchers are also tracking water at the inflows and outflows of each garden in addition to water depth and soil moisture.

The sites were first instrumented beginning in August 2014, Albright says. The most recent one was set up in August of this year.

"The study is mostly looking at the volume of stormwater runoff being collected by these sites, and how that can be optimized in the future," said Albright. "We don't collect samples or analyze anything for water quality. It is strictly a water quantity study."

Sites are tested by applying simulated storms and then assessing how each garden does. These simulated runoff tests involve using fire hoses to apply metered hydrant flow to the systems and simulate a storm of a specific duration, volume or intensity.

Albright says the simulations help researchers to verify that their instrumentation is working properly and to judge how the rain gardens are performing. If the installations are underperforming, investigators look to discover design changes that could be made in the future to save money in construction and maximize performance over time.

A considerable amount of data have been gathered so far, even though the project is slated to continue for another year and a half.

"We are trying to learn more about the processes involved in green infrastructure, specifically infiltration and evapotranspiration, and how these processes can be maximized in order to keep the most runoff out of the streets," said Albright. "The idea is to take runoff from impervious surfaces and direct it up via evapotranspiration or down through infiltration to prevent flooding and combined sewer overflows; this study will be very important for the future of green stormwater infrastructure design in urban areas."

The collaborative nature of the project also affects how the findings are getting used. And a lot of what comes out of the work is going to help drive changes to Philadelphia's green stormwater infrastructure design and maintenance.

"There are a lot of challenges with green infrastructure in the urban environment having to do with maintenance of the sites, so we are using the data to inform future maintenance practices as well," said Albright. ☑



All Photos: Villanova University

CONDUCTIVITY AS A TRACER

University of Minnesota researchers find that using conductivity as a tracer is more cost-effective and straightforward than other methods.

BY DANIEL KELLY

Many studies tracking the movement of groundwater these days rely on the use of isotopes, such as those of oxygen and hydrogen, to gauge where the water's from. That method involves taking water samples manually and then lugging them back to the lab for analysis. But there may be another way, say scientists at the University of Minnesota. They've found that using specific conductivity as a tracer holds a lot of promise.

Chris Lenhart, research assistant professor in the university's Department of Bioproducts and Biosystems Engineering, thinks he knows why using conductivity as a tracer hasn't caught on nearly as much.

"People have seen it for a while. It's not a brand-new, cutting-edge method," said Lenhart. "People think, 'Yeah, yeah, I learned about that in Limnology.' Isotopes are more awe-inspiring." However, relatively, new data loggers allow for the collection of tens of thousands of data points in a season, allowing researchers to clearly distinguish water sources.

He first noticed just how useful the parameter was in tracing groundwater movement while out in the field with Joe Wagner, research professor in the same department. They were working

at Elm Creek in southern Minnesota, gathering measurements with a YSI probe.

Lenhart started to see that the conductivity measurements coming in were correlated with the water source. For those data that were around 0-20 microsiemens per centimeter (uS/cm), it was safe to assume they were coming from fresh rainfall. For measurements in the range of 50 to 400, that was more recent runoff.

"The thing is that, in the soil, water picks up cations and anions and there's a real clear delineation between groundwater, tile flow, rainfall and recent runoff," said Lenhart. "From tile drains, it's somewhere around 600 to 800 uS/cm with groundwater over 1,200 uS/cm in calcareous glacial till typical of much of the northern parts of the Midwest."

He and other researchers in his lab have used conductivity as a tracer successfully in several studies. In a following investigation for the Minnesota Department of Agriculture, part of which took place in Elm Creek, investigators assessed hydrological processes in relation to increased rates of stream bank erosion.

Part of that study was dissecting water sources in the flows of streams under consideration. Solinst LTC Leveloggers, deployed in shallow monitoring wells, gathered data on level, temperature and conductivity to inform observations.

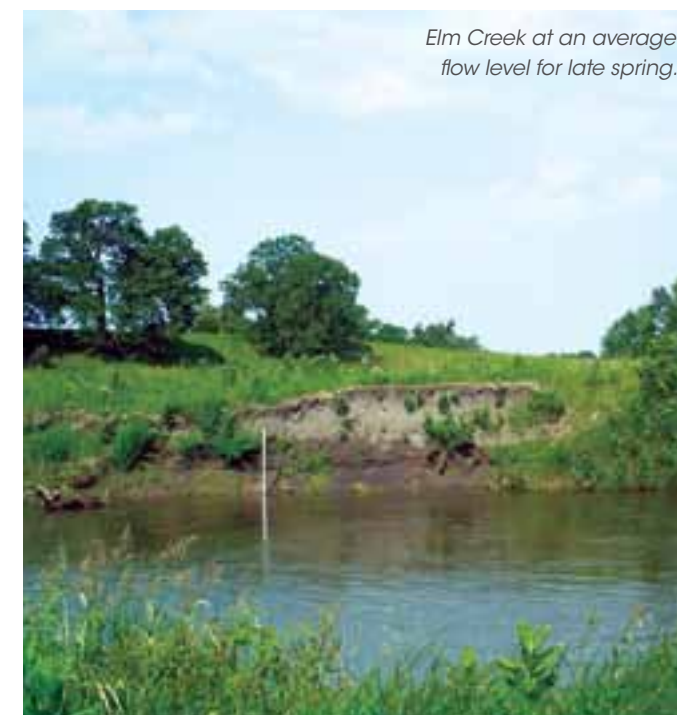
"In these agricultural areas with the upper to western part of the Midwest, there has been a lot of increased flow in rivers. And people wanted to know how much tile drains were contributing to erosion. People have been debating that issue for a long time," said Lenhart. "For Elm Creek, we looked at the flow sources and calculated that, on an annual basis, about 70 percent of the river flow had come from tiles in 2014." Although the highest flows cause the most erosion, he says, the increased volume of flow contributes to higher flows across the board and more frequent initiation of erosion in the channels.

That number (70 percent) was larger than expected, Lenhart says, while noting that it made sense because of the widespread nature and increasing density of tile drains in the watershed.

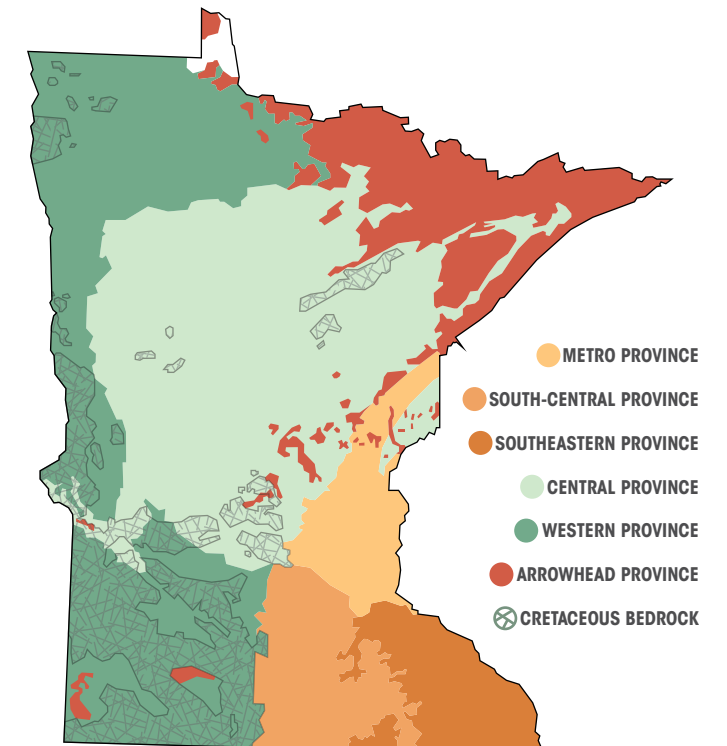
Lenhart and others have used conductivity as a tracer in a few other investigations. These include a look at the rainfall responses of experimental stands of black ash trees in northern Minnesota and the variability of flows in a subsurface-drained landscape in Iowa. Other scientists from the U.S. Geological Survey's Utah Water Science Center, he says, have used the approach successfully on snowmelt-dominated streams in the Colorado River Basin.

But still, there are some important limitations to note when using conductivity as a tracer. There is a lot of variability in the conductivity values that can emerge. Likewise, it's important to consider that baseline levels of conductivity can change depending on the region.

"If you know the range of local values, you can use it successfully," said Lenhart. "... In some ways it's more simple than other approaches, but regionality is an issue."



Elm Creek at an average flow level for late spring.



Minnesota Groundwater Provinces.

That's because soil properties and geologic setting vary from area to another. Variables like glacial till or karst systems can influence what conductivity baselines are. Other complicating factors include treatments for snowy roads, which can introduce a lot of salinity, a parameter close to conductivity.

"There are some things that can mess that up and can spike the conductivity numbers, such as road salt. But in rural areas, it has worked pretty well," said Lenhart. "... It's not a silver bullet. It does give you a lot of data, but it's probably best used in concert with other approaches. We're also doing isotopes and flow monitoring to identify water sources."

So what can be done to spur the adoption of using conductivity as a tracer? The benefits the approach offers, such as more data and lower costs, haven't yet edged it into the monitoring mainstream.

Lenhart says it could start with government agencies making conductivity data standard measurements at their sites. He notes the U.S. Geological Survey gathers data at some of its streamgage sites, depending on the needs of different investigations. But something like deploying a conductivity logger with stream gauging sites or new drainage control structures when they're installed could provide some outstanding insights.

"Once you build up regional water data sets, soil and water conservation districts (SWCDs) might start using them and applying them in their own situations," said Lenhart. "It's something that doesn't have to be done everywhere since a few long-term studies can serve as a benchmark for a region. But with local stormwater managers and SWCD stuff, just providing education and training could spread more use since it is a cost-effective and straightforward technique."

Photo: (left) Chris Lenhart / University of Minnesota; (map) Nate Christopher based on data from Minnesota Department of Natural Resources

Photo: Tim Kiser / CC BY-SA 2.5



BUOY ON A MISSION

Researchers at Ohio State University's Stone Lab gather algae measurements using a cellular data buoy with the goal of one day predicting bloom toxicity.

BY DANIEL KELLY

Scientists at Ohio State University are at the fore of the fight against harmful algal blooms in Lake Erie. In fact, they deployed a new cellular data buoy off the shore of Gibraltar Island in 2014, months before the Toledo Water Crisis spurred a boom in monitoring platforms around the lake.

That was in part because researchers at the university's Stone Laboratory, backed by Ohio Sea Grant and housed on Gibraltar, had been seeing a resurgence of blooms in the lake long before international attention came around following the crisis. There was an opportunity, they saw, to continue advancing the mission of research, education and outreach on Lake Erie. The cellular data buoy complimented that in a great way.

While it's in the water, the NexSens CB-800 data buoy platform donated by Fondriest Environmental helps gather important measurements on weather and water quality. These are achieved through a Lufft WS600 Multi-Parameter Weather Sensor, YSI EXO2 Multi-Parameter Water Quality Sonde (funded by Ohio Sea Grant) and two NexSens T-Node FR thermistors. These connect to a cellular data logger housed within the buoy.

The solar-powered platform is deployed most of the year, but gets pulled in the winter due to ice formation on Lake Erie. During the sampling season, its weather sensor provides measurements on air temperature, barometric pressure, wind speed and direction, humidity and precipitation. The sonde chips in dynamics of water temperature, conductivity, depth, pH, turbidity, dissolved oxygen and total algae. Thermistors track water temperatures at the surface and 1 meter.

The cellular data buoy's location near the island is key, as it gives scientists an ideal spot for gathering water samples to verify algae data.

"... We can take small boats to the buoy several times a week to collect a water sample adjacent to the buoy and compare that to the data recorded by the buoy," said Justin Chaffin, research coordinator and senior researcher at Stone Laboratory. "This will allow us to answer the question, 'How well does the buoy work at tracking blooms?'"

During the 2015 algal bloom, he notes that data on cyanobacteria biomass and that found in water samples were highly correlated. The find is not only good for the buoy near Gibraltar, but others around the lake that carry similar algae-sensing equipment.



"We are vetting the buoy measurements against water sample measurements. Initial data suggests that the buoys work very well for tracking cyanobacteria biomass," said Chaffin. "The next step would be to compare buoy data to water sample microcystin (the toxin produced by cyanobacteria) concentration data. We are researching if buoy data can be used to help predict toxicity of blooms."

The positive implication from that knowledge is that data buoys serving as early-warning systems for algae blooms near water treatment plant intakes are providing reliable information to drinking water managers. Chaffin notes that the buoy at Stone Laboratory serves as an early-warning system for treatment plants in the Bass Islands region of Lake Erie.

Measurements from the platform are transmitted by the cellular data logger every 15 minutes to a NexSens WQData LIVE web datacenter where researchers can view them in real time. The data are also shared with the Great Lakes Observing System (GLOS) so that scientists around the entire basin may use them.


The GLOS portal also includes data from other buoys and water intake pipes around the basin used by plant operators to adjust treatments as appropriate. Measurements are also posted to the Stone Laboratory website to make another avenue for easy public access.

"The third mission of Stone Lab is public outreach. Every person that visits Gibraltar Island, the island home of Stone Lab, passes by the buoy en route from South Bass Island to Gibraltar Island," said Chaffin. "This simple piece of the program allows us to show to the public the what, how, and why these data buoys are used by researchers and agencies to track water quality."



Ohio State University researchers get ready to deploy a data buoy near Lake Erie's Gibraltar Island.

Chaffin notes that data alert the public about conditions in the lake and any algal blooms that are present. Importantly, the measurements also let people know where there is no algae.

"Blooms only occur in a small percentage of the lake for a short duration. Data showing that the lake is bloom-free is just as important as data showing the presence of a bloom," said Chaffin. "Lake Erie is a great lake, not just in size, but in greatness. It is important to convey the greatness of Lake Erie and not dwell on the blooms." 

DATA BUOY SYSTEM

The Stone Lab buoy system is centered on a NexSens CB-800 Data Buoy that is an ideal platform for standing up to wave action in Lake Erie's western basin. Deployed just off the shore of Gibraltar Island, the buoy supports three 10-watt solar panels, a rechargeable battery pack and internal data logger.

On top of the platform is a solar marine light to alert boaters of its location, as well as a Lufft WS600 Multi-Parameter Weather Sensor tracking air temperature, barometric pressure, wind speed and direction, humidity and precipitation. Beneath the water, mounted securely in a deployment pipe, is a YSI EXO2 Multi-Parameter Water Quality Sonde. It measures a number of Lake Erie dynamics, including temperature, conductivity, depth, pH, turbidity, dissolved oxygen and total algae. Nearby on a buoy cage are two NexSens T-Node FR Thermistors. One gauges temperature near the surface while the other tracks it at 1 meter.

All sensor data are recorded by the NexSens SDL500C submersible data logger inside the buoy. Equipped with cellular telemetry, this logger beams all of the measurements back to researchers at Ohio State University who view them in real time through a NexSens WQData LIVE Web Datacenter. Data are also published to the Stone Lab website for public access.



Photo: Nate Christopher / Fondriest Environmental

Photo: Ohio Sea Grant



WEATHER BIKES

Photo: Eric Pedersen / University of Wisconsin

Researchers using weather bikes tap into their potential for studying urban heat, air pollution and the effectiveness of green infrastructure.

BY DANIEL KELLY

Bikes are one of the most time-tested methods of transportation. People have been riding them for centuries. But it has been only recently that folks started strapping on high-tech sensors to turn bikes into mobile labs for studying things like air pollution and the urban heat island effect.

These weather bikes provide the ultimate in data collection for some studies. This is because they're not limited to a specific area. Their riders can weave and dodge through traffic, steer down alleyways or wheel through regions with or without vegetation. There are all sorts of dynamics at play that stationary sensing devices just can't capture.

"By having it all in one mobile, portable setup, we can cover a greater area of the city," said Carly Ziter, doctoral student in zoology at the University of Wisconsin who is using a weather bike around Madison. "We can reach areas that aren't accessible by other methods. It also avoids issues with leaving expensive equipment throughout the city. The advantage is that you can take it all with you."

We recently spoke with Ziter and a few other scientists who are leveraging the potential of bikes as platforms for mobile research. These include Steve Hankey, an assistant professor of urban affairs and planning at Virginia Tech, and Paul Coseo who is an assistant professor at The Design School at Arizona State University.

Each clued us in on how they're using or have used weather bikes to research important issues facing cities around the U.S. Urban heat island is a big one, but investigators are also tackling small-scale air pollution and the effectiveness of green infrastructure.

A big thanks to Nick Rajkovich, assistant professor of architecture at the University at Buffalo, who gave us the scoop on these researchers after telling us about his efforts to study urban heat island in Cleveland using bike-mounted sensors. His work, which we covered on our news site, spanned urban and rural regions and revealed that air temperatures were often lower near water or trees, an expected find. But there is still more he'd like to learn about the impacts of cars and industry on the city's heat island effect.

Photo: Carly Ziter / University of Wisconsin



This bicycle-mounted temperature sensor provides an efficient, cost-effective way to study fine-scale variation in the urban heat island.

TRACKING URBAN HEAT ISLAND

Questions on vegetation are at the heart of Ziter's research in Madison, Wisc., a city known for its lakes with a slightly smaller population than Cleveland. That could change in the future as Madison's population continues to grow, introducing a host of new issues land managers will have to contend with.

She has been riding her weather bike around the city for the past year, gathering measurements on temperature and solar radiation. The data are adding to a repository of knowledge collected by static sensors that other researchers at the university have deployed.

These were launched by Chris Kucharik, professor of agronomy at the university, and Jason Schatz who is a postdoctoral researcher there. They've amassed around four years of research on urban heat island in the city as part of the Water Sustainability and Climate Project.

Along the way, they and others have found that the growing season within urban Madison is about a week longer than rural areas surrounding it because of extra heat. But the parks within the city have an effect that normalizes the average length of the growing season in the city to be more like that of its rural counterpart.

"We're building on those long-term efforts and trying to fill in the gaps to see what's driving temperatures," said Ziter. The bike is



PhD candidate Carly Ziter uses a bicycle-based temperature sensor to collect data in Madison, Wisc.

a great way to do that since it can cover all the areas that the stationary temperature sensors can't.

In addition to its pyranometer and Campbell Scientific rapid-response temperature sensor, its payload includes a GPS which is important for keeping track of where measurements are taken.

"It's all wired to a data logger and battery and we program it on a computer to take measurements every second as we're riding," said Ziter. "It's actually portable. You can move it from bike to bike as long as you have a standard bike rack."

That's something we haven't commonly seen on other platforms, and the portability means that multiple riders can use the equipment to gather data around Madison. Most of these rides have taken place during the day, but Ziter says a few have been done at night.

She and others are seeking to get a high-resolution dataset of the region's temperature dynamics, no matter where they have to take the bike.

"There's the urban heat island effect inside the city but we understand that temperatures don't just differ between the city and the surrounding area. There are differences within the city itself," said Ziter. "We want to fill in gaps between urban forests, parks and trees. By capturing data at a rapid rate, it allows us to capture the data we need at a fine scale."

When winter set in, bike rides weren't as frequent as they were in the summer. And the time typically spent riding started going toward analyzing the data that's been gathered.

Ziter doesn't yet have concrete findings to share. But there are a few trends that have started to take shape.

"There's a lot of variation in temperatures and a lot is driven by the canopy. We're starting to tease out the details of that," said Ziter. "We know trees are important, but is there a certain number or density, or a period when we should be planting?"

That there has been so much variation isn't a surprise, but Ziter admits she was a little taken with just how quickly temperatures can change over a short distance. It may be that vegetation is an important consideration, as previous research by Kucharik and others has shown.

But more work needs to be done to nail down the finer points of what that means exactly. There is a strong correlation between temperatures and vegetation, she says, but previous works haven't yet determined how important different vegetation types can be. Hopes are that rides on the weather bike can reveal the dynamics at play.

"We know that urban heat island is becoming more important as people move into cities. And we are expecting more heat with climate change," said Ziter. "... It's important to remember that

BY CAPTURING DATA AT A RAPID RATE, IT ALLOWS US TO CAPTURE THE DATA WE NEED AT A FINE SCALE."

-Carly Ziter
University of Wisconsin

when you're dealing with trees, they take years to grow. So hopefully by including new techniques like this bike we can increase understanding and inform management decisions."

Funding for Ziter's work is provided by the National Science Foundation and the Garden Club of America's Urban Forestry Partnership.

BIKING AGAINST AIR POLLUTION

Conventional air quality samplers, complete with screens and filters for gathering contaminants, don't offer a lot of resolution to the data they collect. That is, they really only keep tabs on the areas around them.

Because of those limitations, it wasn't hard for Steve Hankey to see the upside of using bike-mounted sensors to take

measurements of air quality. He first got into using them during research for his doctoral dissertation in Minneapolis.

"You have to take measurements at many sites, typically with stationary monitors. It's really expensive to do," said Hankey. He says that each one can cost up to \$8,000 and anywhere from 25 to 100 would be needed to get the sort of coverage he can get with sensors on his bike. "We started doing these with a bicycle to get a spatial measurement and to do it in a cost-effective way. We wanted to see if we could get a better idea of what cyclists are exposed to."

The work in Minneapolis was a starting point for the efforts underway these days. Back then, Hankey was the main rider, but nowadays he has help from students in his lab. He's also been able to tweak the design and ensure that some really spectacular data can be collected.

The bike he and others are using around Blacksburg, Va., is outfitted with some advanced air quality sensors we'd never heard of. They include a micro aethalometer that gathers particulates on a filter and then blasts them with a laser to discern optical properties. Also onboard is a condensation particle counter that enlarges particles through cold condensation and then heated rubbing alcohol to create droplets large enough for the sensor to analyze.

They're so much cooler than any other particulate sampler we've seen.



Photo: Steve Hankey / Virginia Tech

A Virginia Tech student goes for a ride around Blacksburg, Va., with Assistant Professor Steve Hankey's weather bike.

Photo: Eric Pedersen / University of Wisconsin

Instrumentation used to study air pollutants on the back of a weather bike.



"The really old school way is to collect air samples on a filter and weigh them," said Hankey. "But the devices we're using can measure every second, tagged with a GPS location."

Students in his lab take turns riding those new sensors around Blacksburg, in shifts that line up every two hours throughout the day's sampling period.

Hankey told us that the rides began in late August 2016 and were on track to be completed in the middle of October. The goal was to reach 1,500 miles of total distance. Around 700 had been ridden at that point, so there weren't a lot of findings to share. But Hankey was able to give some perspective based on his previous research.

"In Minneapolis, we found that these pollutants degrade pretty quickly as you get away from major roads. For example, if you just moved one block away ... that could reduce your exposure by 15 to 20 percent," said Hankey. "It's a pretty minor shift to note if you're planning a bicycle network."

He and others also developed models using the air quality measurements, on a 50- to 100-meter scale, showing patterns across Minneapolis. That was the primary goal of the work there, during which Hankey made plenty of bike rides through rush hour.

"What we're trying to do here in Blacksburg is all day -- from 7 a.m. to 7 p.m. Our typical concerns are: Is the weather normal? Is it different? Are there spatial patterns?" said Hankey. "We want to

see how they change over the course of the day. It's similar, but we're going a step deeper."

As in Minneapolis, plans are to share findings with the Town of Blacksburg once they're available. In Minneapolis, the local pollution control agency is using the findings to help in future plans. Officials there have also begun riding their own sensor-equipped bike to gather more data.

Officials in Blacksburg are aware of the work and are interested in seeing the results. Hankey says that other researchers at the university will also see them, and plans are to launch a website that can serve the general public as well.

"We're interested in the effects on designing healthy neighborhoods and other structures. We're measuring bike and health assessments, even looking at people's moods," said Hankey. "How do you find communities with low exposure to contaminants? Or are there effects on mental health? We're actively compiling a website to make sure the info is available so they can know where they should bike or walk."

GAUGING GREEN INFRASTRUCTURE

For Paul Coseo, using a weather bike had an altogether different goal. He was interested in assessing the effectiveness of Chicago's Green Alley Program, an effort that was just in its beginning stages during his 2010 research.

"We were looking at heat vulnerability in eight Chicago neighborhoods. The trike was used to examine Chicago's Green Alley Program. As part of that program, the City was redoing alley ways to test out new pavement types such as highly reflective and porous pavements," said Coseo. "There were a couple goals for the program, but one was to reduce urban heat islands."

He says that he and others, including Nick Rajkovich, designed the bike to be a mobile weather station to take measurements. They rode around Chicago using a first-generation trike, and would soon learn that three wheels work better than two (a second-generation bike was used in Rajkovich's Cleveland study) for the kind of sampling they were after. Stops were made at certain locations along alleys, with riders resting at each around six seconds so that sensors onboard could gather measurements.

Those included an anemometer for wind dynamics and a net radiometer, for irradiance, as well as sensors for air temperature and humidity mounted on a mast. A pyranometer gathered measurements of solar radiation and a GPS unit onboard kept track of the rider's location.

Along with those sensors on the bike, there were also HOBO loggers deployed on utility poles in the alley ways Coseo traversed.

"I could raise the mast up and take measurements at each predetermined location," said Coseo. "When we combined that with the HOBO weather stations, we could get a nice cross-section of the urban climate with the trike. It wasn't so easy to move long distances, but the bike was great for short stretches in Chicago."

This sort of approach took place across eight neighborhoods in Chicago. Broken into groups of two, researchers had four pairs of alley ways to compare. Each pair contained a conventional alley way and another that had been upgraded in some way.

Most of the treatments used were meant to battle stormwater in a bid to help fight the city's persistent flooding problem.

"Sometimes they'd use high-reflectance pavements with high albedo, porous pavement or other pavers," said Coseo. "The heat island effect seemed more like a secondary concern to flooding, which makes sense because of the recent uptick in flood events."

The results of the effort were different than some might expect. The porous pavers or reflective surfaces that were used didn't have much of an impact on urban heat.

"There are so many other surfaces contributing to air temperatures that changing one surface had little effect on that. When I looked at porous pavers, they did have lower surface temperature than conventional asphalt," said Coseo. "But in terms of the actual effects on air temperature, it's much more complicated."

Coseo says that he was surprised by the findings, as he had thought there would be some sort of measurable impact from the green alley ways. But he notes that the results probably serve as good proof that more sophisticated sensors are needed to measure the dynamics that take place in sometimes very tight spaces.

CONVERSATION STARTERS

The potential of weather bikes is clearly huge for data collection. But these sensor-equipped crafts have other uses. Sure, they can also provide those riding them with a nice workout while gathering measurements. But along the trip, these bikes provide an incredibly valuable icebreaker allowing scientists to communicate directly with folks who often have no idea what's going on.

"People would take a look. They'd walk up, probably expecting to see a baby. But they'd walk up and see lights and tubes everywhere. I'm sure many people were sure I was the Google Street View guy," said Hankey. "But as a cyclist, it was nice to have people pull up and talk for 10 minutes or so."

Coseo had a similar experience, even getting help from a few youngsters hanging out on a stoop when his sensor mast broke one day.

"I loved being able to have conversations about what I was doing in fairly diverse neighborhoods," said Coseo. "I had people literally stop their cars to ask me what I was doing."

Ziter gets at least one question every time that she goes out for a ride.

"This new technique can help us grapple with the fine-scale issue in an interesting way. It's really visible and encourages a lot of engagement with the public. There's a lot of value for getting science into the community," said Ziter. "Most people say, 'Hey, what's on your bike?' Some people guess that it's a weather station. It leads to a conversation about the area." 



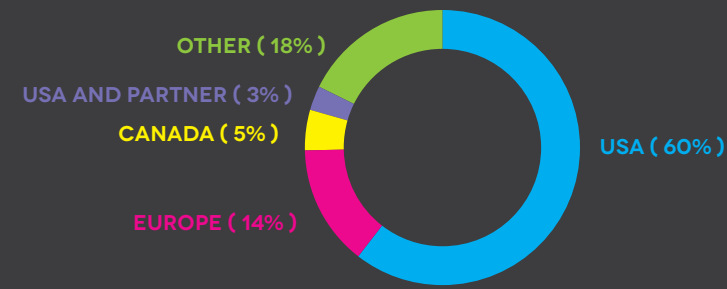
Paul Coseo takes notes near his weather bike during a 2010 investigation in Chicago.

Photo: Steve Hankey / Virginia Tech

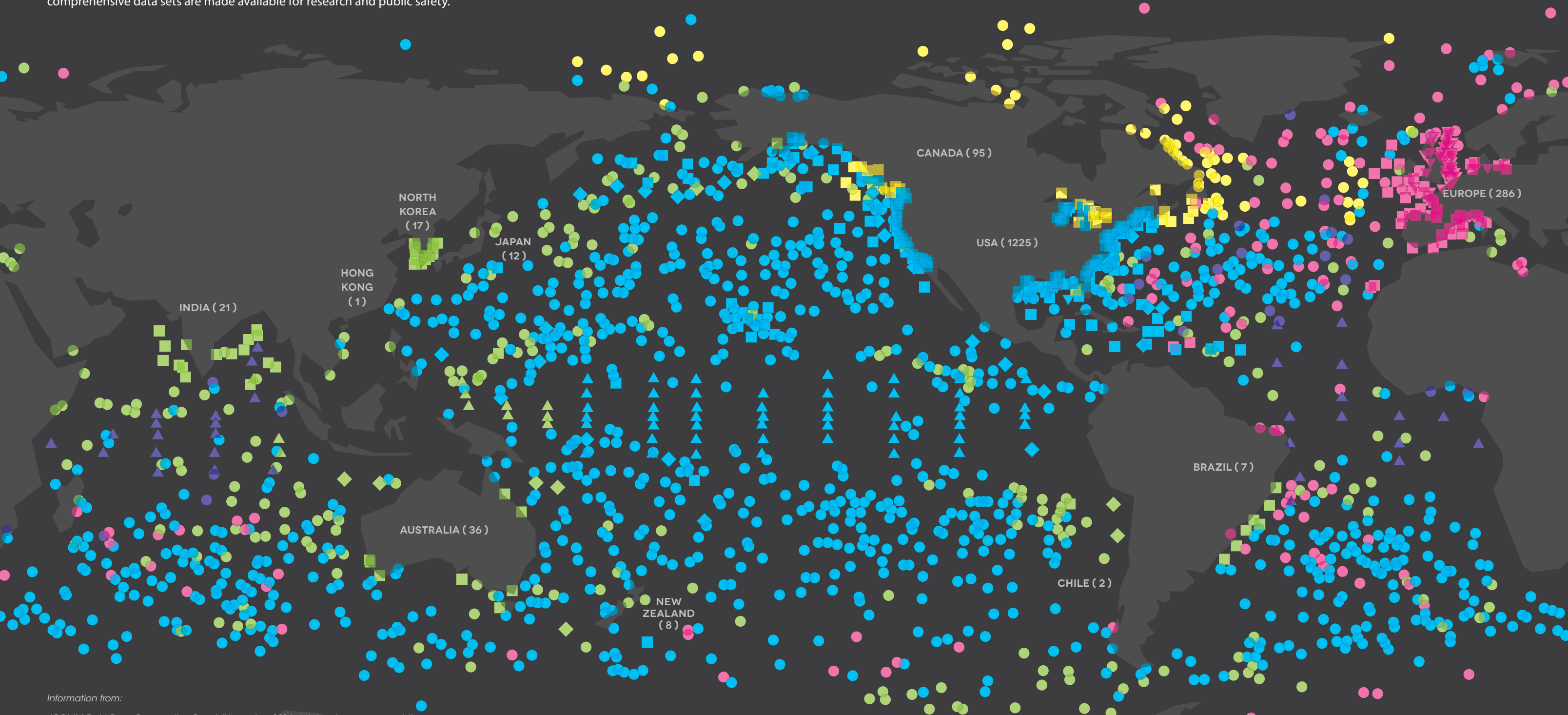
Photo: Paul Coseo / Arizona State University

DATA BUOYS

Organizations across the globe use data buoy systems to observe and monitor atmospheric and oceanographic conditions in remote locations. Measurements range from air pressure, humidity, wind speed and direction to wave height, water temperature, dissolved oxygen and other water quality parameters. With the help of national and international networks, reliable and comprehensive data sets are made available for research and public safety.



- DRIFTING (1453)
- COASTAL / NATIONAL (336)
- ▽ FIXED PLATFORMS (104)
- ◇ TSUNAMETERS (37)
- △ TROPICAL (93)



Information from:
 JCOMM Data Buoy Cooperation Panel (November 2016 data) — jcommops.org/dbcp
 NOAA National Data Buoy Center — ndbc.noaa.gov
 NOAA National Centers for Environmental Information — nodc.noaa.gov/BUOY

All graphics: Nate Christopher / Fondriest Environmental

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Solinst LevelSender

Wirelessly send measurements from Solinst dataloggers to multiple email addresses or SMS recipients via cellular signal with the LevelSender. This remote station is compact enough for deployment inside 2" diameter monitoring wells and housings. It features a single port for connecting with one Solinst logger at a time, while an optional splitter expands that number to two. This allows for deployment of a levellogger and barologger within the same well. Data are managed in the LevelSender PC software, which is compatible with other external databases and apps.



Eos Arrow Gold

This GNSS receiver is the first to bring together all four global positioning constellations, including GPS, GLONASS, Galileo and BeiDou, as well as three frequencies and satellite-based RTK augmentation. The Arrow Gold has a feature called SafeRTK so that RTK-level accuracy can be maintained even if there's no cell coverage, for up to 20 minutes. It is compatible with all iOS, Android and Windows devices and interfaces via Bluetooth.



NexSens G2-RAIN

The NexSens G2-RAIN Alert System is an all-in-one tipping bucket rain gauge, data logger, cellular modem and battery pack for real-time rainfall monitoring and alert notifications. It can be quickly deployed on a 2" NPT pole for use in flood alert systems, stormwater applications and construction site monitoring. The integrated lithium battery pack boasts a 4-year life, powering a system that transmits from anywhere with Verizon 3G cellular coverage. All data are sent to a secure WQData LIVE web datacenter where project managers can view real-time readings, configure rain alerts and export data.



YOUNG ResponseONE

The ResponseONE measures five key meteorological variables in one compact and rugged instrument, including ultrasonic wind speed and direction, barometric pressure, relative humidity and temperature. It is ideal for weather monitoring applications requiring accurate, reliable measurements and features a corrosion-resistant construction, low power consumption and a customizable digital output. An integrated compass also enables automatic direction alignment in mobile applications.



Laser Technology TruPoint 300 Total Station

This station produces survey-grade accuracy with onboard data storage and calculations, while still costing less than other total stations. The TruPoint 300 measures distance, inclination and horizontal angles for X, Y, Z measurements. Accurate laser measurements are possible up to 300 meters in a small and lightweight package. The mapping tool is ideal for applications in GIS, surveying, construction, electric utilities and more.



YSI Pro20i

The Pro20i is a rugged and advanced handheld DO meter at a very attractive price point. The meter features an integral cable assembly with 1m, 4m, and 10m length options. Compatible polarographic and galvanic sensors use polyethylene membranes that reduce stirring requirements over Teflon. The Pro20i's sensor response time is faster than any other handheld on the market, while still maintaining data accuracy. The IP67-rated instrument is fully submersible and can withstand drops up to 1 meter. This field-ready, easy-to-use meter features one-touch calibration and has a 3-year warranty.

Turner Designs C6P

There are six optical sensors compatible with this fluorometer, covering the deep ultraviolet to the infrared spectrum. Data can be logged to internal memory for long- or short-term deployments, and managed using C-Soft software. Each C6P fluorometer comes with a temperature sensor installed, while depth sensors and mechanical wipers are optional. The whole unit is housed in delrin for durability in harsh environments and can be powered by an external lithium ion battery pack or data logger.



Heron dipper-Tough

The dipper-Tough is a rugged, high-quality instrument used for measuring static and falling water levels in harsh environments such as at waste disposal and remediation sites. Its drawDown feature makes it ideal for use during pump-and-treat testing, when contaminants are found in groundwater. With this sort of durability in mind, the meter's steel-core tape comes wrapped in a hydrocarbon-resistant Kynar jacket and is embedded directly into the probe body, drastically improving the useful life of tape and probe.

GREEN INFRASTRUCTURE TRADEOFFS

In the field with Northern Kentucky University scientists studying greenhouse gas flux in constructed wetlands and other green infrastructure sites.

BY DANIEL KELLY

Green infrastructure installations, like green roofs, permeable parking lots or bioswales, are increasingly popular these days. They are built for good reasons, like decreasing urban runoff or improving a stream's water quality, among other things. But as with anything, there are tradeoffs to implementing them.

A study led by scientists at Northern Kentucky University is evaluating some of the costs and benefits to using one type of green infrastructure in a study considering constructed wetland sites in Kenton County, Kentucky. The research, led by Sarah Stryffeler, an undergraduate student studying environmental science, has looked at multiple sites using gas-catching chambers that have given scientists the means to analyze the greenhouse gases emitted by the manmade wetlands.

The Environmental Monitor caught up with the NKU team while they visited one of the wetland sites, in the middle of Cappel Park near Covington, Kentucky. The constructed wetland there is used as a filter to help clean water that flows into a tributary of the Licking River, which later empties into the Ohio River.

"That's what this site is, and so, in an urban area, people are putting in wetlands and rain gardens and retention ponds and

all these different things to deal with stormwater runoff. And we know that they're really beneficial in improving water quality, but nobody's looking at what some of those tradeoffs might be," said Kristy Hopfensperger, associate professor and director of the environmental science program at NKU. "So if we put in a bunch of wetlands, yes, we know we can improve water quality, but are we throwing more methane into the air of an urban environment. So what might tradeoffs of the green infrastructure be?"

Methane is just one of the greenhouse gases that is being considered in the study. The other two are carbon dioxide and nitrous oxide. These are evaluated using chambers that segment small portions of wetland and capture the gases they emit. The circular gas-catching chambers don't have bottoms so their walls can be shoved into the dirt to create the study plots. Each features a special construction to ensure a gas-tight seal.

The researchers take the chambers to every site, deploy them, and then collect samples of the gases emitted via syringes that insert into the lids. Samples are gathered every 10 minutes for a half hour during each deployment. From that point, they are analyzed using a gas chromatograph.

"So we trap atmosphere and we see what happens to that atmosphere with its change in greenhouse gas composition for half an hour to get that rate," said Hopfensperger. "Because the rate is more interesting to us — how fast the greenhouse gases are moving in and out of the soil. That is more interesting than just the actual concentration itself."

Measurements of soil moisture, temperature and organic matter are also taken.

"Soil moisture is used as a proxy for letting us know if the system is aerobic or anaerobic. So if there's no oxygen in the soil, if it's an anaerobic situation, then you're going to have really high soil moisture," said Hopfensperger. "There's going to be a lot of water in the soil pore space instead of oxygen."

Temperature is useful for gauging microbial activity, she says, because greenhouse gas fluctuation can increase as conditions get warmer. Organic matter is a metric that helps answer decomposition questions.

Soil temperature is tracked with a regular glass thermometer that can be stuck in the muck. For moisture, researchers use a two-pronged soil sensor.

"We need it (the soil sensor) to be kind of level with the chambers so that we know that they have the same moisture content," said Stryffeler, as she stuck the soil probe into the dirt near a gas-catching chamber. "And then, this is super easy, all that you do is press 'on' and then it just tells you what your reading is."

Those measurements have helped the scientists make some interesting finds about the wetland we visited, as well as some of the others under study.

"This site is our most natural-looking, with thick vegetation. And we have the highest CO₂ rates here, which makes sense because you're going to get a lot of respiration from the plants,"



Photos: Daniel Kelly / Fondriest Environmental

Sarah Stryffeler gathers a sample from a gas-catching chamber using a syringe. A glass thermometer near the front of the chamber measures soil temperature.



Kristy Hopfensperger inspects a gas-catching chamber after sampling.


said Hopfensperger. Another site, a retention basin, was found to be sequestering methane. All of the sites, except for one that was barely sequestering nitrous oxide, were found to emit nitrous oxide. "Our ranges are within (those of) the natural (not manmade) systems, but they're lower. So far, we're finding that these ecosystems are not emitting as much greenhouse gases as some of the natural systems might be."

Hopfensperger says that the lower rates might be due to the fact that there's less organic matter in the constructed wetlands compared to natural sites that have been in existence much longer.

Still more data need to be collected, she says. And one thing that would really help the effort is to do a mass-balance of gases emitted across sites.

"So with an ecosystem, you can say, 'Hey, this ecosystem's emitting methane, but at the same time, all this vegetation's taking CO₂ out of the atmosphere.' So you have to kind of balance that," said Hopfensperger. "You can say emitting methane is bad. We know it's a harmful greenhouse gas, but maybe the wetland takes in so much more CO₂ that it offsets it and it's not really a big deal. So right now we're just gathering the data on the greenhouse gas rates. And that would be the next step to kind of calculate those mass balances."

Moving forward, Hopfensperger is hoping to use data collected during the project, which began in June 2015, in funding proposals that could lead to larger studies into the tradeoffs that green infrastructure projects present. For Stryffeler, the work so far has helped get her feet wet in studying environmental science.

"I'm hoping to go into environmental engineering eventually. That's the dream," said Stryffeler. "Renewable energy or oceans cleanup. So this is my experiment of 'is this really what I want to do for the rest of my life.'" 

WATERSHED WATCH

The Boise River Watershed Watch program is an increasingly popular citizen science program teaching volunteers about the river's health and water quality.

BY DANIEL KELLY

Having just wrapped up its ninth year, the Boise River Watershed Watch program is an increasingly popular citizen science program in Boise, Idaho. It takes interested volunteers and joins them with expert scientists from the U.S. Geological Survey (USGS) who teach them about the river's health and sampling water quality using transparency tubes, dip nets and chemical test kits.

"Our focus is to educate folks on the parameters that we measure, to give them an idea of the river's health," said Tim Merrick, public information officer at the USGS' Idaho Water Science Center. "So they can collect data on the river's conditions and get plugged in."

To help, scientists with the agency give volunteers training upfront on things like how to sample for macroinvertebrates or how to spot certain invasive species that the Boise River is facing. They recently helped participants sampling along 14 sites from the Lucky Peak Reservoir all the way to Parma.

The citizen scientists are looking at parameters like temperature, pH and dissolved oxygen. Others include phosphorus, typically measured through lab analysis, and turbidity levels that are tracked with transparency tubes. Some of those are a little more complex than the rest, but the gear used is meant to keep things easy.

"Because it's a citizen science effort run by the City of Boise, these are simple test kits that we use," said Merrick. "Sometimes we bring out gear that we use for sampling, but not this year. We always open up one of our streamgauge sites to explain what it's measuring and why that's important."



The introduction to one of the USGS' most basic tools for data collection goes to any mix of volunteers. Depending on the year, they can consist mostly of elementary or high school students, and several adults usually chip in as well.

This year, most of the crew was made up by students from the College of Western Idaho. It's nice to know that they weren't awarded any extra class credit for coming. Their attendance was completely up to them, says Cindy Busche, education coordinator with the Boise WaterShed Environmental Education Center.

The students got to get out of the classroom while getting their hands dirty with some scientific methods they'd mostly not seen before.

"We also do a grab sample that's analyzed by labs nearby, looking at total suspended solids, total phosphorus and E. Coli. We're also kind of assessing if there are aquatic invasive species," said Busche. Purple loosestrife and eurasian watermilfoil are a few that volunteers have found. In the downstream reaches, there are New Zealand mudsnails, but there have luckily been no quagga mussels so far. "We get training from the state invasive species coordinator prior to the event. At each site, we also get training from the USGS macroinvertebrate specialist for Idaho."

Those populations are sampled using dip nets, and both Busche and Merrick agree that the macroinvertebrate activity is the most exciting every year. A large part of that is just because folks often don't know that there is so much life thriving in a streambed.

"They just go out with dip nets and kick up some sediment. It's always the most popular part of Watershed Watch," said Merrick. "Volunteers can see all the tiny living things in ice trays, and they love it. And with that, we're looking at species that are more or less tolerant of pollution like caddisflies and stoneflies."

"Others really like the pH, when kids can see a color change when they drop a tablet in," said Busche. "It may be the first exposure to chemistry for some of the kids."

Amongst the findings that volunteers reported this year contained few surprises for Busche. Temperatures were higher downstream than upstream. Phosphorus levels also crept up. ☑

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Photos: (left) Cindy Busche / City of Boise; (right) Tim Merrick / U.S. Geological Survey

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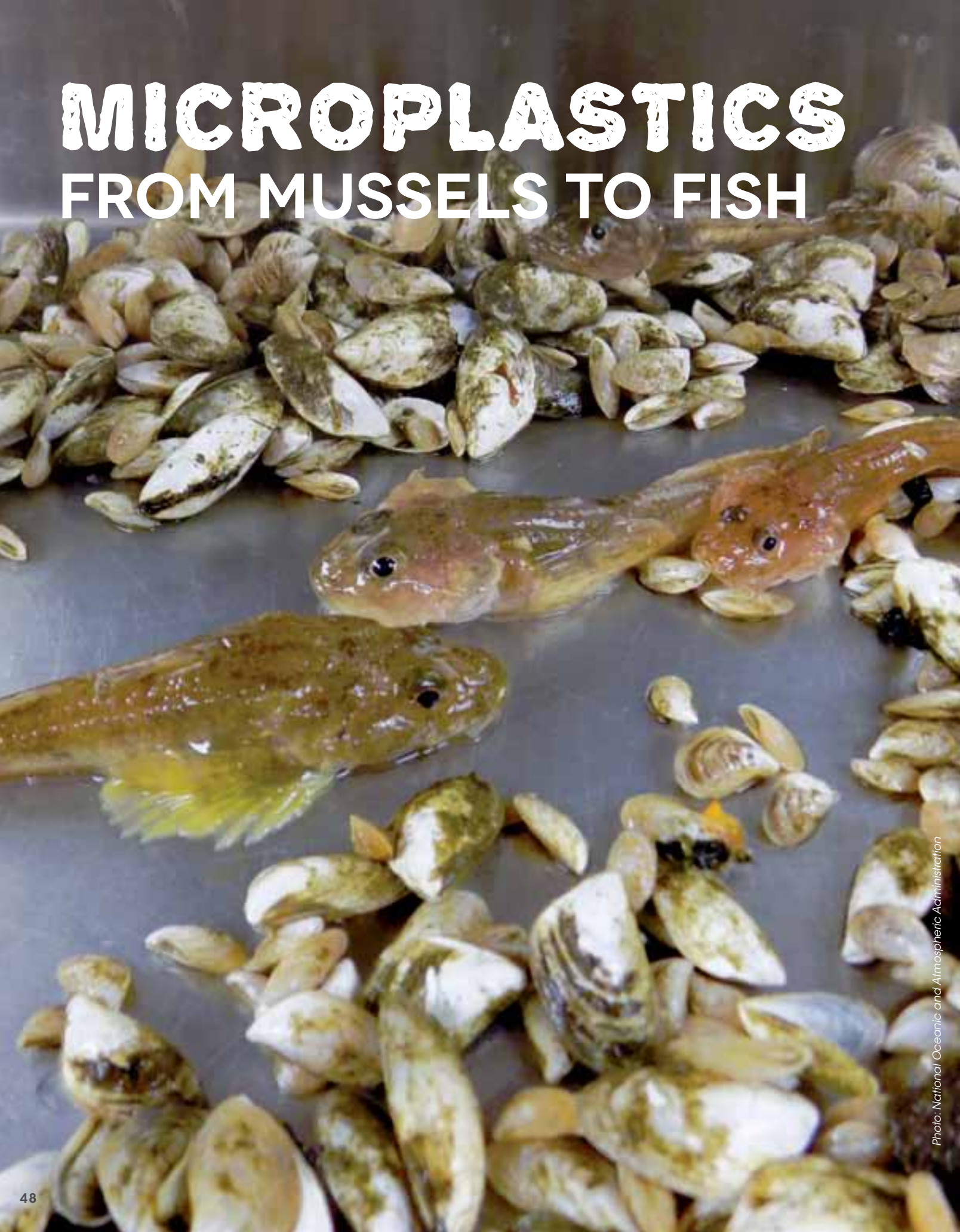


Photo: National Oceanic and Atmospheric Administration

A pilot study by scientists at University of Notre Dame is charting the processes by which microplastics move from filter feeders to sculpin.

BY DANIEL KELLY

Microscopic beads and fabrics float in our waterways, get ingested by fish and other creatures, and impact the environment in lots of negative ways. But despite that knowledge, there is little we know about how these microplastics first enter aquatic food webs.

In a pilot study, researchers at the University of Notre Dame are studying the dynamics of just how microscopic plastics are first transferred from filter feeders to fish. Their investigation is using Asian clams and sculpin to pinpoint the interactions underway.

The researchers originally wanted to use round gobies, a prolific invasive fish in Lake Erie. But they opted for sculpin instead because of limitations on using gobies enforced by the Linked Experimental Ecosystem Facility at Notre Dame, where much of their study is taking place. Sculpin are like round gobies in that they are bottom-dwelling and lack a swim bladder.

"The sculpin are found more in Great Lakes tributaries. They're sort of a classic fish in those systems," said Katherine O'Reilly, doctoral student in the Stream and Wetland Ecology Lab at the university. "The USGS (U.S. Geological Survey) did a survey that found these rivers have a ton of microplastics in them and may be a source to the Great Lakes. They're not exactly the same, but we thought sculpin were a good proxy."

In the effort, she and collaborator Whitney Conard, a doctoral student in the same lab, are injecting fluids filled with microscopic bits of fluorescent plastic into the tissues of the Asian clams, which serve as proxies for zebra and quagga mussels. From there, they are feeding the mussels to sculpin and later image how the microplastics pass through. Matthew Leevy, research assistant professor of biological sciences at Notre Dame, helps with that.

Feeding takes place in a large water bath, with each sculpin in its own tiny mesh enclosure. These are typically held underwater by rocks that scientists source from their surroundings. During this step of the effort, conditions in the water bath are monitored using a YSI handheld water quality meter. The thinking is that it's best to keep conditions level for all the sculpin as they chow down.

"That's really just to monitor our mesocosm setup. It makes sure conditions are good for sculpin, to make sure they're healthy and ready to eat," said O'Reilly. "... We want to minimize variables in water and light. We could even do different treatments or clams with different microplastic levels."

It wasn't always so straightforward, says O'Reilly, noting that the advantage of such pilot studies is that they allow scientists to figure out what's the best approach.

"We first tried to feed the clams microplastics in an algae mixture. ... But the clams were really sensitive and some of them actually

died off," said O'Reilly. "... The beauty of a pilot project is that we can figure out what works and what doesn't."

At this point, investigators are just trying the experiment with sculpin. In the future, they may scale up efforts to see how other fish higher in the food chain may be affected.

"The main idea is to see how these microplastics move from a filter feeder to that first level," said O'Reilly. "Maybe a future study would be to look at how predators like smallmouth bass are affected, and trace it along the food web."

She and others expect that the results of the work may show that the microplastics pass through sculpin fairly quickly. Unlike microfibers, O'Reilly says, the fluids can probably move out more easily and not get stuck. Hopes are to wrap up fieldwork before winter sets in and have results by early 2017.

But it will be interesting to learn more about the time it takes for the microscopic bits to pass. Scientists are looking to nail down just how long they persist.



"Basically, does it impact the fish before excretion? I think if we were looking at microfibers, it would get more tangled up," said O'Reilly, noting that each mussel used in the investigation does already have a baseline of microplastics in its tissues before getting injections. "It will be interesting to see what we get here."

As for microfibers, other investigations looking at their movement through fish have shown entanglement is commonly an issue in the small intestine. One recent summer survey on the St. Joseph River completed by an undergraduate student, with O'Reilly's help, also shows that they could be much more common than has been thought.

The summer effort showed that microfibers from clothing and other things are everywhere, even in the effluent of surrounding wastewater treatment plants. Those usually aren't equipped with the technology needed to remove microfibers.


"It's amazing what you can find in a water sample. We even found microscopic styrofoam particles. But microfibers were more constant," said O'Reilly. "Everyone thinks of microplastics, but really it seems like the most common is microfiber." 

Photo: AnRo0002 / Public Domain



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SUPERIOR

Officials at the Michigan Department of Natural Resources (DNR) have decided to suspend the stocking of Chinook salmon in Lake Superior indefinitely. The move comes following the success of wild populations that have become self-sustaining in the lake. Scientists have found that more than 99 percent of angler-caught Chinooks in Michigan waters originate from natural reproduction. This was determined through DNR creel surveys that documented ratios of unclipped, or wild, versus stocked and clipped Chinook in Lake Superior since 2012. With such consistent harvests of Chinook salmon creel, there is good reason to believe that anglers will continue to catch salmon even though the stocking program has ended.

Michigan Department of Natural Resources. (2016). Lake Superior Goes Wild For Salmon. (Press Release). Retrieved from <http://www.michigan.gov/som/0,4669,7-192-47796-397246--,00.html>

MICHIGAN

Results of a three-year study looking at white suckers in several Lake Michigan tributaries show a high abundance of liver tumors, according to U.S. Geological Survey scientists. The investigation considered three Wisconsin rivers, of which two are listed as Areas of Concern (AOCs). The three-year study looked at tumor prevalence in white suckers in the Sheboygan River and Milwaukee Estuary, with researchers at the agency gathering findings on fish gathered at four sites. The specimens were captured for analysis with nets, after which investigators inspected the suckers and recorded data. At three of the sites, scientists found an abundance of liver tumors and skin lesions on the fish collected. Most of those came from two AOCs, while others came from the Root River that doesn't have the designation.

U.S. Geological Survey. (2016). High Rate of Tumors Found on White Sucker in some Wisconsin Rivers. (Press Release). Retrieved from <https://www.usgs.gov/news/high-rate-tumors-found-white-sucker-some-wisconsin-rivers>



Photo: (Superior) U.S. Fish and Wildlife Service; (Michigan) U.S. Geological Survey

HURON

The glory days of Lake Huron's Chinook salmon fishery will likely never return, according to the results of a modeling study led by researchers at the University of Michigan. Findings of the work suggest that the lake's resource managers should instead focus on restoring native fish species like lake trout, walleye, lake whitefish and lake herring. Modeling also revealed that Lake Huron will very likely experience a collapse in alewife populations in the future, which would lead to a collapse of the Chinook fishery there. Scientists say their findings serve as a reality check to those who would have stocking of Chinook salmon continue, while noting the positive implication for native fish.

University of Michigan. (2016). Lake Huron's Chinook salmon fishery unlikely to recover due to ongoing food shortage. (Press Release). Retrieved from <http://ns.umich.edu/new/releases/23602-lake-huron-s-chinook-salmon-fishery-unlikely-to-recover-due-to-ongoing-food-shortage>



Photo: (Huron) University of Michigan; (Ontario) State University of New York; (Erie) Ohio State University

ONTARIO

Not long after an algal bloom wreaked havoc on the water quality in Lake Ontario's Sodus Bay in 2011, scientists at the State University of New York deployed data buoys to learn more about what happened. Luckily, another bloom hasn't taken place, but that hasn't stopped researchers from continuing their efforts. Three NexSens MB-300 data buoys are stationed throughout the bay. Two are equipped with weather stations, while all three have sensors for water quality. These complement a weather station on LeRoy Island that reveals changes occurring just above the water's surface.

Environmental Monitor. (2016). Sodus Bay Water Quality Tracking Improves Bloom Predictions. (News Article). Retrieved from <http://www.fondriest.com/news/sodus-bay-water-quality-tracking-improves-bloom-predictions.htm>

ERIE

In recent years, blooms of algae have clouded the waters that Lake Erie walleye hunt in and the effects of that aren't yet fully understood. At the forefront of dissecting these impacts to the famous predator are researchers at Ohio State University who are using a series of experiments to learn more about how walleyes and emerald shiners, common walleye prey, respond to varying levels of visibility. Scientists are using a number of behavioral experiments to test how well the two species of fish can see under different levels of turbidity. They expect that both species will have diminished visual abilities at higher turbidity, whether from increased algae or sediments.

Environmental Monitor. (2016). Are Higher Levels Of Turbidity Impacting Lake Erie Walleye? (News Article). Retrieved from <http://www.fondriest.com/news/higher-levels-turbidity-impacting-lake-erie-walleye.htm>





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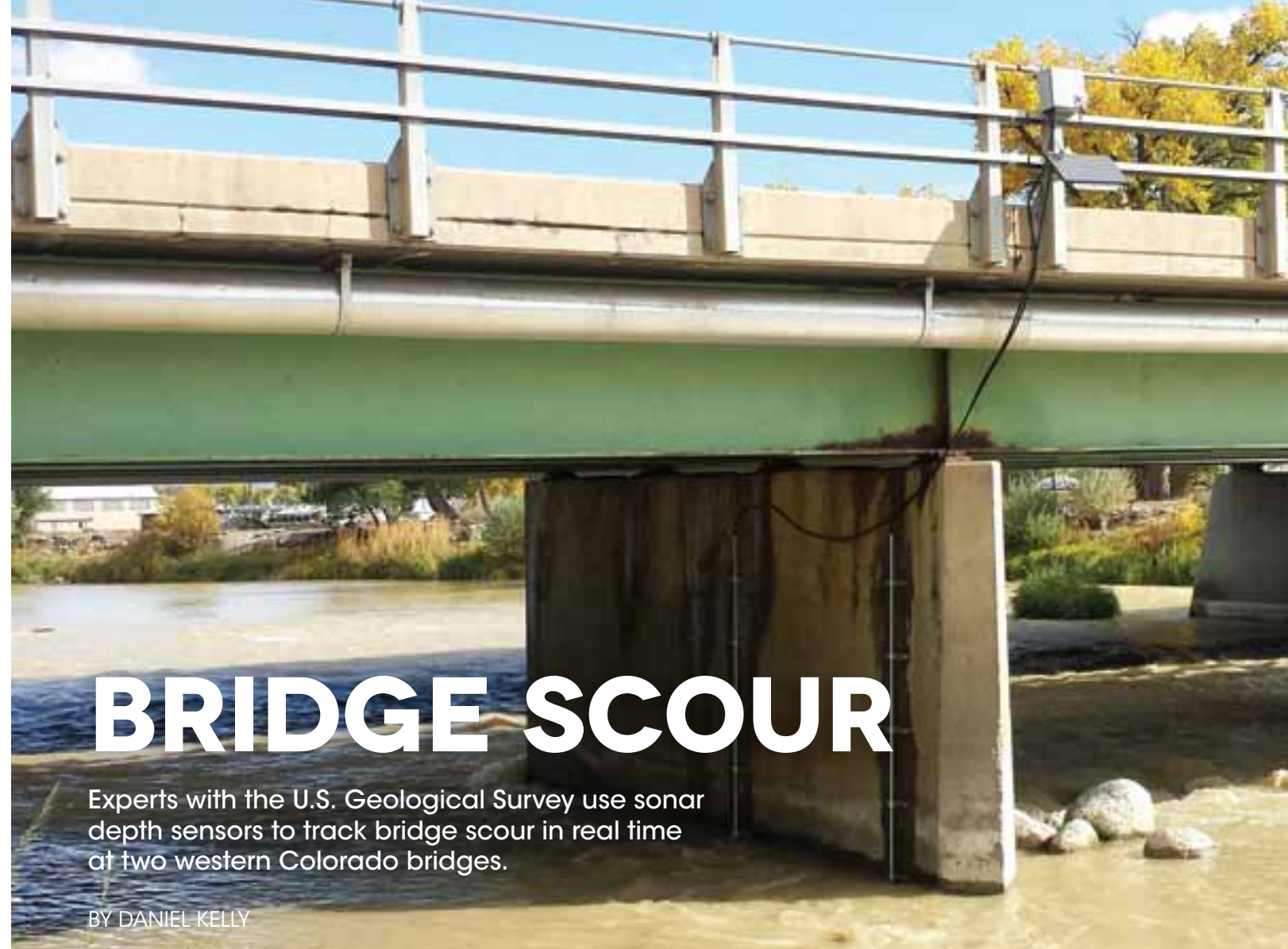
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BRIDGE SCOUR

Experts with the U.S. Geological Survey use sonar depth sensors to track bridge scour in real time at two western Colorado bridges.

BY DANIEL KELLY

Editor's Note: Any use of trade, firm, or product names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

When we drive over bridges, we probably don't think too much about the water body that we're crossing. After all, the only thing we see are the cars in front of us and the asphalt beneath our tires. But there is something incredibly important occurring just under the water's surface: bridge scour.

All over the United States, government agencies keep an eye on bridge scour because of the damaging impacts it can have if left to fester. Too much erosion around piers supporting bridges can threaten bridge collapse and endanger driver safety.

One of the agencies that keeps tabs on bridge scour is the U.S. Geological Survey (USGS). In a recent project in partnership with the Colorado Department of Transportation, researchers with the USGS set up stations to monitor bridge scour in real time.

The work focused on two bridges in western Colorado. Relying on Airmar EchoRange SS510 Smart Sonar Depth Sensors

mounted on bridge piers, USGS scientists didn't find any surprises in the effort.

"We are using the depth sensors to measure the streambed elevations. ... To provide real-time streambed elevations during high-flow periods," said Mark Henneberg, hydrologist with the agency's Colorado Water Science Center.

To gather data in real time, USGS scientists rigged up data loggers on the bridges that are equipped with telemetry, such as cellular or satellite, to ping measurements to them at project-defined intervals.

Complementing those data are measurements on water level that are gathered as part of another USGS effort.

"River stage is also being measured by existing gaging station infrastructure," said Henneberg.


That's important because high water levels, or flooding, can coincide with increased bridge scour. This is especially true because water tends to flow faster around piers and abutments, increasing the scour they experience on a more local level. 

Photo: U.S. Geological Survey

Q&A: Brian Helmuth



Brian Helmuth is a professor in the Department of Marine and Environmental Sciences at Northeastern University in Boston. Along with collaborators, he has deployed “robomussels” for varying lengths of time at 71 sites worldwide. At some of the sites, the temperature loggers deployed in mussel shells have been recording nearly continuous measurements for 18 years. The Environmental Monitor recently asked him about that work using biomimetic sensors and other findings he’s made relating to tidal ecosystems.

Environmental Monitor: Why did you want to develop the robomussel loggers?

Brian Helmuth: The main impetus for the development of the loggers was the realization that the temperature of any object (animal, plant, recording instrument) exposed to the sun is typically much warmer than the temperature of the surrounding air. Since, unlike mammals, 99 percent of organisms on Earth don’t make metabolic heat, this means that the vast majority of terrestrial and intertidal organisms have body temperatures that can’t be determined from air temperature alone. Moreover, the color, shape and size of an organism drives how much heat it absorbs,

so two animals sitting side by side under the same conditions can have radically different temperatures from one another as well as from the surrounding air and surface. This is key since it is the temperature of the animal’s body — and not its surroundings — that drives physiological stress and risk of death.

EM: What are biomimetic sensors?

BH: Biomimetic sensors mimic the thermal characteristics of animals by nature of having the same color, shape and thermal mass (product of mass times specific heat capacity). We found, for example, that commercially available, unmodified loggers record temperatures that are, on average, 14 degrees Celsius different from that of adjacent mussels. When we encase those same sensors in epoxy shells that mimic mussels, robomussels, temperatures are within about 2 degrees Celsius, even when temperatures are rising and falling by 15 to 20 degrees Celsius in a matter of a few hours.

EM: How do you get data off the temperature sensors?

BH: Typically, we base the robomussels on a commercial logger produced by the Onset Computer Corporation. Those loggers communicate using two LEDs that rapidly flash as the means of communicating the data. We modify the Onset data shuttles so that they can be fit over the curved surface of the robomussels.

EM: Is there other fieldwork that accompanies temperature data collection?

BH: The robomussel data are, as you suggest, only part of a much larger picture. As part of the metadata that we use to describe the temperature data, we use a high-resolution Trimble RTK (Real Time Kinematic) system to measure the elevations of the microsites where we place our loggers. We also deploy pressure sensors to measure tidal elevations which help us to understand when the mussels are in air and when they are underwater. And, we also use the data from the temperature loggers to validate computer models that we have created which allow us to forecast mussel temperatures using data from satellites and from weather stations.

EM: What are some key findings you’ve made?

BH: One of the main findings of this project is that air temperature — while relevant to humans because of the way we interact with our environment — is actually a pretty poor predictor of the temperatures of most animals and plants. For the vast majority of organisms in the sun, air temperature sets the lower limit and solar radiation then heats it further, in some cases 10 to 15 degrees Celsius above air temperature (in the same way that a parking lot on a sunny day heats to temperatures well above air temperature).

This means many organisms are likely living much closer to their lethal limits than we previously thought. It also means that when we take a “nonhuman eye view” of nature, we see patterns that are otherwise foreign to us. For example, we often just look at the extremes of a species distribution that are closest to the equator, assuming that this is where they will be hottest. Our results suggest that local conditions can be so important that they can overwhelm these latitudinal trends. Instead of “latitudinal gradients,” we instead see what we are calling “mosaics” that are far more complex.

Our latest efforts have combined the field measurements with physiological models to further look at current and future patterns of



Real mussel and a robomussel next to each other on a shore.

All Photos: Northeastern University

growth and survival, again in aquacultured mussels (Montalto et al. 2016).

EM: You’ve recently brought together much of your observations. What do you think the larger dataset could reveal?

BH: We have analyzed portions of the robomussel data to answer specific questions, but this is the first time that data from all of the sites have been assembled into a single database, and we have yet to look at patterns in aggregate. In a 2002 Science paper, we measured patterns in extreme temperature at a series of sites along the West Coast of the U.S. and showed that, in these intertidal sites, the typical assumption of “conditions get more extreme the closer one gets to the equator” does not hold. Instead, the influence of local environmental conditions, such as the time that low tide typically occurs in summer and the amount of cloud cover and wind speed, are so important that they completely overwhelm the idea of a “latitudinal gradient” in stress. Since the release of that paper, similar patterns have been shown for various organisms at sites around the world both by our team and by others.

EM: How else are your data being used?

BH: Many other groups are beginning to use this dataset, which in part is what prompted us to make it public so that others could as well. For example, a recent paper led by Kristy Kroeker, assistant

professor of ecology and evolutionary biology at University of California – Santa Cruz, found mosaic geographic patterns not just in temperature (from our data) but also in ocean pH and food, and found that mussel growth was lowest where conditions of high temperature, low food and low pH coincided.

A group that we work with in Palermo, Italy, has used the models (validated with the loggers) to help inform shellfish aquaculture. We are working with faculty in China to determine how the building of massive seawalls may facilitate the spread of invasive species, and we are also working with another group in Israel to ask how the complexity of the shoreline may enhance resilience to heat waves.

EM: What are your plans for the future?

BH: The only thing I would add is that despite what we often hear in the mainstream media, the question of whether climate change is occurring, and whether it is impacting ecosystems, has long been settled in the scientific community. We are now looking forward to asking where, when and with what magnitude are changes most and least likely to occur, and what can we do to prevent damage? Data collection and instrumentation at small scales is going to play a vital role in this endeavor, and I see many opportunities between ecologists and engineers as we attempt to dream up novel ways of adapting to climate change. ☺



HydroSphere Drifter

The HydroSphere, a new type of autonomous drifter developed by Planktos Instruments, is looking to change the way that scientists study rivers and other freshwater bodies. The device makes it easier to gather spatial and temporal data in such studies while filling in gaps other monitoring approaches leave behind.

"You have these networks of buoys that have great time series of data," said Scott Ensign, owner of the company. "But what you really want to do is connect the dots."

Ensign launched the company back in 2013 with an eye toward sampling in rivers. There are already plenty of ways to study rivers of course, but none that can achieve the kind of data he was after.

The goal was Lagrangian sampling, a type of approach used commonly in oceans to study conditions as they change with the movements of currents and other swirling dynamics. There wasn't anything on the market that could do that in rivers at the time, and Ensign was in for some challenges as the HydroSphere came to be.

"We spent the first year or so of the project trying to make sure it could go down rivers," said Ensign, discussing the HydroSphere's design. In a nutshell, it uses a polycarbonate sphere to house a number of sensors for measuring water quality and a GPS tracker. "So if you're a ball, it's easy to be rolled off the bank and back downstream. It's also effective if it hits debris."

Sensors within the sphere are recessed, giving them access to the waters nearby. Parameters that they record are similar to

those measured by typical water quality sondes. The data can be easily downloaded from the sphere and transferred to a computer, Ensign says.

One beautiful feature of the design is that it allows for a little bit of water to enter into the sphere, easing the interactions that the device has with moving waters around it. It gives it some momentum as it's pushed downstream by currents.

The feature also helps the sphere to be neutrally buoyant, which is something that smaller drifters can't boast. Because of their designs, usually modeled after buoys, these drifters also have a tendency to get snagged on shorelines. That limits the amount of data that can be gathered.

"It acts as a particle drifting below the surface so it can go far downstream. Compare that to the buoys that flow on the surface, you're able to go about 10 times as far," said Ensign. "It's opened up a whole line of scientific questions. ... The longest drift we've had so far is 40 kilometers."

After the HydroSphere has sampled for the desired channel length, there is a cartridge of carbon dioxide that releases from within to bring the sphere to the surface. The user has the ability to program when the cartridge triggers and can then plan out a field trip to retrieve it using the GPS.

Before that, the device floats along while remaining concealed underwater. That provides the HydroSphere with protection from vandals.

"Some of the most surprising things has been watching these things move down river after storms. I was watching one on Google Maps once and I thought someone had taken it out of the river," said Ensign, discussing a test deployment on a river he'd studied extensively in the past. "One time, after a flood, the flood waters had taken it up near some houses. But 12 hours later it was back in the tidal estuary and it had flushed back down. I thought I knew the system like the back of my hand. It blew my mind."

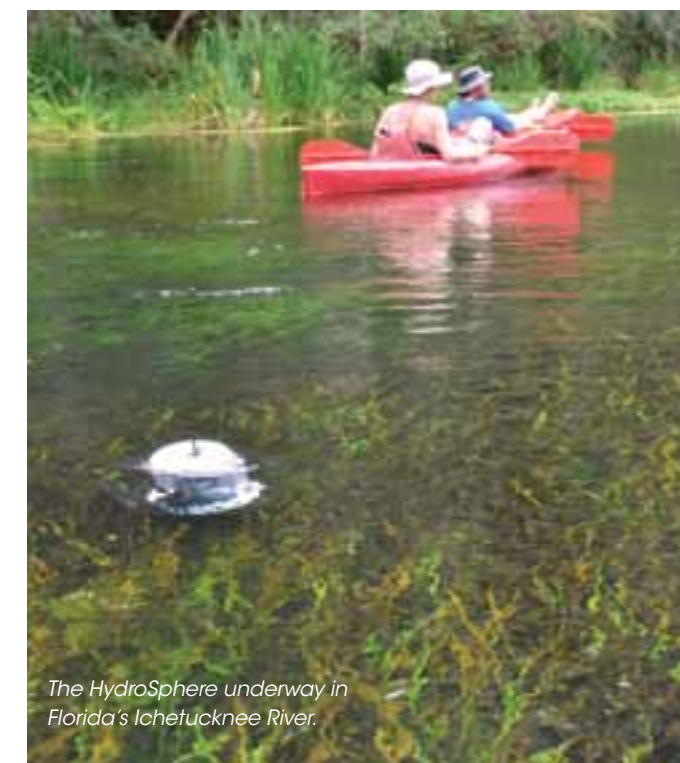
The HydroSphere's tough, polycarbonate construction has also held up well in several deployments, Ensign says. These include rivers in Florida and North Carolina and lakes in Wisconsin.

The safeguards help to protect onboard sensors collecting data on temperature, dissolved oxygen, pH, conductivity, salinity, oxidation-reduction potential and light intensity.

"That suite is pretty standard. What's slightly unique is the capability to measure light intensity," said Ensign. "Imagine the device floating down the river, going up and down as it's moving. It replicates what phytoplankton are doing and is seeing the light regime they experience. It's really helpful for estimating productivity in a river. And you can do that with standard limnological techniques, but we're actually measuring the particle movement through space and time."

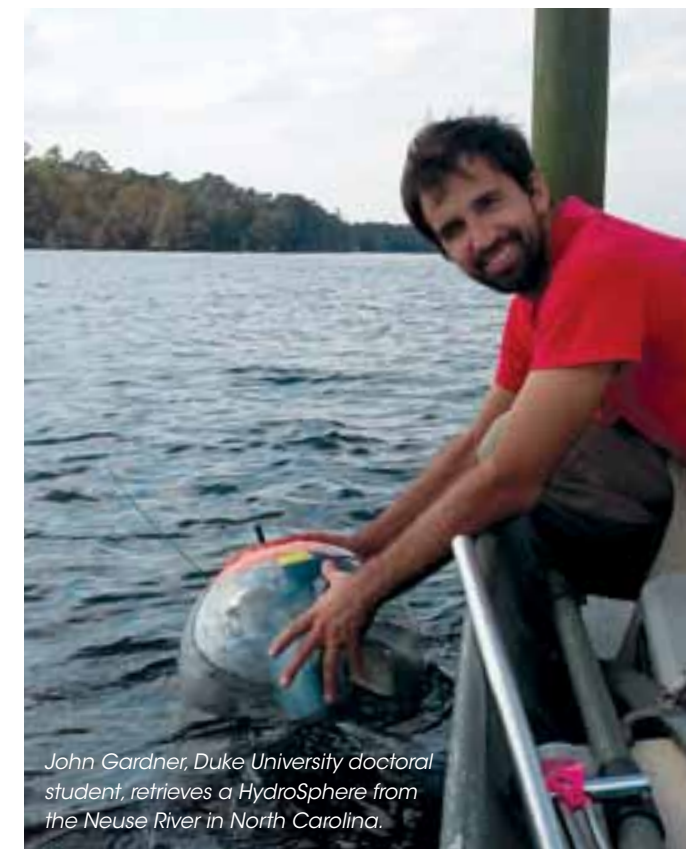
Other aspects of operating the device are quite similar to using a water quality sonde, Ensign says. Calibrating the sensors is the same, as is setting up a logging interval. The most important thing to program is the surfacing mechanism.

With their ease of use and novelty, a few scientists are already using HydroSpheres to tackle pressing issues. Ensign tells us that one project led by Nathan Hall, research associate at the Institute of Marine Sciences at the University of North Carolina, Chapel Hill (UNC), is using one to incubate phytoplankton.



The HydroSphere underway in Florida's Ichetucknee River.

All Photos: Scott Ensign / Planktos Instruments




John Gardner, Duke University doctoral student, retrieves a HydroSphere from the Neuse River in North Carolina.

"He's using the HydroSphere as a little lab. While it's floating downstream, he's using little mesocosms to measure phytoplankton growth," said Ensign. "His research is aimed at predicting harmful algal blooms near the Cape Fear River to inform drinking water advisories, to understand the dynamics of the river that allow harmful algal blooms to occur."

Martin Doyle, director of the Water Policy Program at Duke University, is another researcher testing out the HydroSphere. He is attempting to measure the metabolism of the Mississippi River and others on the East Coast as an indicator of overall aquatic health.

The device was also recently used on Wisconsin's Sparkling Lake during a collaboration with Emily Stanley, professor of zoology at University of Wisconsin - Madison, to gather data that could be compared to those taken by a FLAME sampler. The Fast Limnology Automated Measurement platform is a boat-mounted system with sensors set up to sample water quality as fast as boats can go.

"The FLAME approach captures measurements of a lake at one time. Ours is the opposite," said Ensign. "... The HydroSphere data can help you interpret the FLAME data. We're fitting the pieces of spatial and temporal together to understand those dynamics and what creates that pattern and what does it mean for what's going on in a lake or river."

More deployments are in the works for the future. Ensign says that the San Francisco Bay area is at the top of the list. The ultimate goal is to commercialize the HydroSphere, which is currently patent-pending. Ryan Neve, a research technician at UNC's Institute of Marine Sciences, contributed to its hardware design. 

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