

# ENVIRONMENTAL monitor

SUMMER 2013

APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS



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## WELCOME...

Welcome to the Summer Edition of the Environmental Monitor. This issue features two international stories, including an effort in Senegal to restore a native prawn species that preys on a disease-carrying snail. We also head to Guatemala, where scientists are working with citizens to conserve the threatened Lake Atitlán. Back in the states, we take a look at monitoring networks in Puget Sound, Alaska and along Florida's Gulf Coast. We also have something for you DIY types, including a PVC-and-pegboard buoy and a thermistor string on a shoestring budget.

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**Fondriest Environmental, Inc.** | tel: 888.426.2151  
2091 Exchange Court | fax: 937.426.1125  
Fairborn, OH 45324 | customercare@fondriest.com

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## STAFF

**Steve Fondriest**, President  
steve@fondriest.com

**Paul Nieberding**, General Manager  
paul@fondriest.com

**Jeff Gillies**, Editor  
jeff@fondriest.com

**Austen Verrilli**, Staff Writer  
austen@fondriest.com

**Daniel Kelly**, Staff Writer  
daniel@fondriest.com

**Adam Redling**, Contributing Writer  
adam@fondriest.com

**Kevin Rose**, Science Writer  
kevin@fondriest.com

**Mike Voellmecke**, Applications Engineer  
mike@fondriest.com

**Tyler Fondriest**, Mechanical Engineer  
tyler@fondriest.com

**Marina Lamquin**, Marketing Specialist  
marina@fondriest.com

**Nate Christopher**, Graphic Designer  
nate@fondriest.com

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### LSU Documents Rare Oarfish

Louisiana State University recently released rare footage of a swimming oarfish. The longest known species of bony fish in the world, the oarfish looks more at home in a science fiction movie than the ocean, with antennae and a squirming reflective dorsal fin. Oarfish were documented by remotely operated vehicles through a partnership between researchers and the oil and gas industry.

Photo: Mark Benfield / Louisiana State University



### Breath of the Amazon

The Amazon Rainforest absorbs billions of tons of carbon dioxide from the Earth's atmosphere each year. The carbon is bound up in the bark and stems that end up washing into the Amazon River. Past research assumed that the woody debris was too tough for the river's bacteria to break down and release as CO<sub>2</sub>, but recent work from the University of Washington shows that's not the case.

Photo: NASA



### Connecting Great Lakes Streams

Great Lakes Basin streams are hindered more by road crossings than dams, researchers at the University of Wisconsin found. Many migrating fish can't jump over pipes or pass through culverts that make up the road crossings to reach native spawning grounds. There are 38 times as many road crossings as there are dams in the Great Lakes Basin. There are more than 7,000 dams compared to more than 268,000 road crossings.

Photo: Stephanie Januchowski-Hartley

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# Reining in Nature

University of Washington's giant plastic bags help control research conditions

BY DANIEL KELLY



With oceans becoming more acidic worldwide, scientists are getting creative in designing experiments to study them. For example, one group at the University of Washington is using giant plastic bags to study ocean acidification.

Each bag holds about 3,000 liters of seawater and sits in a cylinder-like cage for stability. The group at UW, made up of professors and students, is controlling carbon dioxide levels in the bags over a nearly three-week period, during which they are looking at the effects of increased acidity on organisms living near Washington's San Juan Islands.

"These mesocosms are a way to do a traditional experiment you might do in a lab or classroom," said Jim Murray, professor of oceanography at the University of Washington. The structures, he said, make it possible to bring a part of the natural environment under controlled conditions.

"Ocean acidification is happening, and it's clearly due to increasing CO<sub>2</sub> in the atmosphere," said Murray. "The big unknown is the impact to biology."

The 6-meter polyethylene bags are sealed at their bottom ends. Five meters are submerged and 1 meter remains above the surface. Metal frames give structure to the bags and stabilize the vessels during rough water conditions.

There are nine bags being studied. Three are held at the carbon dioxide levels of water near UW's Friday Harbor lab - 650 parts per million. For comparison, the current concentration of CO<sub>2</sub> in the atmosphere is at 400.

Photo: James Murray

Another three bags are kept at 1,250, while the last three will be allowed to drift throughout the study's course. Drifting occurs because organisms within the bag alter CO<sub>2</sub> levels as they take it in as food.

A LI-COR sensor measures light around the mesocosms to help control algae blooms within the bags, and a CTD sensor measures the temperature and salinity of water in each bag daily. The group controls carbon dioxide levels by bubbling the gas through seawater before adding it to the bags.

"If you start bubbling your experiment, organic matter begins to concentrate on the bubbles and makes changes in the experiment," said Murray.

Murray said keeping the gas concentrations constant helps make sure that the experiment's results reflect the effects of elevated carbon dioxide. Allowing the levels to drop over the course of the three-week period wouldn't make sense when it came time for evaluating results.

Murray said the study, which is about halfway through, is yielding interesting results so far, but the full findings won't be available until after its completion. It's interesting research, he said, but notes that it's also an immersive learning experience for students. Pupils fulfill their credit hour requirements by taking just one class and are at Friday Harbor almost every day. The students talk about their work via a class blog.

"Students get to learn about collecting, sampling and analyzing results," said Murray. "And it's great because they can see if they want to go on in research."

## What About BOB?

Someone within earshot of Lisa Adams while she talks about her water quality monitoring work might wonder how a certain colleague named Bob puts up with her.

"I adopted Bob as my own research program," they might hear her say, as she did in a recent interview.

And it's not just her. "His Bob was in a rice field," she said of one researcher. "They've made a Bob on steroids," she said of another group.

But Adams, an associate professor in the biology and physics department at Kennesaw State University in Georgia, isn't talking about Bob. She's talking about BOB—the Basic Observation Buoy. It's a low-cost, highly adaptable water quality monitoring platform that's forging a connection between students and their local waterways while helping train the next generation of scientists to gather and interpret environmental data.

BOB began as the brainchild of Doug Levin, who developed the buoy while at the National Oceanic and Atmospheric Administration's Chesapeake Bay Office as a way to give students a hands-on experience in learning about local water quality.

The platform is constructed from PVC pipe and pegboard. From there, the design and instruments are customizable for whatever purpose, from casual outreach and education to collecting high-quality data for government monitoring programs.

Adams caught wind of BOB after the Southeast Coastal Ocean Observing Regional Association and Centers for Ocean Sciences Education Excellence (that's SECOORA and COSEE for short) adopted the platform as an outreach tool. In 2009, the groups hosted a BOB workshop and asked Adams to join in.

After that, Adams joined the cause. She exiled the \$13,000 piece of equipment



The standard Basic Observation Buoy build plan calls for pegboard and PVC.

she was using to monitor a tidal creek in South Carolina to a corner of the lab and shifted her focus to bringing the BOB experience to students in the Southeast. She now works to build partnerships between schools and science education centers.

Her first success came in 2010 when she partnered with Angela Taylor, a teacher at Hilton Head Preparatory School, and the Coastal Discovery Museum. The class deployed a buoy in a tidal creek on the museum's property and used salinity data from PASCO sensors to track tide cycles.

"It was a beautiful partnership between a university scientist, a high school that was just dying to get their hands and feet wet, and an informal science education center that used it as an outreach tool," Adams said. "The kids really got into it because the creek was in their backyard. It just became a personal connection and a hands-on experience that was very meaningful for the students involved."

Adams is in the midst of starting a new partnership with the Chattahoochee Nature Center's Director of Education Tom Howick. This BOB floats on one of the center's ponds that leads into the Chattahoochee River. The data they collect is posted on the SECOORA

website similar to a professional monitoring network's data portal.

"Not only do the students get to collect data for their watershed, but they get to post and share it on the SECOORA site for all to see," Adams said. "It parallels what a scientist would be doing in a real ocean observing situation like SECOORA does."

Adams hopes to take student data sharing to another level with her next project, called SPLASH—Student Programs like Aquatic Science Sampling Headquarters. The plan is to build a social network based on water data that will give students experience of collecting data and sharing it online.

Submitting data to a central hub is fairly common practice for professional scientists, but the rigidity of the process makes it difficult to involve students.

"When you think about the big issues like climate change and ocean acidification the future scientists will process vast amounts of data to model and forecast these changes," she said.


"But before these students can become proficient data consumers, they must experience data collection for themselves and be data producers." 

Photo: Lisa Adams

## Flood of Knowledge

On a late summer day in 2011, Jen Whisner and a few of her students from Bloomsburg University of Pennsylvania floated down nearby Fishing Creek, logging the GPS coordinates of stream features like submerged trees, eroding banks and gravel bars.

They were on the lookout for "anything geomorphologically interesting," said Whisner, assistant professor in the school's Department of Environmental, Geographical, and Geological Sciences. They didn't know at the time that the data they collected would soon become the "before" picture—a reference point for a record-setting flood that would ravage the town of Bloomsburg, Pa.

The data is part of a growing initiative to involve Bloomsburg geology and geography students in tracking the changing creek, and the experience will teach students the skills of their chosen field while producing useful data to help regional planners cope with historically flood-prone waterways.

"We have a lot of students who are in geography and planning majors, so they would be the sorts of folks who go out and use these data," Whisner said. "And the geology students would be the ones who go out and produce the data."


By plugging students into the critical thinking behind good natural resources management, the school can help provide that science and a great educational experience. 



Photo: (left) Jen Whisner; (right) Irene Chu of the Water Supplies Department, Hong Kong Special Administrative Region



## World Water Monitoring Challenge

People from America to Zimbabwe began scooping up a cup of the local agua this March, sharing their findings with the world as part of the World Water Monitoring Challenge.

What started as a one-day celebration of the Clean Water Act is now an international awareness event with a quarter million participants spanning time and space to raise awareness about water quality.

"Water monitoring is really one of the tools that we use to get (people) out to their waterways," said Lorien Walsh, who manages the program for the Water Environment Federation.


On Oct. 18, 2002, America's Clean Water Foundation started World Water Monitoring Day on the anniversary of the Clean Water Act. Just a few years later, the Water Environment Federation took over the event. Walsh described the transition as a "natural fit," noting the organization wanted to raise more awareness for the importance of water quality.

One thing that had to change was the limited 24-hour window for monitoring waterways. More international engagement couldn't happen until

people had more time to get out and sample. If the schedule broadened, Walsh and her team thought, groups will sample. So, they turned the one-day event into a ten-month challenge, from March through December.

The idea worked. During the first World Water Monitoring Day coordinated by WEF in 2006, there were 28,150 documented site visits submitted. Participation grew nearly nine times with more than 250,000 site visits documented by 2012. Groups from 66 countries partook in the 2012 event.

WEF and IWA provide water monitoring test kits to challenge participants. The kits include tablets that dissolve in water samples and change color to indicate pH and dissolved oxygen levels. The cup containing the components doubles as a sampling container and is used to measure turbidity with a Secchi disk decal attached to the bottom.

Participants are also welcome to add parameters or use their own instrumentation to collect data. Site visits can be logged into a database on the World Water Monitoring Challenge website, [www.monitorwater.org](http://www.monitorwater.org). 

# Plan for Prawn

African river prawn restoration helps fight a prolific parasitic disease

BY JEFF GILLIES



A dam built on the Senegal River in the 1980s wiped out the basin's population of the African river prawn. A plan to bring them back goes well beyond restoring native biodiversity—it could also save thousands of people from a disease now running rampant among the rural poor in Senegal.

The Diama Dam helped secure the West African coastal nation's supply of fresh irrigation water against encroaching salt water. But it also tipped off an ecological domino effect that led to the outbreak of schistosomiasis, a parasitic disease that attacks the internal organs and can lead to organ failure. Humans pick up the disease through simple contact with shallow river water while playing, bathing or washing clothes and dishes. A free-swimming form of the parasite burrows into human skin.

Freshwater snails play host to the parasite for part of its life cycle. In the Senegal River system, the snails—and by extension, the disease—were once kept in check by the African river prawn, its natural predator. But the dam cut off the prawn's migratory route to its brackish spawning grounds in the river's estuary. Once its predator disappeared, the snail population grew quickly. Schistosomiasis infection rates rose with it.

A drug developed to treat the disease has suppressed infection rates somewhat, but its effects are limited. It's not a cure and it doesn't prevent reinfection.

That's one reason that Elizabeth Huttlinger is leading an initiative to squash the parasite before human infection can occur. Huttlinger leads Project Crevette (French for prawn), a plan to reintroduce African river prawns to the Senegal River basin. If it works, the plan could cut infections, restore a native species and create a local marketplace for the prawn, which is a favorite in restaurants worldwide.

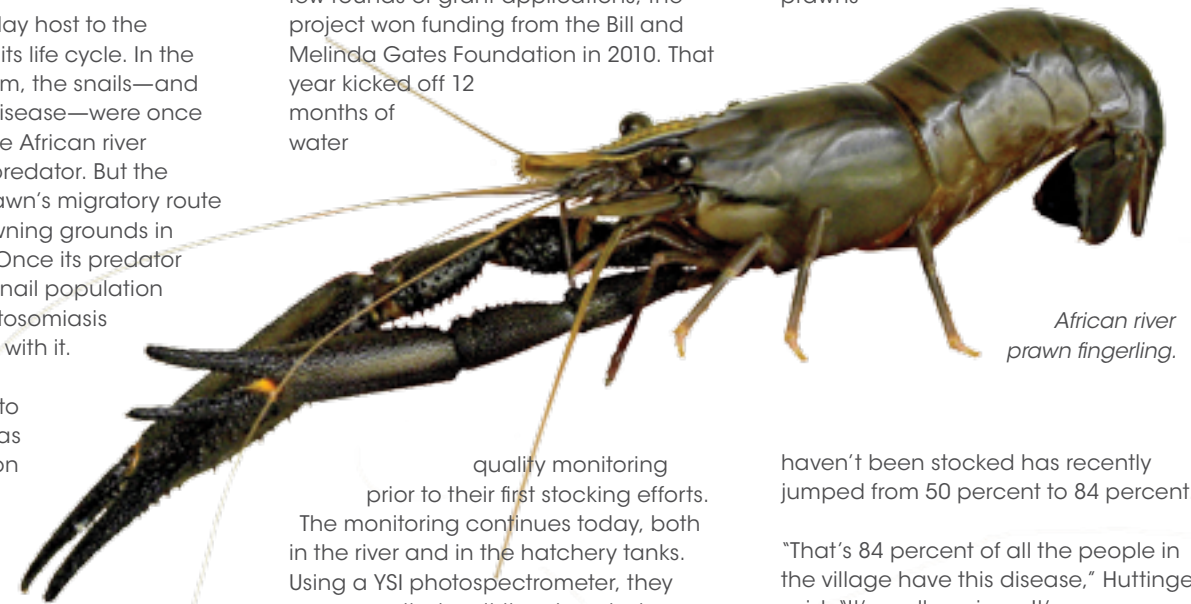
Huttlinger hatched the plan when she was working for the United Nations Global Fund on disease issues. Armand Kuris, a professor at the University of California Santa Barbara, told her about his success in lowering schistosomiasis

infections in Kenya by introducing the Louisiana crayfish.

It occurred to Huttlinger that stocking local water sources with hatchery river prawns could have the same infection-cutting effect. And what's more, the prawn's commercial value could make the strategy self-sustaining. Prawns raised, stocked and sold by villagers could maintain an infection-fighting population that doesn't depend on constant funding from outside foundations or non-profits.

"If you can put money in the pockets of people who are outside the cash economy, that's about as strong a motivator as you can find," Huttlinger said.

After a trip to Senegal in 2007 and a few rounds of grant applications, the project won funding from the Bill and Melinda Gates Foundation in 2010. That year kicked off 12 months of water



African river prawn fingerling.

quality monitoring prior to their first stocking efforts. The monitoring continues today, both in the river and in the hatchery tanks. Using a YSI photospectrometer, they measure nitrate, nitrite, phosphate, calcium hardness, ammonium, magnesium, iron, and pH.

Tracking calcium in the river gave an indication of how the prawns would acquire this mineral for building their thick shells, which they shed many times as they grow. When the project's river monitoring showed very low levels of naturally occurring calcium, the researchers could assume the prawns would get what they needed by feasting on snails.

"It was particularly interesting for us to check calcium in the water because we wanted to know: How activated would their snail-eating instinct be? How voracious would they be towards the snails?" Huttlinger said. "It turns out

they're very aggressive towards the snails because there is no other source of calcium."


The more important evidence that the prawns are doing their job is the shrinking rate of infection at the project's three test sites, where the number of cases has dropped by around 50 percent. Those who do get infected carry a lower number of parasites, which mutes the symptoms.

Though that's good news, the project is still in its early stages. Meanwhile, a species of snail once thought to play host to only the bovine strain of the disease was recently discovered harboring the human strain. A new vector species increases the risk of infection. The rate of infection in a village where prawns

haven't been stocked has recently jumped from 50 percent to 84 percent.

"That's 84 percent of all the people in the village have this disease," Huttlinger said. "It's really serious. It's very grave and tragic. You hope not to see infection rates above the teens or 20 percent."

The project isn't ready yet to provide prawns for the whole region, but they're working hard at their hatchery to get all the parameters right so they can start producing more. Ideally, they'll soon be hatching not only more prawns but more hatcheries.

"We're trying to make it as simple as possible so that any small entrepreneur can start up a small hatchery in their home just as a small business," Huttlinger said. "We want to keep it as foolproof and as cheap as we possibly can." 

All Photos: Elizabeth Huttlinger



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## River in a Box

Model river helps study groundwater discharge

BY DANIEL KELLY

Studying rivers can be unpredictable. Boats can get tossed around by currents and make buoy deployments difficult. Wildlife and debris in the water often get in the way.

To get around Mother Nature's whims, researchers at the University at Buffalo have built their own model rivers. Chris Lowry, an assistant professor of geology, uses one of the scale models to study groundwater discharge in rivers and streams. But he does it in a way few others do, using temperature as a tracer.

"Using temperature as a groundwater tracer is something that's been around for a while. It has a lot of great applications, but it's underutilized," said Lowry.

He can model the interaction between groundwater and surface water, which helps for verifying field results and makes it easier to locate groundwater hotspots in real rivers. The results are important for restoration projects and stream monitoring.

The method involves pumping cold water up through an artificial streambed made of sand. The surface water, meanwhile, is heated and cooled to mimic the temperature change water undergoes in a typical day. By measuring the effect that the cooler simulated groundwater has on the warmer surface water, it's possible to chart how the simulated groundwater spreads.

The tank Lowry uses is made with a metal frame, fiberglass and marine-grade plywood. It's five meters long, a meter tall and about 60 centimeters wide. A divider in the middle separates water going up one side and down the other, making a study area of 10 meters. Perforated pipes at the stream bottom pump in the cooler water, which ranges from 8 to 10 degrees Celsius, and Lowry can control where that water is introduced in the stream.

A Sensornet fiber optic cable detects temperature changes and two temperature loggers confirm them. The cable is buried in the sand.

"The fiber optic cable lets us measure temperature over a distributed area," said Lowry. "We can actually tell the temperature for each meter."

Lowry says using temperature as a tracer is very easy and cheap, noting that the loggers used only cost a few hundred dollars. It's a very useful technique that he says people are overlooking.

It would be easy to change the streambed materials to mimic other environments. Changing from sand to a mix of clay, gravel and other sediment would be simple. As the research progresses, other tracers could be used as well.

But Lowry is focused on a temperature tracer for now.


"I'd like to benchmark this technique, to make it a standard that people use to start to identify where groundwater is discharging and how much," said Lowry. 

Photo: University at Buffalo

# TAKING THE TUNDRA'S TEMPERATURE

A weather station network in Arctic Alaska collects valuable climate and permafrost data while withstanding extreme weather and curious bears

BY JEFF GILLIES



The remote climate stations are accessible by plane in the summer and snowmobile or dogsled in the spring.

All Photos: Frank Urban / USGS



When the U.S. Geological Survey began building their climate and permafrost monitoring network in Arctic Alaska in 1998, there wasn't much precedent for how to build the infrastructure for the instruments in the region's unforgiving environment.

That meant the scientists had to learn the particulars on the fly. For example: On the great expanse of flat, barren tundra, a weather station sticks out like a sore thumb to a curious grizzly bear.

"The initial stations were pretty fragile," said Frank Urban, a geologist with the USGS Geosciences and Environmental Change Science Center. "So the bear and those stations—the bear won every single time without any problem."

Today, the sensors are cinched down tightly to steel or heavy aluminum tripods and the wires are encased in steel conduit to withstand the brute strength of bears. They've also had to overcome another problem more akin to keeping a squirrel out of a bird feeder, but in this case the pests are 30-pound carnivores.

"We have a lot of problems with wolverines up there," Urban said. "They climb the stations, so we've had to work on making them less simple to climb."

The result of all that work adapting to local fauna—not to mention high winds and extreme low temperatures—is an array of 16 climate and permafrost monitoring stations collecting continuous data across two tracts of federal land in northern Alaska.

The data collected by the network is particularly important because polar regions show the effects of climate change more dramatically and more quickly than other parts of the planet, Urban said. Yet the climate in regions like the Arctic National Wildlife Refuge and National Petroleum Reserve – Alaska has been poorly recorded. That's mostly because it's a remote and difficult place to work.

"There are very few if any roads and very few settlements and towns," Urban said. "There haven't

been many people collecting spatially distributed environmental data, whether it's temperature, or snowfall or rain until the last 10 or 15 years."

The 16 stations measure standard climatic variables, including rainfall, air temperature and pressure, wind speed and direction, and snowpack depth and duration.


Another instrument measures subsurface permafrost temperatures at ten depths down to 1.2 meters. Yet at some sites, the permafrost runs as deep as 400 meters. The story of how deep permafrost is measured goes back to the 1970s, when the USGS worked with the U.S. Navy and private oil companies to drill exploratory wells in the National Petroleum Reserve – Alaska, Urban said. None of the wells produced oil, and a USGS researcher on the project had the foresight to suggest to prepare the wells in such a way that crews could return in the future and use them to measure permafrost temperatures.

And now they do.

"We have a winch that we bring and we send a very sensitive thermistor probe down into these boreholes," Urban said. "By taking a set of temperature measurements every one to three years at these places, we can then build up a temperature history of deep permafrost."

Urban said he visits each site at least once a year, and sometimes twice a year. In the summer, the crews maneuver from site to site by helicopter and fixed-wing plane. In the spring, they'll go on long snowmobile expeditions. In the Arctic National Wildlife Refuge, where they discourage motorized vehicles and the distances between sites aren't as far, they'll use dogsleds.

The stations are challenging to get to and the environment is difficult on the sensors and the researchers, but the work is fulfilling, Urban said.

"It's pretty fun to do," He said. "But it's not like putting up a weather station in the field next to your house." 

# Air Quality Egg

Collaborative sensor project shows the power of open source innovation

BY AUSTEN VERRILLI



An openly developed air monitoring device in an egg-shaped package raises a question. Can science work at public demand, or do scientists determine what people need?

In the case of the Air Quality Egg, the public won the tug-of-war. From start to finish, the project has been completely open: Anyone could participate, anyone could draft ideas and anyone could fund the project.

A community effort composed of people across the world built the sensor using open source technology. Most worked in their spare time, contributing whatever expertise or elbow grease they had.

The result was a sensor that collects air quality data outdoors coupled with an egg-shaped base station that

stays indoors. The two communicate wirelessly and the base station transmits air quality data onto a free online database in real time. That's all in a package that costs \$185.

The project started when Ed Borden, the lead organizer, began engaging people through an online social network while working for a company called COSM, which enables tech startups. Borden built a face-to-face community using Meetup, a social network that acts as a catalyst to get enthusiasts together in person.

Borden started a group called Sensemakers in 2010. In October of 2011 people started meeting in person. The project took off with meetings in New York City and Amsterdam to draft ideas, test and build the package. "Our goal was to put something out that was very

active and could get people interested in this issue that affects all of us," Borden said.

Preexisting technology enabled the Air Quality Egg's quick development. The sensor package starts with an Arduino microprocessor designed for a variety of custom DIY computing needs. Developers then integrated coupled carbon monoxide, nitrogen dioxide, temperature and humidity sensors designed for the auto industry.

Once the group had a working prototype, they continued their open source methods by crowdsourcing funding to produce the Eggs. The group asked for \$39,000 total to fund the project through a Kickstarter campaign. They hit their goal in five days and ended up with more than three times the requested amount when the 30-day campaign closed.

"I think it just says this is an issue that's important to people and they want to be involved at some level," Borden said.

The Air Quality Egg is now in production through a contributing company called Wicked Device. About 400 have been built and shipped to people across the world. A total of 1,200 were ordered so far.

Despite success and popularity of the egg, the speed and method of development and release limited its capability.

Borden unabashedly said he knows scientists would not consider the monitoring device accurate enough for their studies. He said the device only detects pollution when it gets to higher levels and does not pick up trace levels.

The package also can't be calibrated. "Calibrating the sensor is something we didn't know how to do at this price point," Borden said.

Despite its low resolution and low accuracy, the sensor may provide some valuable information to average Joes, Janes and scientists alike. There is already a network of the sensors broadcasting information from countries across the world. AV

Photo: Albert Chao

Photo: Iowa State University Limnology Lab

# Muddy Waters

Scientists turn to sensors in Iowa's Storm Lake to sort out resuspending sediment

BY ADAM REDLING

Wind probably isn't the first thing that people think of when considering causes of poor water quality, but sediment disturbances caused by the combination of shallow waters and high winds are threatening the health of Iowa's Storm Lake.

Led by Clayton Williams and John Downing, professors in Iowa State University's Department of Ecology, Evolution and Organismal Biology, a research team has begun monitoring the lake to determine the causes and potential solutions to the lake's sediment issues.

In early April, the researchers placed Manta 2 multiprobe sensors on the water's surface and at the lake's bottom that will continuously measure the water's turbidity, temperature, pH, water depth and conductivity. Researchers are using a YSI 6600 sonde to measure a vertical profile of dissolved oxygen, conductivity, pH, depth, temperature and turbidity. In addition to the team's sensor data, they'll also monitor Storm Lake's algal biomass, total phosphorus,

total suspended solids and total nitrogen conditions.

The monitoring is being conducted at the same time as the Storm Lake Dredging Program, which is an attempt by the Iowa's Department of Natural Resources, Lake Preservation Association, Lake Improvement Committee, Buena Vista County and cities of Storm Lake and Lakeside to increase the lake's depth.

"In Storm Lake, wind is the main driver for the sediment resuspension," Williams said. "So, they're dredging to deepen the overall average depth of the lake to limit the bottom that the wind can hit and impact."

Keeping resuspended sediment down is essential for maintaining Storm Lake's clarity, which is vital for the lake's ecological balance. Limiting light exposure influences the plants that can grow in the lake, Williams said.

"If they don't have enough light, there won't be as many aquatic plants," he

said. "They help stabilize the bottom. They also give a habitat for fish and things fish eat."

Researchers are also investigating other measures to help improve the water's turbidity. For instance, stabilizing shorelines could cut erosion in the watershed. Stopping erosion could help curb sediment pollution from outside sources finding its way to Storm Lake.

It is still too early for researchers to draw definitive conclusions from the data, but their aim is to help provide long-term solutions to the lake's sediment problem.

"Our goal is to provide the Iowa Department of Natural Resources, as well as the partners of Storm Lake and the city of Storm Lake, with various options for how dredging is influencing sediment resuspension," Williams said. "So, we're hoping to be able to link the wind to our in-lake sensors to tell them how the lake responds to wind so they can better manage the lake." AV



# RUNNING RECON

The Sanibel-Captiva Conservation Foundation's observatory network keeps an eye on a Southwest Florida estuary

BY JEFF GILLIES

In January 2010, a cold snap swept through Florida, bringing air and water temperatures down well below normal with disastrous effects for some marine species.

A die-off of snook, a popular game fish, was so widespread that the state closed the recreational harvest for the species—a ban that remains in place today.

The chill was also hard on sea turtles, which suffer from “cold-stunning” when water temperatures drop below a certain threshold, according to A.J. Martignette, a research assistant with the Sanibel-Captiva Conservation Foundation Marine Laboratory.

“They get very lethargic and can have trouble coming to the surface to breathe,” Martignette said.

The conservation foundation laboratory's seven-station water quality monitoring network in the waters around Sanibel and Captiva islands, Gulf Coast barrier islands in Southwest Florida, recorded water temperatures in the mid- to low-40s Fahrenheit. Prior to that, the lowest temperature the system had recorded since its installation in 2007 and 2008 was around 55 degrees.

“We were diving in water that got down to 43 degrees,” Martignette said. “That was very cold for here.”

The River Estuary Coastal Observing Network, or RECON, measures a full array of water quality parameters at seven locations around Sanibel Island and up the Caloosahatchee River. Continuous measurements from a Satlantic LOBO instrument at each site are broadcast in real-time to the network's website.

Today, the network is programmed to alert managers via email if temperatures persistently hover around levels that could trigger another cold-stunning event. The early warning could help save time in rallying troops to help scoop up struggling turtles and take them to rehabilitation centers.

“There are state resources that can be mobilized,” said Eric Milbrandt, the marine laboratory's director. “Universities and research labs that may have vessels can put them on alert and maybe sidetrack some of their other activities to come and rescue animals.”

The real-time data from the network also helps inform the foundation's weekly consultations with the U.S. Army Corps of Engineers over water management in the area. Sanibel Island sits at the mouth of the Caloosahatchee River, which flows from Lake Okeechobee and along the northern edge of the Everglades before draining into the gulf. The corps operates a dam on the river that controls how much water flows into

the estuary. The volume of that flow has a big influence on the nutrients and salinity in the marine habitats around the island, but the corps also has to meet needs for flood control and water storage for Everglades sugar cane farms.

“The fresh water that's coming from that structure is highly managed and manipulated depending on the needs of the people around Lake Okeechobee, the needs of the Everglades and the needs of the Everglades agricultural area,” Milbrandt said.

Releases from the dam are typically low in the winter because the corps is storing water for agriculture. The drop in freshwater inputs drives salinity up around Sanibel Island. In the summer, dam releases are increased to help control flooding, which pushes salinity down.

“And that stops any submerged aquatic vegetation from being able to get a foothold in there,” Martignette said. “The freshwater grasses die off in the winter when the salinity goes up. And then the saltwater grasses die off in the summer when the salinity goes down.”

The flood control releases also bring high nitrogen and phosphorus loading, which is thought to intensify red tide blooms.

So, the Sanibel-Captiva Conservation Foundation joins a weekly conference call of scientists and generally requests that the corps sends more or less water, depending on the time of year. Fresh data from RECON helps back up their arguments.

“That's where the real-time capability comes in very handy,” Martignette said. “If we were getting the data two weeks after the fact, it wouldn't do us much good for that.”

RECON also includes several weather stations that help inform the local boating community. Boaters will also benefit from a planned expansion of the network. A Nortek AWAC sensor paired with a NexSens CB-500 Coastal Data Buoy will bring real-time wave and ocean current readings to the area for the first time, Martignette said.

“We have the scientific reasons for it,” he said. “But the website is there for anyone to go on and check out.”



All Photo: Sanibel-Captiva Conservation Foundation

# BLOOMS ON THE HORIZON

Phosphorus loading means another record  
Lake Erie algal bloom possible

BY AUSTEN VERRILLI

Photo: Tom Archer

A recent resurgence of large scale algal blooms in Lake Erie may be a sign of much more scum to come. It's a fact that a vast collaboration of local and national researchers and regulators are working to combat.

The National Oceanic and Atmospheric Administration, Ohio State University, Heidelberg University and many other organizations have collaborated to predict a 2013 bloom covering about 1,000 square kilometers of the Lake Erie's western basin by September. The groups announced the prediction during a July 2 event gathering researchers and administrators at the Ohio State University Stone Laboratory.

Phosphorus loading from agriculture, cities and municipalities is thought to be the main cause for blooms. Collaborative research through the Ohio Phosphorus Task Force has established target thresholds, which, if met, may greatly reduce the likelihood of future blooms.

Gail Hesse, director of the Lake Erie Commission and co-chair of the Ohio Phosphorus Task Force, said if Ohioans can reduce phosphorus runoff by about 40 percent, algae will not have enough food to create a massive bloom. Spring phosphorus loading from March through June must be less than 800 metric tons to minimize algal blooms.

"To meet that target, the people on the land have to do their part, whether it's changing agricultural practices, sewage treatment upgrades or how they fertilize their own lawns," said Justin Chaffin, research coordinator at the Ohio State University's Stone Laboratory, in a phone interview.

Chaffin was part of a group of 29 researchers participating in a study of causes of Lake Erie's record 2011 algal bloom, which covered 5,000 square kilometers of Lake Erie's Western Basin. The researchers determined that phosphorus loading leaves the lake to mercy of weather patterns, which can foster more massive blooms. The results were published in Proceedings of the National Academy of Sciences in April.

Phosphorus in the lake mainly comes from Maumee Bay, near Toledo. It washes off some 4.5 million acres of agricultural operations pushing to deliver soybeans and corn to market.

Chaffin said calm hot summer weather escalated the situation in 2011. "All that spring (season) water that had phosphorus entered the Maumee Bay and just sat there," he said.

With more than 2,000 metric tons of phosphorus in the mix, the lake became an incubator for cyanobacteria.

Residents on shore soon saw the results. A 10-centimeter-thick fluorescent green scum covered much of the lake's western basin.

That made for a bad summer for Rick Unger, charter boat captain and president of the Ohio Charter Boat Association. "It basically shut down my fishing for that season," he said during the 2013 algal bloom prediction briefing.

Despite bleak predictions, people in the state of Ohio have dealt with this problem before.

In the 1960s and 1970s, harmful algal blooms were a big problem in Lake Erie. "The problem was the same, but the source of phosphorus was different," Chaffin said.

The biggest contributor back then was raw sewage, running into the lake and feeding algae. Municipalities worked to improve water treatment, which reduced the preponderance of blooms.

“REALLY, WE ARE ALL  
IN THIS TOGETHER.”

-Jeff Reutter


Director of the Ohio State University Stone Laboratory

Chaffin said if farmers and citizens can work to mitigate fertilizer runoff, they too can solve the new algal bloom issue in Lake Erie.

Jeff Reutter, director of the Ohio State University Stone Laboratory, said everyone has to keep reduction goals in mind during daily life to help reduce phosphorus. "Really, we are all in this together," he said during the 2013 prediction briefing. "So, we should all be thinking, 'Alright, we need to reduce loading by 40 percent. So, how can I reduce my loading by 40 percent?'"

Hesse, of the Ohio Phosphorus Task Force, and Scott Nally, director of the Ohio Environmental Protection Agency, confirmed that they will be working with farmers, businesses and municipalities to reduce phosphorus runoff. Nally said Ohio EPA will also be the first state regulator to have a nationally sanctioned nutrient management plan, which should be approved in the coming months.

Speakers during the briefing mentioned that local citizens can do their part by using zero phosphorus fertilizer on their lawns, building rain gardens and using low flow toilets.

Harmful algal blooms produce toxic microcystin, which can kill wildlife and even poison people that drink or contact the water. 

# WHALE SOUNDS

A University of Washington team is using sensors meant for measuring earthquakes to track endangered whales

BY DANIEL KELLY

Tagging endangered whales for research is a controversial practice. The leviathans of the deep are mammals, just like humans, and many people believe they have feelings and experience pain just the same.

In response, researchers from the University of Washington have come up with a way to track whales without tagging them. They use seismometers - earthquake sensors - to track the creatures' movements in the deep blue sea.

By following vibrations from sounds the whales make and calculating time between seismometer recordings, it's possible to triangulate the mammals' locations. Knowing their location and movement patterns could help shipping vessels avoid hitting the endangered creatures, one of their biggest threats.

The network of seismometers that the researchers use was originally put down for volcanic study, to listen to earthquake cracks and monitor changes in rock and hydrothermal fluid. It was installed with a remotely operated vehicle on Juan de Fuca Ridge, a seismically active zone off the coast of Washington state.

The seismic sensors used for tracking have been snugly buried in hardened lava near the seafloor. They're placed in a cylinder which is inserted by the remotely operated vehicle into a hole about 15 inches deep and two inches in diameter.

"Sounds travel through the ocean at about a mile per second. A whale can make sounds many meters deep," said William Wilcock, professor of Oceanography. "Seismometers record

the first and last locations and from there we can triangulate movement. At the same time, we're also recording sounds."

Wilcock says that the recorded sounds give a clue to different calling patterns. By looking at those patterns, he says, the whales' behavior can begin to be inferred. The team gets most of its data from fin whales because they are slightly more abundant than more endangered blue whales.

The seismic sensors are designed to listen to sounds at 1-200 Hertz, says Wilcock. Impulsive sounds come from earthquakes, while monotonous sounds come from whales.

"Sounds are different from fin whales, at about 20 Hertz," said Wilcock, noting an interesting communication pattern between two fin whales. "One vocalized every 25 seconds and the other would occasionally pop in. Eighty percent of communication was coming from one whale."

Acoustics are a very powerful technique to cover a large area, says Wilcock. One limitation, however, is that researchers can't be there in person to observe the whales. But researchers are making discoveries in associating sounds with particular behaviors. One of his students determined about 150 tracks of fin whales vocal over the fall, winter and spring seasons.


"We found groups of whales swimming north quickly, which was surprising because of the typical behavior of baleen whales to take in lots of food in high lots," said Wilcock. "They usually go south to breed, but these were heading in the opposite direction." 



Photo: (Clockwise from top) Mitchell Ellend; John Delaney and Deborah Kelley; Deborah Kelley and William Wilcock

Clockwise from top: The remotely operated vehicle ROPOS being recovered by the R/V Thomas G. Thompson with a short period seismometer package; One of eight seismometers installed at an ocean spreading-center volcano 150 miles off Vancouver Island; A Guralp broadband seismometer installed in a MBARI invented housing placed into a hole in sediments on the seafloor.



# EYES OVER PUGET SOUND

State's scientists connect public to Puget Sound with aerial photos and water data

BY JEFF GILLIES

The state scientists who track water quality in Puget Sound in Washington state have found a way to capture something that neither their high-tech sensors nor laboratory analysis could: the public's attention.

Puget Sound is a complex estuary system made up of several branching channels, basins and islands. Four times a month, the Washington State Department of Ecology charters a float plane as a cost-efficient way to hop between 40-odd water sampling stations spread across the Sound's roughly 1,000 square miles.

In 2011, Christopher Krembs, lead oceanographer with the ecology department, realized that the plane had an empty seat on its flights over the Sound and from Olympia where it picks up monitoring equipment. Now Krembs occupies that seat once a month, making good use of his love for photography.

"It's my highlight of the month," Krembs said. "It gets me out of cubicle land."

And it gets the department's Marine Water Monitoring Unit some compelling outreach material at no extra cost. Each flight, Krembs shoots up to 500 aerial photos of the Sound, capturing both the beautiful scenery and important environmental events like algae blooms, oil spills, clustering jellyfish and sediment plumes.

Within two days of the flight, the best handful of photos are packaged with the monitoring program's most recent and long-term data and released online as the "Eyes Over Puget Sound" report. With over half a million downloads in the last year and a half, Krembs said he thinks they've struck a chord with the public.

"The nice thing about these images is we don't need to say very much," he said. "You look at them and you get a sense of scale and of intensity of these processes that are happening out there."

And pairing the pictures with both very recent and long term data helps create context that helps people follow along.

"You can tell a story," he said. "We realized when you tell a story, people really get interested, much more than if you just deliver plain data or graphs."

During the department's sampling flights, the float plane lands at a station and the crew lowers a sensor package from the surface to the bottom, up to 260 meters deep at some locations. The sensors, which include Sea-Bird CTD and WET Labs ECO FLNU units, capture a vertical profile of variables like temperature, salinity, dissolved oxygen, fluorescence and turbidity. Several sample bottles trigger at predetermined depths, collecting water that will later be analyzed for nutrients and pigments.

The program also collects data from five permanent moored stations. These sites are equipped with another suite of Sea-Bird Electronics sensors, though they aren't covered by as many sensors as the flight-based sites. Nor are they given the in-depth chemical analysis.


But while monthly flights cover many more parameters, they're only delivering snapshots. The continuous, high-resolution data from moorings help reveal processes like the transport of low-oxygen water over critical locations and between basins.

"It's like monitoring the heartbeat or the blood pressure," Krembs said of the moored stations. "Our monthly sampling is more like a blood draw where you do a full analysis of your hormone levels and everything that goes with it."

Puget Sound is a tidally driven estuary and is highly influenced by the Pacific Ocean. For example, summertime upwelling from the ocean can bring low-oxygen, high-nutrient water into the sound. Meanwhile, the sound's increasingly peopled shores also have an impact on nutrient levels. Long-term datasets help scientists distinguish between natural variability and human signals.

"The holy grail is to separate them from each other," Krembs said. "That ocean can be a big gorilla, so you have to understand that gorilla in your equation in order to understand the human impact."

Information collected by state agencies often takes a long time to get to the people, Krembs said. By pushing to get fresh data out the door within two days of the monitoring flights, Eyes Over Puget Sound is helping change that. And sprucing up the data with photos from 2,500 feet helps it hit home.

"People see now their own backyard from a very different perspective," Krembs said. "They start to ask more questions. They learn to observe the system with very different eyes. So it's creating awareness." 

*Top three: Aerial photos show blooms and plumes on the sound.*

*Bottom: The plane lowers a suite of water quality sensors at stations across the sound.*



All Photos: Christopher Krembs

# Saving Atlantic Sturgeon

Universities team up to track Atlantic sturgeon and prevent accidental bycatch

BY DANIEL KELLY



Due to over-hunting, sturgeon are incredibly rare. The fish, which was pursued for its caviar in the 19th and 20th centuries, has been deemed one of the most endangered fish in the world. Estimates placed the sturgeon population a century ago at 180,000. Today that number sits at 300 adults.

In one of the efforts to protect the endangered fish, researchers at Delaware State University and University of Delaware have teamed up to help fishermen avoid accidentally catching the creature. The project uses an ocean glider, satellites and hydrophone sensors to track surgically implanted acoustic transmitters in Atlantic sturgeon.

Dewayne Fox, associate professor of Fisheries at Delaware State, has been tagging the fish for years. He says working around sturgeons' tough exteriors can be a challenge.

"Sturgeon in their present form look like they did 73 million years ago. They have five rows of bony plates - 'scutes' - overlapping around the body," said Fox. "Larger plates spread out, so adults will have scutes the size of an appetizer plate. They're hard like bone."

Tagging sturgeon means getting past the bony plates, and Fox says doing so is possible by making a small incision in the fish's abdomen. Tagging older sturgeon is easier because the armor-like plates spread out as the fish matures.

"We cradle the fish in a sling as it comes over the side of the boat and transfer it into a large well," said Fox. "We add an anesthetic powder to the bath that knocks the fish out, then roll the fish belly up, make a small incision in the abdomen, implant the transmitter and suture it up."

Each acoustic transmitter is about the size of an index finger and is implanted within an enclosure of silastic, a latex epoxy developed for organ transplant products to minimize rejection rates. After the operation is complete, the anesthetic is pumped out of the water and the fish regains consciousness before it is released.

Which is when Matt Oliver, assistant professor of oceanography at the University of Delaware, can track the sturgeon with a Slocum glider called OTIS, or oceanographic telemetry identification sensor, in Delaware Bay. The glider works with hydrophone sensors moored along the bay, for tracking sturgeon

numbers there by picking up the acoustic transmitter signals when sturgeon swim by.

"We started thinking about how the fish utilizes and selects environments of the coastal ocean for a possible regulation of the species to find out how to avoid bycatch - when you catch a species of fish that you're not intending to catch," said Oliver. "There's no one out there trying to catch sturgeon."

The glider is also giving data on water quality while completing its three-month mission. It pulls in data on oxygen levels, temperature, salinity, currents, clarity and turbidity in addition to a few other parameters. The data will help detect where the fish is most likely to go and Oliver hopes to one day forecast the likely locations of sturgeon so fishermen can avoid those areas.

"Matt's glider can go where we can't put hydrophone sensors," said Fox. "And as it goes on, it collects attributes related to water quality."

The glider's water quality data may also help in the mission to protect native spawning grounds.

Sturgeon spawn in rivers and then go into the ocean to mature. Luckily, Fox has that part covered. He helped found the ACT



Atlantic sturgeon are weighed shortly after being brought aboard. All photographs taken under the authority of NOAA-NMFS Permit No. 16507

(Atlantic Cooperative Telemetry) network, a group of researchers who share data on more than 45 tagged species up and down the Atlantic coast.

"We maintain a network of 150 hydrophone sensors from the coast of Virginia to the Hudson River, working with partners in New Jersey and Pennsylvania," said Fox. "When a tagged sturgeon swims by, a hydrophone detects it."

Satellites are used to measure ocean parameters in broad sweeps, interpreting certain conditions into colors which tell researchers what it's like in a particular area.

The glider, satellite data and acoustic transmitters combine to give researchers a view into what types of water near Delaware Bay attract sturgeon.

"In using the ocean tech that we have, like autonomous vehicles and satellites, it's easy to see that the hydrology of the coastal ocean is not homogeneous," said Oliver.

The project touches on some of the main threats to the fish, which include bycatch and habitat destruction that comes when newly built dams keep sturgeon from reaching native spawning grounds. Another threat comes from large shipping boats that use rivers to ferry their goods, Fox says. Sturgeon often reproduce in the deepest water achievable. Since modern shipping boats are so large, their propellers sometimes cross right where sturgeon are spawning.

But if bycatch can be reduced in Delaware Bay, that's one small win for sturgeon conservation efforts—something that Fox's tagging has a pulse on.

"Between 2005 and 2007 - fishing in Delaware Bay - we sampled for three years and captured around 30 sturgeon," said Fox. "This year, we've caught 50." 



OTIS - a Slocum glider - picks up signals from acoustic transmitters implanted in sturgeon and measures water quality parameters.

Photo: Delaware State University Aquatic Sciences

Photo: (left) Amy Comer; (right) Delaware State University Aquatic Sciences



# MONITORING GEAR



## PONSEL DIGISENS

The PONSEL DIGISENS water quality sensors measure turbidity, optical dissolved oxygen, conductivity, or pH/ORP. The smart digital technology stores calibration and history data within the sensor for swapping instruments in the field without the need to recalibrate. Using the built-in Modbus or SDI-12 protocols, the sensors easily transmit data to the ODEON X handheld water quality meter for spot sampling or NexSens data logging and telemetry systems for continuous remote data collection.

Applications include water quality monitoring in urban wastewater treatment, sanitation networks, industrial effluent treatment, surface water, groundwater, and drinking water.

## Lufft WS-Series

Lufft WS-Series all-in-one weather sensors are easily integrated into solutions for air pollution, hydrology, water quality, or general purpose environmental monitoring. Simultaneously measure a combination of air temperature, relative humidity, air pressure, wind direction, wind speed, liquid precipitation, and solar radiation using the integrated design with ventilated radiation protection. A built-in compass automatically corrects for wind direction on moving platforms.

Measurement output can be accessed using SDI-12 and Modbus protocols. The sensors are compatible with NexSens data logging and telemetry systems for a real-time weather monitoring solution.



## YSI MultiLab

These easy-to-use benchtop meters are ideal for laboratory applications. Measurement parameters include pH, oxygen reduction potential, conductivity, resistivity, salinity, total dissolved solids, partial pressure and optical dissolved oxygen. USB connectivity is standard for all meters to upload and manage data from a PC.

The single channel meter stores up to 500 data sets in manual mode and 5,000 data sets in automatic logging mode. The dual and triple channel meters feature a color display and store up to 500 data sets in manual mode and 10,000 data sets in automatic logging. The Intelligent Digital Sensors automatically store calibration history to transmit that information from instrument to instrument.



## Trimble Juno T41

A powerful and rugged solution for field personnel, the Trimble Juno T41 Handheld Computer has voice, SMS text and 3.75G cellular data transfer capabilities on GSM cellular networks worldwide. Users can easily download data through the Wi-Fi or WWAN connections. An 8 megapixel camera captures images that automatically include location data from the GPS receiver with 2 to 4 meter accuracy. The embedded Handheld 6.5 or Android 4.1 operating systems interface with built-in sensors, help customize applications and integrate with many systems to create a flexible complement to any project.

The long-lasting battery life provides all-day reliability. A 1GHz processor with 512 MB RAM runs software applications smoothly. The computer is built tough to withstand water, dust, shock, drop, vibration and extreme temperatures. USB devices, 9-pin serial devices or a battery charger connect easily through the custom port.



## Geneq SXBlue III

The palm-sized receiver uses both GPS and GLONASS satellites for centimeter-level horizontal and vertical accuracy in real-time. Choose the L1/L2 GPS/GLONASS RTK for real-time centimeter accuracy or GPS/GLONASS SBAS for 30-centimeter real-time mapping. The SXBlue can also operate using GLONASS with reference stations, even if the RTK network used does not support GLONASS.

The receiver can be connected to any smartphone or tablet computer like the Geneq SXPad Handheld Computer using Bluetooth, USB or RS-232. The Windows-based software allows the receiver to connect to any of the hundreds of RTK networks and RTK reference stations around the world.

## Airmar EchoRange

Measure distance to the sea, lake or stream bed using the Airmar EchoRange Smart Sonar Depth Sensor. The sensor mounts to a moving aquatic vehicle for a portable hydrographic survey system or is used as a stationary tool for scour monitoring on bridges and pillars. Made of robust stainless steel housing, the depth sensor is built to withstand high-pressure underwater environments.

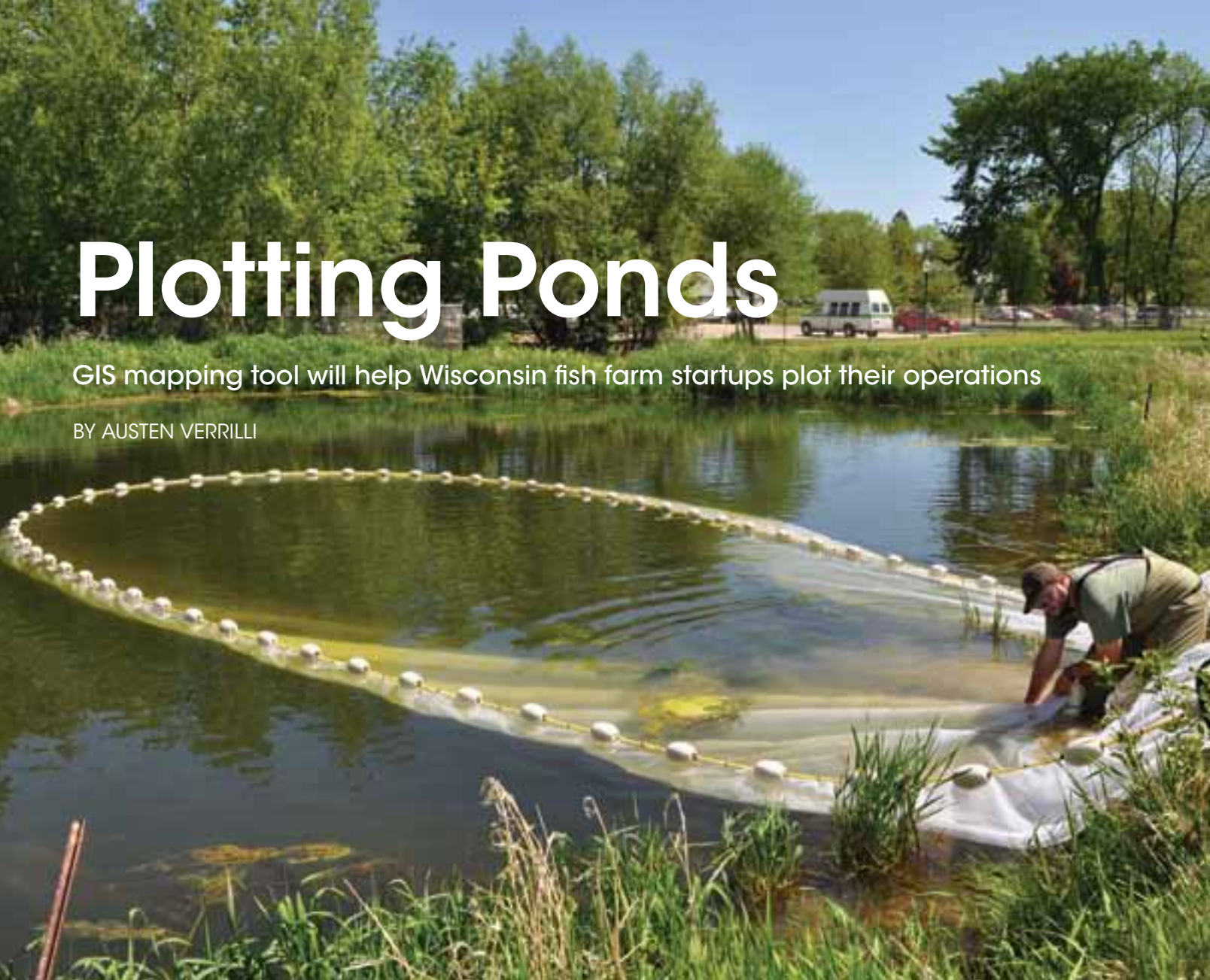
The sensor digitally processes depth signals to communicate data via NMEA 0183 protocol. Using NMEA 0183, the sensor easily interfaces with NexSens iSIC or SDL500 data loggers for real-time readings of depth and temperature.



# Plotting Ponds

GIS mapping tool will help Wisconsin fish farm startups plot their operations

BY AUSTEN VERRILLI



A new tool created by a graduate student and professor from the University of Wisconsin Stevens Point may foster a new entrepreneurial symbiosis between aquaculturists and municipalities.

Chris Hartleb, a biology professor and co-director of the UWSP Northern Aquaculture Demonstration Facility, and Allen Brandt, a UWSP graduate student focused on aquaculture, will soon release a geographic information systems tool that will show aspiring aquaculturists the best places in Wisconsin to start a fish farm.

Hartleb said GIS maps for aquaculture land planning have been created in a few states, but there was still an informational void. "It just seemed like it had been broadly applied and hadn't been used at a large scale in the industry," he said.

Aquaculture is prevalent in Wisconsin, with about 2,500 fish farms across the state. "A good chunk of that are more of the personal ponds," Brandt said.

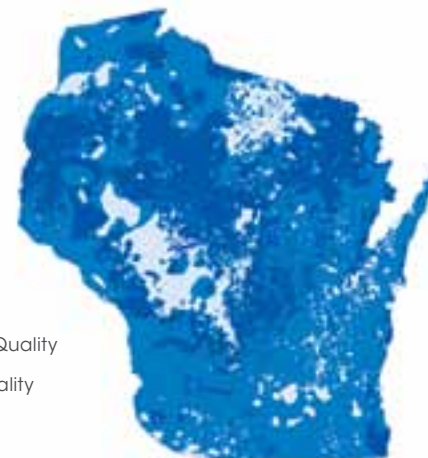
Still, there are a few hundred commercial operations in the state producing farmed fish for market. Hartleb said he knows several people looking to start a fish farm. Now, they have little choice other than to poke around different plots of land until they find something they think should work.

Hartleb saw the need for a guide for entrepreneurs seeking the right plot of land for a new farm. Brandt needed a thesis project. So, the two got to work creating a tool that would give more precision to scouting land for fish farms.

The map will incorporate a GIS map of Wisconsin with different layers of data related to aquaculture. Areas of the state will be graded based on factors like land cover, available land and water quality. Users will also be able to see locations of other fish farms.

Brandt spent some time looking over the farms already in the state to gain some insight into what makes for the best fish farm locations. He analyzed them based on the amount of time

All Photos: Chris Hartleb



## State Water Quality

- Unacceptable Water Quality
- Acceptable Water Quality
- Optimal Water Quality

Allen Brandt collected water quality data from across Wisconsin to create a GIS map layer to guide aquaculturalists.

the farms have been in business. Then he looked at the land they covered and water quality used in their operations. "The higher longevity, longer-living fish farms had similar water quality between them," Brandt said.

The farms also usually occupy land near agricultural fields or forested areas, Brandt said.

The pair's goal was also to collect an extensive list of water quality data parameters from counties in Wisconsin. They wanted to see information on dissolved oxygen, metal concentrations, pH, nutrients, pesticides and more.

Brandt was tasked with gathering water quality data from each county in the state. He gathered county-reported information, as well as data collected by the U.S. Geological Survey and data from the UW Center for Groundwater Studies.

Hartleb said things didn't go exactly to plan. "We had this long list, but the list became rather short when we looked at it in terms of what data sets are available," he said.

County-reported data ranged from extensive to downright dry, Brandt said. He found there were four parameters consistently reported by most Wisconsin counties. So water quality ratings for the map focus on pH, alkalinity, temperature and hardness.

Now that the pair has all the data collected, they are in the process of creating the map and programming in models.

There has already been interest in the map from aquaculture professionals and municipalities in the state looking to attract businesses.

Hartleb said they may take their approach to other states where there is an interest in fostering more aquaculture business. He said collaboration with Ohio State University is in the works for an Ohio map.

Once finished, the map will be uploaded to a website so anyone can access it. Brandt said it should be online by the summer. AV

## About the Northern Aquaculture Demonstration Facility



University of Wisconsin Stevens Point took over the Northern Aquaculture Demonstration Facility in 2005. The 8500 square foot facility is a center for research, collaboration and education for aquaculturists, faculty and students.

The university provides students the unique opportunity to minor in aquaculture and learn the trade in a facility equipped for research and production.

Faculty and staff also host open workshops for professionals on a range of topics from biosecurity to aquaponics, the science of raising fish and aquatic plants simultaneously.

Inside the facility, there are three recirculating aquaculture systems, which have the capacity to raise fish in warm and cold water temperatures. There are also free-flow tanks, a water testing lab and an incubation system.

Outside, the facility has four half acre ponds, two 60 foot raceways and two high capacity wells, capable of supplying 1,600 gallons of cold, clean water per minute to the facility.

If you have any questions about Wisconsin Aquaculture look up the center on the University of Wisconsin Stevens Point website.



Lake Herring fingerlings school in a tank in the Northern Aquaculture Demonstration Facility.

# Dissolved Solids Dwindling Insects

Researchers explore the connection between coal mining and dwindling stream insects

BY JEFF GILLIES



The rubble left behind after a Central Appalachian mining operation scrapes or blasts its way to a coal seam isn't as inert as it looks.

Around a decade of research has increasingly associated compounds that leach away from the freshly exposed rocks with declines in sensitive insects that live in the headwater streams draining the mined mountain region.

But there are aspects of the relationship between bug populations and the compounds—measured collectively as total dissolved solids, or TDS—that remain unexplained. Scientists at Virginia Tech's Virginia Water Resources Research Center are seeking answers through a stream monitoring program that is helping to keep regulators, policy makers and members of the mining industry informed.

Mining unearths long-buried rocks, exposing them to oxygen and water. This kicks off chemical reactions that release anions and cations like calcium, sulfate, magnesium and bicarbonate.

"They leach when they're exposed to water," said Stephen Schoenholtz, a professor with Virginia Tech's Department of Forest Resources and Environmental Conservation and the research center's director. "They leach into the streams and often will create high pulses of these solids that can be, in high levels, detrimental to the biota in the streams."

Despite the apparent connection between high dissolved solids and impaired macroinvertebrate populations, the details of the cause-and-effect relationship between the two has been contentious and in need of unbiased study, he said.

An effort to meet that need began when Anthony Timpano came to the research center as a graduate student in 2008. Timpano, a life-long Virginian, fostered an interest in aquatic insects while fishing in the state's headwater streams.

"I developed an interest in these benthic macroinvertebrate communities because they're the primary diet for trout, and we mimic them with flies," said Timpano, now a research associate with the research center. "That's how I learned about them as a young person, and as I grew older I realized that these organisms are a key component of biological monitoring."

With funding from sources including two Virginia state agencies involved in mining regulation and permitting—the Department of Environmental Quality and the Department of Mines, Minerals and Energy—Timpano began his research with a quest for study sites. He sought out streams in Virginia coal fields that had elevated TDS levels but were otherwise relatively undisturbed. Focusing on streams without other stressors like sedimentation or road crossings helps isolate whether TDS levels are related to bug population measurements. Starting with a list of 250 candidate streams, Timpano visited potential sites and scrutinized past monitoring data, aerial images and topographic maps to narrow the list to 21 study sites.

At the selected sites, the researchers collected water samples and macroinvertebrates up to four times from 2008 to 2011. After evaluating TDS levels and macroinvertebrate metrics, they found that when dissolved solids were high, diversity of the macroinvertebrate community often dropped off.

Although the work verified the association between high TDS and impaired bug populations, it became apparent to the



researchers that their methods weren't capturing the whole picture of the relationship between the two.

"In looking at our work, we started to realize how variable these relationships are," Schoenholtz said. "They're statistical, they're rather convincing, but there's a lot of variability and resultant uncertainty. And this uncertainty creates challenges for coal mining companies and regulators."

One potential source of that variability is the fluctuation of dissolved solid concentrations in a stream over time—a shift that periodic spot sampling is likely to miss.

"Measuring conductivity or TDS is not a one-shot deal," Schoenholtz said. "You just can't go out there once or twice a year to accurately characterize stream condition. That's what we're finding."

In an attempt to gain a clearer understanding of long-term TDS levels, the researchers obtained additional funding from U.S. Office of Surface Mining to expand their monitoring. The program now measures specific conductance—a surrogate for TDS—every 15 minutes in 27 streams with conductivity loggers. They're also sampling macroinvertebrate communities once a month.

The continuous and higher-frequency monitoring will contribute to a clearer understanding of the mechanisms through which dissolved solids affect macroinvertebrate populations. The data could help answer important questions about the timing of TDS exposure and the structure of state macroinvertebrate monitoring programs.

For example, how useful is it to compare TDS measurements and macroinvertebrate samples taken on the same day? Some aquatic insects spend two or three years in a stream, so a TDS measurement taken at the time of a macroinvertebrate sample may not explain the state of the bug population as accurately as a TDS measurement taken months earlier.

There is also a question of dose. Which has a more important effect on the insects: low-but-consistent levels of TDS or occasional spikes?

"This is classic ecotoxicology," Schoenholtz said. "Are bugs more susceptible to being chronically exposed or is exposure to very high levels occasionally causing declines in bug communities? Huge questions still remain that we all need to work on as we try to hone in on how to best manage these resources."

In the meantime, the research center's findings have gone on to state agencies, federal agencies, and coal companies to help inform standards and regulations. Though coal extraction is a controversial issue in the region, the center strives to remain an impartial source of good science, Schoenholtz said.

"Our agenda is to publish research, do good work and provide unbiased information for this decision process, which is very complicated," he said. "It really makes for an exciting place to work and hopefully will make a difference somewhere as we grapple with how to utilize resources, and at the same time, sustain these resources for future generations."

Photo: Anthony Timpano

Photo: (top left) Robert Krenz; (bottom left and right) Anthony Timpano



# DOWN,

# BUT NOT OUT

Scientists track reservoir through water quality highs and lows

BY AUSTEN VERRILLI

Lake Mead has seen its share of hard times while serving Las Vegas drinking water for Las Vegas, but scientists from federal agencies now closely monitor the lake to make sure water quality isn't a gamble.

Hydrologists on Lake Mead keep track of contaminants with U.S. Geological Survey-designed passive samplers and custom water quality monitoring platforms that profile the lake as deep as 111 meters.

Data collected shows the lake is in relatively good health, especially compared to 2001 when a massive algal bloom turned the lake green.

Still, Lake Mead has some looming problems like the trillions of quagga mussels covering most hard surfaces in the lake.

Then there are the predictions that the lake may run dry by 2021. The problem has enough potential to inspire a ticker on the Las Vegas Sun website counting down the days until Lake Mead goes dry.

A dry Lake Mead worries scientists like Michael Rosen, a U.S. Geological Survey water quality specialist who works on the lake.

"Lake Mead, on an average year, will drop 12 feet," he said. "The hope is that the (water) managers will manipulate water in such a way that they will be able to compensate for the low years by moving water different places."

Despite the gloomy outlook for water supplies, monitoring technology has also shown some interesting trends about Lake Mead said Ron Veley, a hydrologist with the USGS Nevada Water Science Center, who manages the water quality monitoring platforms.

Veley said observed temperature profiles show that the man made lake acts like a natural lake in some respects. "I think one of the observations that jumped out at us was that the lake actually turns over at a higher frequency than previously thought," he said.

Monitoring platforms equipped with Campbell Scientific data logger-controlled smart winches profile the lake four times each day. A YSI multi parameter water quality sonde takes readings of temperature, specific conductance, pH, dissolved oxygen, chlorophyll, fluorescence and turbidity. Some of the platforms also have weather stations and water velocity meters.

Photos: USGS

One of the 7-by-11-foot platforms is operating on the lake. It is deployed near Sentinel Island.

Veley said his team decided on custom platforms over monitoring buoys or off-the-shelf solutions due to high waves seen in the lake. "We initially thought it was safer," Veley said.

He said Lake Mead's waves can reach up to eight feet tall on rough days. That makes for a tricky transfer from boat to platform for scientists, though the researchers generally stay off the lake on rough days.

USGS also monitors contaminants entering the lake using passive samplers. That's Rosen's specialty.

He uses two types of passive samplers to track contaminants in the lake. A semipermeable membrane device detects hydrophobic contaminants commonly found in fish fat. The sampler, invented by the USGS, has lipids inside and pollutants bind to them.

The advantage of a passive sampler over catching and examining fish is much more consistent results.

Rosen said fish can travel throughout the lake and metabolize contaminants differently making it difficult to quantify

contaminants. With the samplers, "you can compare between sites a lot more easily," said Rosen.

He also uses polar organic chemical integrative samplers to detect polar organic hydrophilic chemicals in Lake Mead.

Some of the most prolific chemicals Rosen said he detects are fragrances from detergents and soap. The antibacterial chemical Triclosan is also prevalent in the lake. Rosen said DDT from waste piles at decommissioned plants near the lake also leaches into Lake Mead.

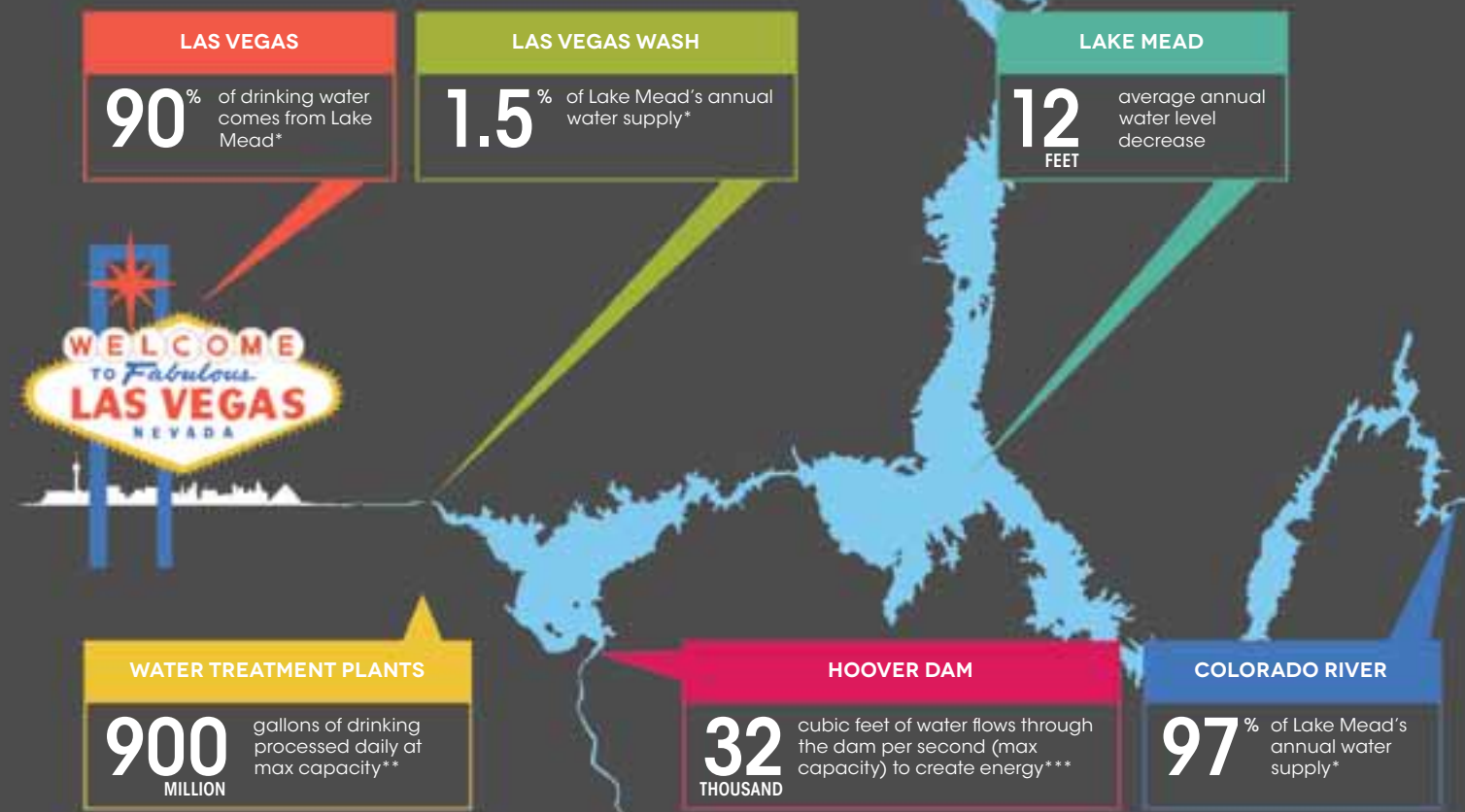
Nevada's desert climate makes keeping the lake clean a challenge. Droughts can change the ecosystem quickly. "It also lowers the quality of water because there will be less dilution," Rosen said.

Scientists from the National Parks Service, Bureau of Reclamation, U.S. Fish and Wildlife Service, Southern Nevada Water Authority and USGS work together to monitor and maintain the quality of the lake.

Lake Mead serves 22 million users in the Southwest. Lucky for them, water quality monitoring in the lake means opening the tap isn't a roll of the dice. <sup>AV</sup>

## LAKE MEAD CIRCULATION

Facts and figures sources from:  
\*Las Vegas Valley Water District  
\*\*Southern Nevada Water Authority  
\*\*\*U.S. Bureau of Reclamation



# Fish Kill Foresight

Monitoring network offers a rare look into King Harbor fish kill

BY JEFF GILLIES

Fish kills are almost always quick and unexpected, leaving onlookers to wonder how a waterbody without any visible signs of distress could suddenly be topped with a layer of dead fish.

But in 2011, when 15,000 kilograms of dead sardines and other baitfish went belly up in King Harbor in Redondo Beach, Calif., a monitoring network installed five years prior was ready to help managers figure out what happened. Data from those sensors and other surveying efforts suggest that a combination of biological, meteorological and oceanographic events suffocated around a million fish in the harbor over a few hours.

This recreational and commercial harbor within Santa Monica Bay had seen an earlier fish kill in 2005. Anticipating that something like that could happen again, researchers from University of Southern California installed water quality sensors in 2006. Two WET Labs sensors affixed to floating docks in the harbor measure temperature, salinity, dissolved oxygen and chlorophyll a fluorescence every 30 minutes. Within hours after first hearing about the fish kill, a team of USC scientists had data in hand that began to tell the story of plummeting dissolved oxygen levels in the harbor.


"We started getting phone calls first thing that morning," said Beth Stauffer, who was a graduate student at USC at the time. "We grabbed some lab gear and a small team of us went out and we immediately accessed that data."

Stauffer, now a postdoctoral research scientist with the Lamont-Doherty Earth Observatory at Columbia University, is the lead author of an analysis of the data, published in *Marine Ecology Progress Series*. The study points to two contributing factors to the hypoxia. The first is the sheer abundance of fish in the harbor breathing it all up. The second is related to the California Current system, which occasionally pushes low-oxygen water from deep offshore water toward the coast. This upwelled water likely made it into the harbor and exacerbated the hypoxia there.

Around the time of the die off, the water quality sensors in the harbor detected a slight drop in temperature and an increase in salinity, which would be expected following a pulse of oxygen-depleted water from offshore.

In the days and weeks following the fish kill, the researchers recorded vertical profiles of the harbor and out into Santa Monica Bay by lowering a Hach DS5 Hydrolab multi-parameter sonde into the water column. They also deployed a YSI EcoMapper autonomous underwater vehicle along a transect in the harbor. That additional data collection helped make it clear that the hypoxia was localized to the harbor and wasn't showing up in the bay.

These surveys also let the researchers watch the hypoxic system recover. Oxygen levels reset after a heavy storm blew through.

"For this system, it took a full overturning of the water column to get oxygen back into that northern basin," Stauffer said. "The profiles and the EcoMapper were really important in helping us see that." 

Photos: Erica Seubert

# Conserving Lake Atitlán

Scientists in the mountains of Guatemala are working to conserve Central America's deepest lake

BY KEVIN ROSE



Photo: Kevin Rose

How do you conserve a lake in a region where people can't afford to put food on the table? High in the mountains of Guatemala, scientists are working to answer that question.

Guatemala is one of the poorest countries in the Western hemisphere. It is also home to the deepest, and arguably prettiest, lake in Central America: Lake Atitlán. However, the lake's water quality has been rapidly declining. The lake's traditionally clear blue waters are becoming a darker shade of green as the lake becomes more eutrophic.

How do you protect a lake when poverty, population, and an annual hurricane season work against you?

"Education is key," said Sudeep Chandra, an associate professor of natural resources and environmental science with the University of Nevada, Reno. "People value this amazing resource. They know how important it is. They just don't know how to conserve it."

With a grant from the U.S. Agency for International Development, Chandra is training Guatemalan students and citizens to monitor the water quality of

Lake Atitlán. Working with scientists from both the U.S. and Guatemala, Chandra is also working to understand why water quality is degrading and what can be done to stop it.


The degrading water quality first grabbed attention in late 2008 and 2009 when cyanobacteria bloomed in the lake for the first recorded time. A second bloom in 2009 was worse and lasted two months before clearing. Cyanobacteria blooms can be harmful, producing toxins that affect fish, pets, and humans.

Fortunately, those blooms weren't producing toxins, but that didn't stop people from fearing them. That was a problem, as most of the local population depended on the lake for drinking water and transportation.

"People who lived around the lake did not know what was causing the bloom or what effects it might be having. People were scared," Chandra said. Another big increase in cyanobacteria was noted in 2010, less than two months after Tropical Storm Agatha washed whole mountainsides into the lake.

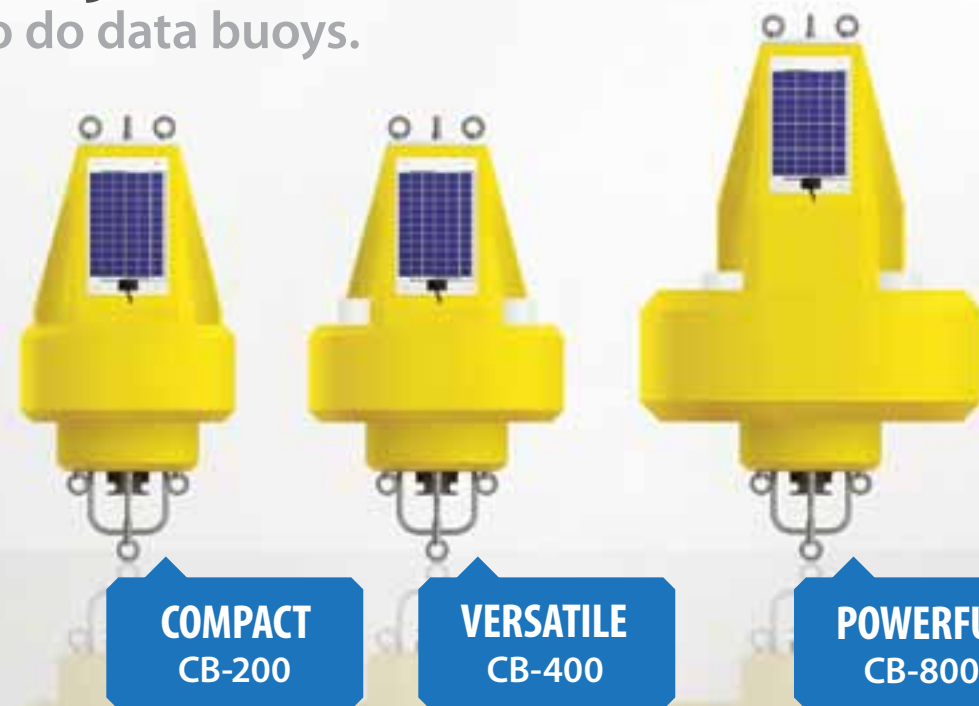
Chandra and his team have developed a series of short courses and field training programs to teach students and community members about the lake and basic limnology. Working in both Spanish and English, students rise with the sun and head out to sample the lake each day. The students learn about limiting nutrients, phytoplankton, pathogens, water clarity, and the importance of waste water treatment.

Students also spend time in the watershed learning about how land use affects water quality. They also visit wetlands to learn about species diversity and nutrient cycling. The local 'Amigos del Lago' organization is also contributing to the program by providing space for students and scientists to stay and learn.

"This is such an amazing opportunity," said Joaquin Arango, a student at Rafael Landívar University in Guatemala City. "We are learning things we couldn't have learned otherwise. These skills and experiences are invaluable, both in our personal lives and in efforts to save the lake." 

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# DIY Temperature String

A low-cost iButton array tracks lake turnover for Missouri volunteers

BY DANIEL KELLY



When Howard Webb set out to monitor turnover in Whitecliff Quarry Lake, his custom-built system of temperature sensors worked perfectly. Until the muskrats showed up.

Webb, a volunteer with the Lakes of Missouri Volunteer Program, devised an inexpensive array to monitor the lake in St. Louis' Crestwood suburb. His design for looking at the effect of temperature turnover on algae cycling centered on iButtons, small metal loggers that were very reliable, but not waterproof.

That meant Webb had to find an equally inexpensive way to keep them dry. The solution? Small Nalgene water bottles to hold the loggers. Muskrats, however, mistook the bottles – which became covered in algae – for food, tearing into them and flooding the iButtons.

"We thought, 'Let's give this a try.' There was no budget, no funding," said Webb. "What can we pull together on a shoestring budget?"

The first design used Nalgene bottles and plastic bags to keep the iButtons dry, but an updated design added PVC pipe as a protective housing to hold the bottles. "At that point, we were just looking for

something a muskrat wouldn't chew through easily and I just happened to have some around," Webb said.

The iButtons are attached to a chain that hangs in the water column suspended from a buoy. The buoy is also a product of Webb's knack for homespun design.

"The buoy is a piece of PVC pipe with a swimming pool noodle in it," he said.


The chain is tethered to a concrete cinder block that acts as an anchor. If the array is ever vandalized, Webb said he can easily use a grappling hook to latch onto the cinder block and retrieve it.

In all, the sensor setup is a cost-effective way for the Lakes of Missouri Volunteer Program to collect data, which Webb said are very high quality. The organization has quality control measures in place that verify results so data are trustworthy enough for inclusion in research papers and government reports.

Cost for the whole array is around \$200, which is mostly for the cost of the iButton sensors. The Nalgene bottles run 80 cents each and PVC pipe costs a few dollars for a 10-foot section.

"The key word on the project is 'cheap,'" Webb said.

But the data coming out of Whitecliff Lake are anything but cheap, Webb said, noting that the data plots have been clear and easy to understand. The entire array could easily be replicated for deployments across the state of Missouri.

"Until now, this has been a unique one-off," Webb said. "Whitecliff will give us a typical profile from which to start." 

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Photo: Howard Webb





# Q&A John LENTERS

Lake observing systems from Alaska to Nebraska

Hydroclimatologist John Lenters got his start working with lake observing systems as a postdoctoral researcher with the University of Wisconsin-Madison in 1996. Today, Lenters is an associate professor with the University of Nebraska-Lincoln and an independent contractor with LimnoTech, Inc., in Ann Arbor, Mich. He's helped set up monitoring stations on lakes across North America.



Through spotty cell phone reception in Michigan's Upper Peninsula on his drive back from a research site on Lake Superior, Lenters spoke with us about Great Lakes evaporation rates, losing instruments to polar bears and paddling a surfboard across hypersaline lakes in Nebraska.

variables, and then we've got precision radiometers to measure the energy balance of the lake. The most important part is an eddy covariance system that measures wind speed and vapor pressure at a sampling frequency of 10 hertz. So every tenth of a second, we get detailed measurements of water vapor, wind speed and CO2. In total, we're measuring fluxes of heat, carbon dioxide, and water vapor, which gives us an accurate estimate of evaporation out on the lake some distance from the island.

Our goal is to basically develop a Great Lakes evaporation network and to make the data available for research projects and operational forecasting of Great Lakes water levels. It's grown from one or two stations to now 6 or 7, including quite a number of investigators from Canada and the U.S.

**EM: You also have a project setting up observing stations in lakes across Arctic Alaska. What's going on up there?**

**JL:** Up there, it's a very different system. As the permafrost thaws, the ice-rich sediments form depressions, and they fill with water. You get ponds, basically. They're pretty shallow, but they occupy a large fraction of the land area. The landscape up there is 40 percent covered by either lakes or drained thaw-lake basins. So they're a pretty dominant part of the landscape.

We just recently received funding to start a National Science Foundation-funded Arctic Observing Network focused on lakes. The AON program previously didn't have any groups studying lakes in the Arctic, and so we proposed to establish a lake monitoring network for the Arctic. We're calling it CALON, which refers to the Circumarctic Lakes Observation Network. The goal is to establish an observation network in northern Alaska and use that as our test bed. With additional funding in future years, we would then expand that to include lakes in northern Canada, Siberia and elsewhere in the Arctic.

**EM: Is it a difficult place to work?**

**JL:** It's a challenging environment to work in because the weather conditions are often quite bad. It's remote, so you have to get to your sites by snowmachine, helicopter, or float plane. The helicopter and float plane are highly dependent on weather conditions. Sometimes you simply can't fly, so you can't access your sites. We've had stations that were demolished by polar bears, wires chewed up by Arctic foxes, and buoys destroyed by high winds and mobile lake ice.

**EM: Is it the most difficult place you've worked?**

**JL:** One of my more challenging sites has been in western Nebraska. This is a semi-arid part of the country, which makes it somewhat ironic that there are lakes, but they're groundwater fed. It's in the Sandhills region, and the rain that lands on

the sand immediately infiltrates into the soil. Eventually, the groundwater seeps into the wetlands of the low-lying areas, and you get these lakes that then evaporate very rapidly. It's the highest evaporation rate of any of the lakes that we've measured. Since most of these lakes have no stream outlet, all the salts are left behind during the evaporation process, so you get these hypersaline lakes in the Sandhills region of western Nebraska. The primary lake that we're studying has salinity levels that are two to three times that of seawater.

The water is not only salty; it's also alkaline. So it easily eats away at the seals of the small raft that we had out there, so the raft sank. But it's a shallow lake, so the instruments stayed above the water. In terms of accessing data from the site, there's no cell coverage, it's a muddy lake, hard to get out to, and it's usually

very shallow. We wear waders and have often had to take a small surfboard to paddle out to the station.

Somewhat surprisingly, the landscape looks amazingly like Alaska. When we go from this hot, dry environment in western Nebraska up to northern Alaska, it's very different in terms of its climate, but strikingly similar in terms of the overall landscape and shallow lakes. I'll even use pictures of these two sites in presentations to quiz the audience on which landscape is Alaska and which one is Nebraska. They often stare at it for quite a while before answering, and sometimes they guess wrong – until I show them a picture of a cow or a caribou on top of each of the two landscapes. If it wasn't for the different flora and fauna, you'd hardly know the difference.

**Environmental Monitor: You're on your way back from doing some work on your observing station on Granite Island in Lake Superior. What are you measuring there?**

**John Lenters:** We're primarily interested in evaporation rates. Great Lakes water levels are impacted by precipitation, runoff, and evaporation, and while precipitation and runoff are reasonably well measured over land, much less is known about over-lake precipitation and evaporation. Prior to 2008, we never actually had any direct measurements of evaporation over the Great Lakes. It's been estimated through models since about 1948, but especially now with Lake Michigan-Huron having recently hit record low levels, everybody's concerned about the impacts of climate change on ice cover, water temperatures, and evaporation, as well as what that all means for future lake levels.

I was fortunate enough to get in touch with the owner of Granite Island back in 2007. It's privately owned by a fellow from Marquette, Michigan, and his wife. They've made the island available for philanthropic purposes in the past, such as research projects, lighthouse enthusiasts, and other interest groups. So he was very open to the idea.

We installed the monitoring station in the summer of 2009, and it's basically a weather station on steroids. It starts out with very basic instruments that measure a lot of regular meteorological

A "weather station on steroids" above a Lake Superior island measures the lake's energy balance.



Photo: John Lenters

## TACOS PROJECT

Research projects have serious missions, and often go by complicated acronyms that leave you scratching your head. But there is one with a name that stands out – the TACOS project.

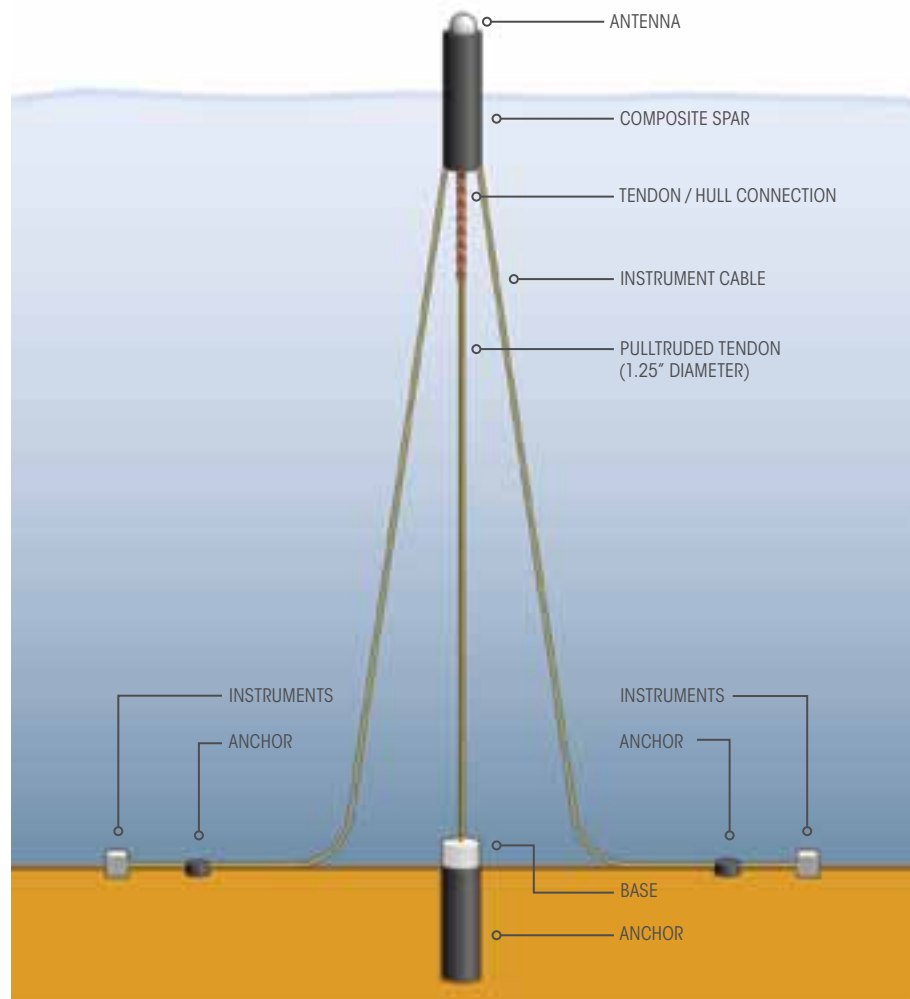
Scientists at the Scripps Institution of Oceanography at the University of California San Diego came up with the name, which stands for Tendon Anchored Composite Ocean Spar. Led by Scripps scientists John Orcutt and Jon Berger, the project's goal is to design a sensor platform that can be left in the ocean for decades with minimal maintenance.

"If I have to rebuild a system periodically, the cost of maintaining the site will be very high," said Orcutt, distinguished professor of geophysics with Scripps. "We want to reduce life cycle costs and make it more affordable."

The design has a long, thin spar made of extremely durable composite materials that is tethered to the ocean floor using a tendon cable. A large mass and small waterplane area make spars very stable and a popular choice for ocean deployments.

"A spar puts the center of buoyancy deep in the seawater, tens of meters down," said Orcutt. "Because wave motion decays exponentially with depth, the vertical motion of the spar is small."

The spar's power will come from wave action. With buoyancy centered deeper in the water and the spar platform more stable, wave energy is easier to harvest. Orcutt says wave action will create enough power for the system, and that he and Berger, a Scripps senior researcher, are looking to provide a kilowatt of power. With technological advances, especially in electronics, communications and computing that will occur through time, the system should become increasingly efficient.



The TACOS design can support the same sensors as a conventional buoy design, including those for conductivity, temperature and depth. Other instruments that measure optical backscatter and the sun's radiance are also easily integrated into an ocean spar system.

Orcutt also says the spar platform is stable enough to use LIDAR, which measures atmospheric backscatter from particulates and water vapor with the goal of developing a three-dimensional profile of the winds overhead. Seafloor sensors including seismometers, hydrophones, pressure gauges and others are served by cables running from TACOS to the seafloor.

"The spar buoy has tremendous advantages to reduce pitch and roll," said Orcutt. "Having a stable platform with more satellite bandwidth gives us

a lot of options and opens up huge technical and scientific advantages."

Increased bandwidth comes from the fiber optics running down the center of the thick tendon cable. Since light travels so quickly, power and communication signals transmit more efficiently. Once data from sensors are collected, it will be sent via C-, Ku-, and Ka-Band satellite to the Internet. Orcutt notes that the data will also be backed up on the platform.

The design will take about a year, Orcutt says. He and Berger are working with Horton Wison Deepwater and John Crane Associates to further develop the new buoys. The TACOS name, however, is one innovation that won't need further development.

"It's an acronym that makes a lot of sense," said Orcutt. "But the name may be a bit too clever." ☒

## New Water Quality Apps

New mobile technology is bringing water quality monitoring into a new age of accessibility. Two new apps for use with smartphone and tablet devices promise to make collecting water quality data easier and faster than ever before. - ADAM REDLING



### WaterQuality

WaterQuality, an app for Apple's iOS devices, is changing the way water monitoring data is cataloged. The result of a collaboration between Northern Kentucky University and the Foundation for Ohio River Education, which teamed up to improve the efficiency of water quality monitoring, while at the same time, provide a platform for learning.



Led by Steve Kerlin, director of the NKU Center for Environmental Education, a team began developing the program in the spring of 2012 after receiving a mini-grant from the NKU College of Education and Human Services. WaterQuality version 1.0 was released in October 2012.

WaterQuality allows users to create a profile for a monitoring site in which they can enter chemical and bacterial monitoring data obtained from standard monitoring equipment. The app then provides graphs and illustrations that show healthy ranges for various water quality measurables.

Users can log 11 different chemical and bacterial parameters, including dissolved oxygen, E.coli, pH, water temperature, nutrients, turbidity and conductivity.

WaterQuality's developmental team is confident that the program will help users make sense of complicated data.

"We're finding teachers and student science monitors gather a number but don't really understand what the number means or if it's in acceptable parameters," Kerlin said. "So what it does is allow you to log data, but also to make sense of that data."

### Charles River Observer

New software is making it easier for researchers on Massachusetts's Charles River to conduct large-scale water monitoring, thanks to a collaboration between a local watershed association and technology company.



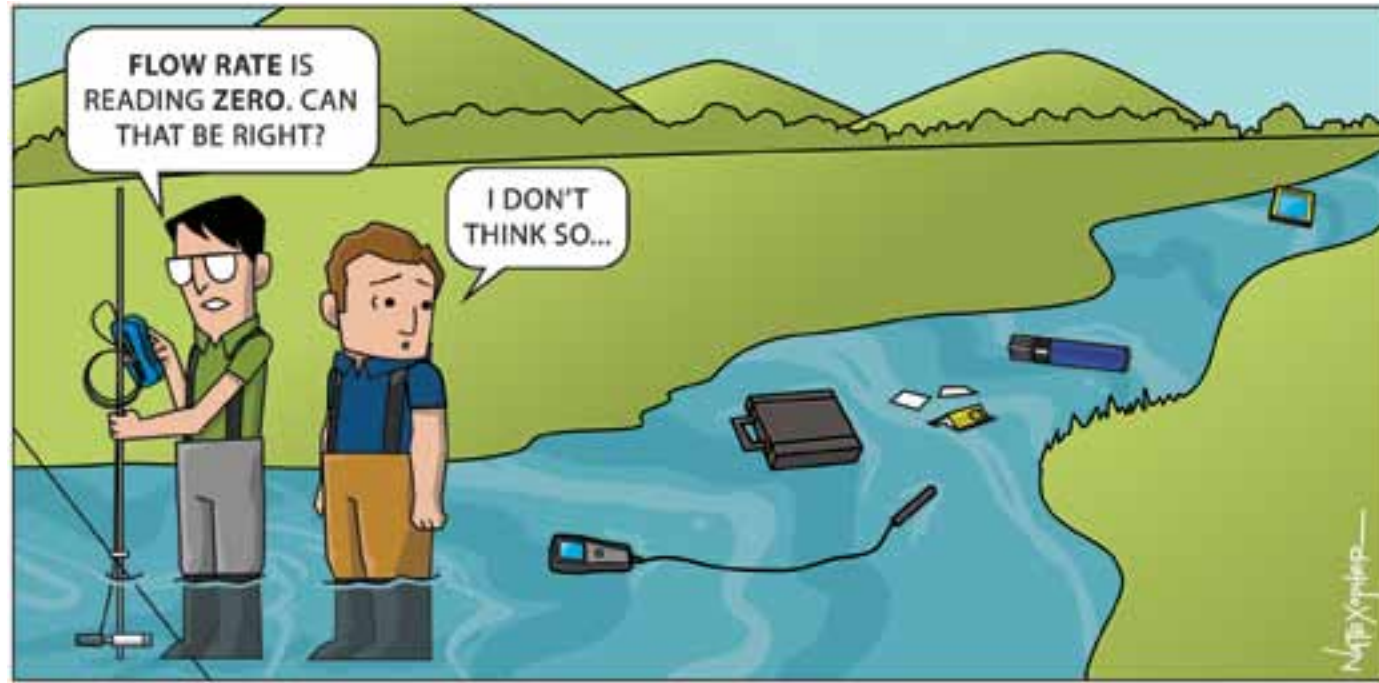
The Charles River Watershed Association works to protect the river's 308-square-mile watershed, but their monitoring capabilities have been limited by antiquated water monitoring techniques like committing water quality records to paper.

Led by Julie Wood, senior scientist at the CRWA, the group set out to change their old ways in early 2012 by partnering with Aecern, a nearby education and technology company, to begin work on developing the Charles River App.

The app will allow workers to chart water temperature and depth measurements, as well as observations, descriptions and photographs from various sites. Researchers can also upload information about regional wildlife and abnormal river conditions in the Charles River watershed.

The app aims to streamline the lines of communication between volunteers and CRWA scientists, but the new technology also figures to have applications inside the classroom as well.

The CRWA is partnering with a local elementary school, Woodside Montessori Academy, to develop an interactive website where students can analyze data collected with the app. The group is piloting the app with a select group of volunteers, but hopes the program will be widely adopted throughout the year.



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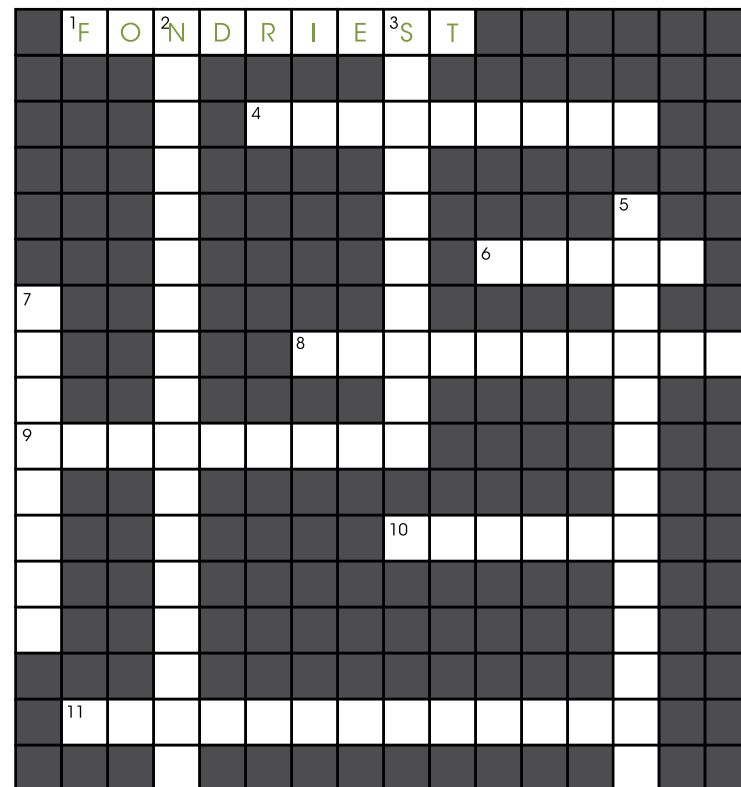
## Invasive Species

### Across

- Where to buy water monitoring equipment
- Introduced to U.S. as a tool for aquaculture farms
- A frog accidentally introduced to Hawaii
- Perennial wetland grass that can grow to 15 feet
- Small, aggressive bottom-dwelling fish in lakes & rivers
- Otter-like mammals that destroy critical marsh habitat
- Attach to surfaces using byssal threads

### Down

- Toothy freshwater fish that can breath out of water
- Eel-like fish uses suction-cup-like mouth to feed on blood
- Likely spread through dumping of bait buckets and aquariums, and activities of commercial aquaculture
- Grows in dense strands from the bottom to the top of water and forms mats sprawling across the surface



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