ENVIRONMENTAL
monitor
FALL 2014
APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS

EYES ON ERIE

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Mapping bird habitat from the air

Toledo Water Crisis
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Underwater Video
Submersible cameras ease fish counts

FONDRIEST
ENVIRONMENTAL

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IN THE NEXT EDITION

Buffalo Pound Lake in southern Saskatchewan poses a challenge for scientists looking to model it and for treatment plant operators that draw water from the bloom-prone reservoir. A new data buoy wrapping up its first field season should be able to help with both.

Cover Photo: Doug Nguyen / NexSens Technology

WELCOME...

Welcome to the Fall 2014 edition of the Environmental Monitor. It's all about buoys around here, with feature stories on platforms tracking lake and marine conditions across the country. That includes a buoy off the coast of Erie, Pennsylvania, measuring waves, weather and water quality. More importantly, it has its own T-shirt design. Joining that data buoy in Lake Erie is another one floating near the City of Toledo's water intake crib, a project that was fast-tracked after a toxic algae bloom left 500,000 people without access to tap water this summer. We also have a tour of buoys throughout Maine and a look at a platform measuring waves off Majuro Atoll in the Marshall Islands.

Beyond buoys, we've got a first look at the SondeCAM, a high-end underwater camera from FishSens Technology. They're designed for anglers or fisheries researchers looking to identify structure and track water quality.

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

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

tel: 888.426.2151
fax: 937.426.1125
customercare@fondriest.com

STAFF

Steve Fondriest, President
steve@fondriest.com

Paul Nieberding, General Manager
paul@fondriest.com

Jeff Gillies, Editor
jeff@fondriest.com

Daniel Kelly, Staff Writer
daniel@fondriest.com

Alex Card, Staff Writer
alex@fondriest.com

Charity Smalls, Freelance Writer
charity@fondriest.com

Nate Christopher, Graphic Designer
nate@fondriest.com

Marina Lamquin, Marketing Specialist
marina@fondriest.com

Christine Kemker, Marketing Specialist
christine@fondriest.com

Mike Voellmecke, Applications Engineer
mike@fondriest.com

Tyler Fondriest, Mechanical Engineer
tyler@fondriest.com

WEB EXCLUSIVES

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Warmer temps and greater tree growth could slim Sierra Nevada streams

In California's reality of shrinking snowpack and rising temperatures, there appears to be a new threat to the state's freshwater supplies on the horizon: expanding mountain forests. Researchers at the University of California, Irvine made the connection in a study that assumed a more than 4-degrees-Celsius rise for temperatures in the Sierra Nevada by 2100.

Cooler temperatures in high elevations keep tree growth at a slow pace. But if temperatures rise by their predicted levels, that growth will ramp up and evapotranspiration — essentially evaporation combined with plant transpiration — will follow. That translates into a massive drop in runoff feeding tributaries below.

The findings have already advanced understanding of the Sierra Nevada's hydrology and the interactions its forests have with ecosystems surrounding them. But what is one of the first looks into the likelihood of expanded tree growth there has also revealed what impacts climate change may have on future water availability in California.

Smart Forest Network looks to ease sensor data flow from experimental forests

There's something growing in the United States' Northern forests: a vision for a cross-country network of forest sensor stations delivering high-quality data to anyone who wants them.

Today, the so-called Smart Forest Network provides hydrological and meteorological data from just three sites in the U.S. Forest Service's Experimental Forest system. But as the program continues to grow, the network will provide consistent measurements that will make it easier to see how forest ecosystems function and change across the country's small watersheds. The sensors are already installed at many experimental forests, but tracking down and working with those data isn't simple for researchers interested in studying multiple sites, according to John Campbell, a research ecologist with the U.S. Forest Service.

"They're not collected in a common format. The units are all different. You would have to contact individuals at the site to try and get the data," Campbell said. "Even though the data are being collected, they're not really in a form that's all that usable."

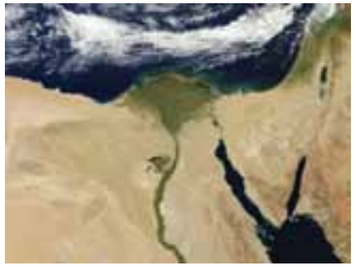
Future of eDNA could bring easier, low-cost marine species monitoring

Jesse Port imagines a future where fishery managers and conservationists might rely on a few quick water samples to determine great white shark populations or human waterborne pathogens, rather than spending dozens of hours and significant resources on traditional monitoring approaches. An early career fellow at Stanford University's Center for Ocean Solutions, Port believes the key to this feat is environmental DNA, or eDNA, the genetic information left in an environment by animals.

Port is a co-author on a paper published in the research journal Science alongside scientists from the University of Washington and the University of Copenhagen. The paper proposes the use of eDNA sampling for assessing the biodiversity of marine ecosystems. The microbial studies that Port mentioned focused largely on uncovering new species. The methods proposed in the paper would help researchers, aquatic managers and others locate and quantify known species of concern.

Photo: (top) Geographer, via Wikimedia Commons / CC BY 1.0; (center) Ian Halm, U.S. Forest Service; (bottom) Jesse Port

IN THE NEWS



Nile River monitoring to help users respond to fluctuating volume

Scientists from Curtin University in Australia are monitoring the Nile River Basin to help the countries that depend on its waters respond to fluctuations in the river's volume, according to a university release.

Associate professor Joseph Awange monitors the Nile's inputs and outputs from rainstorms, drought and human use, then gives the information to affected countries so they can adjust their resource management plans.

The Gravity Recovery and Climate Experiment satellite mission provides data for the project. Its two satellites pick up changes in the Earth's gravity field to help determine a specific area's soil moisture, surface water and groundwater levels.

Rain Cell Africa group wants to boost cell tower-based rainfall monitoring

Scientists in Africa want to partner with cell phone tower companies to track rainfall, according to a release from the Instiut de Recherché pour le Développement.

Cell towers cover a majority of the globe's inhabited areas and track signal interruptions due to precipitation. The Rain Cell Africa partnership wants to use this information to enhance rainfall auditing. Their idea is based on telecommunications companies' knowledge of rain's effects on signal transmission. Rain Cell Africa successfully partnered with a local cellphone operator company and had access to data recorded from a monsoon in 2012. They hope to convince other companies to participate.

Robotic floats seek oceanic clues to slowed global warming

Scientists released two robot prototypes into the Pacific Ocean near New Zealand, according to the New York Times.

The robots are engineered to monitor temperature and other parameters more than three miles below the surface. The robots, launched in June, resurface regularly to transmit their recordings to a satellite before returning underwater. Ideally, more of these robots will be launched into the ocean over time to contribute to the Argo network.

Scientists believe that ocean activity can help decode the mystery of slowed global warming in recent years. Researchers have speculated that typical climate variability and China's increased use of coal have contributed to the slowed warming. However, studies indicate that global warming pauses have occurred before.

Much of Earth's water older than the sun

A new study asserts that 30 to 50 percent of Earth's water is older than the sun, the Washington Post reported. The findings could help scientists unravel the mystery behind the source of water on this planet and others.

By analyzing deuterium, an isotope of hydrogen that forms what scientists call "heavy water," researchers found that water molecules may have been left over from the gaseous cloud that formed the sun. Following the sun's birth, a protoplanetary disk of matter would have been left behind. Water from this disk likely ended up here on Earth.

If stars typically form a protoplanetary disk — scientists are pretty sure that's the case — and if water can be present in any of those disks, then there's a good chance water exists on plenty of other planets across the universe, the researchers say.

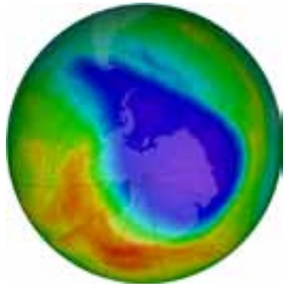


Photo: (left) NASA; (right) NASA

Hole in the ozone layer may be shrinking as regulations aid rebound

For the first time in decades, scientists have found that ozone concentrations in the atmosphere have gone up by a significant amount, according to NPR. NASA researchers made the discovery and say the giant hole in Earth's ozone layer may be shrinking as a result.

From 2000 to 2013, scientists say that ozone levels climbed by four percent in the mid-northern latitudes. That's located about 30 miles up, at the upper edge of the stratosphere.

An increase of ozone to the stratosphere is a considerable achievement for scientists who first noticed that CFCs were destroying the gas above Antarctica in the 1970s. And some say that steps taken in the 1980s, notably the Montreal Protocol which phased out CFC use, are finally yielding benefits today.

Deforestation in Amazon Rainforest jumps 29 percent

Satellite data through the end of July 2013 show that an area half the size of Puerto Rico has been cleared from the Amazon rainforest over 12 months, according to The Guardian. The destruction marks a reversal in restoration gains seen in tree cover there since 2009.

The Brazilian government reports that 5,891 square kilometers of the forest have been cleared in its Amazon regions, up 29 percent from the year before. The largest decreases were seen in Brazil's Para and Mato Grosso states.

Illegal logging as well as public infrastructure projects are expected to have contributed to the increase in deforestation. Despite the move upward, figures are still not as bad as they were in 2004, when almost 30,000 square kilometers of forest were lost.

Seismometer lost in Japanese tsunami washes up on Canadian shore 3 years later

A seismometer that captured data on an earthquake that caused a massive tsunami off the coast of Japan has been found floating in a swath of ocean debris, according to Global News. The University of Japan lost contact with the device shortly after the natural disaster began in March 2011.

A fisherman found the lost device, which appeared from faraway as a giant, orange ball. As it was deployed on the ocean floor, closer inspection revealed the seismometer was encrusted with gooseneck barnacles.

Researchers at the University of Japan are hopeful that the device contains usable data on the earthquake and events that followed. Other debris from the tsunami have been washing up on Japanese shores this year, as shifting currents and winds have brought in more than 100 cubic meters of matter.

Photo: Jim Norris / Scripps Institution of Oceanography

Science solves mystery of Death Valley's slithering stones

In California's Death Valley, the stones on the desert floor have been known to move on their own accord, leaving trails in the sand that have bamboozled onlookers for decades. But with the help of GPS transponders and a video camera, one geologist from the Scripps Institution of Oceanography believes he's found the answer to this ongoing riddle, NPR reported.

The boulders — some weighing up to 500 pounds — seem to skate across the playa sand in a variety of patterns, from straight to crooked and even reversing course. Geologist Richard Norris tagged one stone with a GPS unit and set up a camera nearby.

He found that a thin layer of ice would occasionally form over the playa, then melt and shift, moving the boulders as well. However, the phenomenon requires specific conditions: rain, then cold air and sunshine with a little breeze.

Boogie Down

Floating a boogie board down an urban creek downstream of a wastewater treatment facility in Kansas might not sound like the most enticing day on the water. But it made for a good day of data collection for scientists who loaded up their custom board with water quality sensors and measured the effects of the treatment plant's recent upgrades.

On the day of the deployment on Indian Creek, the crew learned quickly to help the platform get around stream features disrupting its free-floating path. The craft needed a foot and half of depth, so when it came up on shallow riffles, someone had to pick it up and move it downstream, according to USGS hydrologist Guy Foster. "And when we hit some of the longer, deeper pools, which didn't have any velocity in them, we had to get out and push, so to speak," Foster said.

Photo: Guy Foster / U.S. Geological Survey

R/V Folger

Lake Champlain's size and saltwater history makes it a great place for inland academics to study oceanography and marine geology. Middlebury College's loaded R/V David Folger is a great way to get students on the water.

The 48-Foot R/V David Folger is equipped with state-of-the-art instruments to map the lake bottom, track currents, measure water chemistry and sample sediments. It's at the forefront of the experiential, hands-on approach to learning in Middlebury's geology courses.

"We make sure we are out in the field every week and making sure students learn the whole process of how to collect data, how to interpret data and how to present that data," said Patricia Manley, a professor of geology at Middlebury College in Vermont. "In essence, it's the scientific method."

The students can collect that data with acoustic Doppler current profilers, a multibeam echo sounder, a CTD rosette and sediment corers. What they'll use depends on the research focus at the time. For introductory-level oceanography classes, the students get a choice between tasks like mapping bottom morphology, or looking at circulation, water chemistry or sediment history.

The students have made a few discoveries, including a coastal jet and a bathymetric feature previously known only to fishermen but absent from some maps. Last fall, a class found a large underwater landslide. JG

Crawfish Frog

Researchers in Southern Indiana are trying to find the right place to reintroduce the endangered crawfish frog, which relies on crawfish burrows to hide from predators and can only live where the species coexist. A groundwater monitoring project there benefits not just the frog, but also federal land managers and undergraduate students looking for real-word experience.

Scientists want to introduce crawfish frog eggs in suitable habitats, which includes a water table within six feet of the land surface. Brandon Root, a senior geology student at the University of Southern Indiana, was looking for a course project. Managers at the Patoka National Wildlife Refuge had just the thing for him.

"I had a few ideas in mind," Root said. "But they said if you really want to help us, we've got this issue where we want to release these frog eggs."

Root took up the cause, securing a grant to cover the cost of well materials and pressure transducers to equip a long-term monitoring network.

But an early survey turned up no trace of the water table, ruling out one site as potential crawfish frog habitat. That saved the time, money and egg masses that would have been wasted on a failed reintroduction. In the meantime, Root has already gained exposure to the workings of government land management, a career path that he's interested in. JG

Photo: (top) Patricia Manley; (bottom) Brandon Root

Elwha River Class

When the largest dam removal project in history was set to begin on the Elwha River, poised to release thousands of tons of sediment locked away for decades, scientists at the University of Washington saw a need to investigate. No one was sure what such a highly concentrated flow of sediment could mean for the Strait of Juan de Fuca downstream.

Plenty of students were interested in the high-profile project, so university officials put together a 10-week, investigative course to meet both their needs and those of researchers looking for answers.

"The class gives a good introduction to the basics while bringing in the things they're interested in," said Andrea Ogston, professor of oceanography at the University of Washington. She has taught the class since it began, instructing students whose majors span the environmental fields.

Since work began to remove the dam, students have taken up residence in UW's Friday Harbor Labs every year to take the specialized course. "They're immersed in science, which really helps them get the ins and outs and hit the objectives of the course," Ogston said.

With the last piece of the dam recently removed, Ogston and her students are excited to see what it's holding back. "The fall and winter streams and floods — we think these could be some of the biggest sediment flows we've seen," she said. DK

Miller Run

Miller Run flows through the campus of Bucknell University via underground pipes and a concrete channel lined with riprap. It empties into Limestone Run, a tributary to the much larger Susquehanna River.

Along its passage, Miller Run doesn't get much attention. And though the slender, brown stream isn't much to look at, a grant from the Pennsylvania Department of Environmental Protection has brought new monitoring equipment to study its hydrology. Project managers plan to use the data to inform restoration work set to begin on Miller Run, as well as in computer science projects to create data visualizations and models.

Since the project began, Miller Run has been outfitted with a weather station and three stream gauges that measure its depth, temperature and pH, as well as dissolved oxygen levels. Data are then transmitted back to researchers. They add to a record that spans the whole Susquehanna River, as Bucknell already manages the largest monitoring network there.

"Our goal is to combine all of these data sources and create a visualization that makes it easy to understand the data," said Alan Marchiori, professor of computer science. Gilbert Kim, a research intern, will put together a database to integrate sensors from stations on Miller Run and those deployed on the Susquehanna River. DK

Photo: (top) Emily Eidam; (bottom) Bucknell University

> "IT'S NOT JUST AN EXERCISE IN MACHISMO. THERE'S A LOT AT STAKE HERE."
>
> **-James Gibbs**
> Professor of vertebrate conservation biology at the State University of New York College of Environmental Science and Forestry

BIRD'S EYE VIEW

A recent Galapagos expedition shows UAVs open new doors for counting rare species and map habitat in this remote and rugged landscape.

BY JEFF GILLIES

Conservation research on the Galapagos Islands is crucial to track the dozens of bird, reptile and plant species that can't be found anywhere else, and without some intervention, might not be found anywhere at all.

But getting to some of the dozens of islands and islets of the equator-straddling archipelago can be tough for scientists. And the work doesn't get easier once they're ashore, according to James Gibbs, professor of vertebrate conservation biology at the State University of New York College of Environmental Science and Forestry.

"We've been doing a lot of monitoring and inventory work the old-fashioned way, which is getting out there with a machete, notebook and your legs and doing the best you can," said Gibbs, who has been working in the Galapagos for 30 years.

To help conservationists cover more ground, Gibbs and his colleagues are pioneering the use of camera-equipped unmanned aerial vehicles in the Galapagos. A trip there in June made possible by the Galapagos National Park and Galapagos Conservancy showed them that despite some limitations, low-cost UAVs can fill an important niche in ecological and environmental monitoring, from counting albatrosses to mapping plant cover.

Gibbs was joined by Sean Burnett and Greg Carney, partners in a small enterprise called Wildlife Intel that had previously developed anti-poaching technology. Burnett, a health economist by training and data warehouse analytics specialist by trade, has also dabbled in electronics for more than a decade. He said when he began working on UAVs for this project in 2012, the technology was "just starting to get off the ground." That meant it was often inaccessible and buggy — a conspicuous problem when a sensor error can knock a quadcopter out of the sky.

But since then, the sophistication and number of options of UAV platforms has skyrocketed, he said. He and the Wildlife Intel team assembled a package — the UAV platform, batteries, image processing hardware, a camera that could take crisp photos while jostling in flight — that they could test in the Galapagos.

For Burnett and Carney, who both live in British Columbia, that took 32 hours of flight before joining Gibbs for an 8-hour boat ride across rough seas. That gave them plenty of time to think about how the DIY electronics they were working with aren't exactly rugged.

All Photos: Sean Burnett

"The water was so choppy that in our bunks we'd actually get airborne a little coming down off some of the waves," Burnett said. "The whole time you're cringing that your copters are getting bashed around."

They boated from the main island to the smaller islands they had targeted for their research and offloaded their electronics, a generator for charging UAV batteries, food, water and other supplies onto the shore. From there, they hiked across tough terrain carrying the supplies to the campsite, from which they'd break out on day hikes to do the aerial imaging.

It was hard work, but this was no regular backcountry expedition. One of their study sites is the only island in the world where a particular albatross species in known to nest.

"It's not just an exercise in machismo," Gibbs said. "There's a lot at stake here."

Once they were settled, they learned that their concern for the delicacy of the electronics was justified. Of the five UAVs they hiked in, they salvaged three. At one point they splinted a broken frame with a stick. They also learned that the wind and hot, thin air over the islands would cut into the estimated flight time available for each battery charge, dropping it from 20 minutes to 10.

Despite those setbacks, they still completely imaged two islands: one with iguanas and one without. That will help further research on the influence of herbivores on engineering the environment in these ecosystems, Gibbs said. Beyond that, they demonstrated that UAVs can fill a niche between what scientists can see on the ground and what manned flights or satellites can see from the air.

They're already able to identify animals and distinguish between saltbush and cactus in their imagery. As the technology improves, so too will its contribution to important research.

"With a bigger machine and better cameras we could actually do the first census of this highly endangered species of albatross, which would be a major service for conservation," Gibbs said. JG

School of Ants

The School of Ants project documents ant populations across the U.S. while proving that citizen scientists can produce high-quality data.

BY DANIEL KELLY

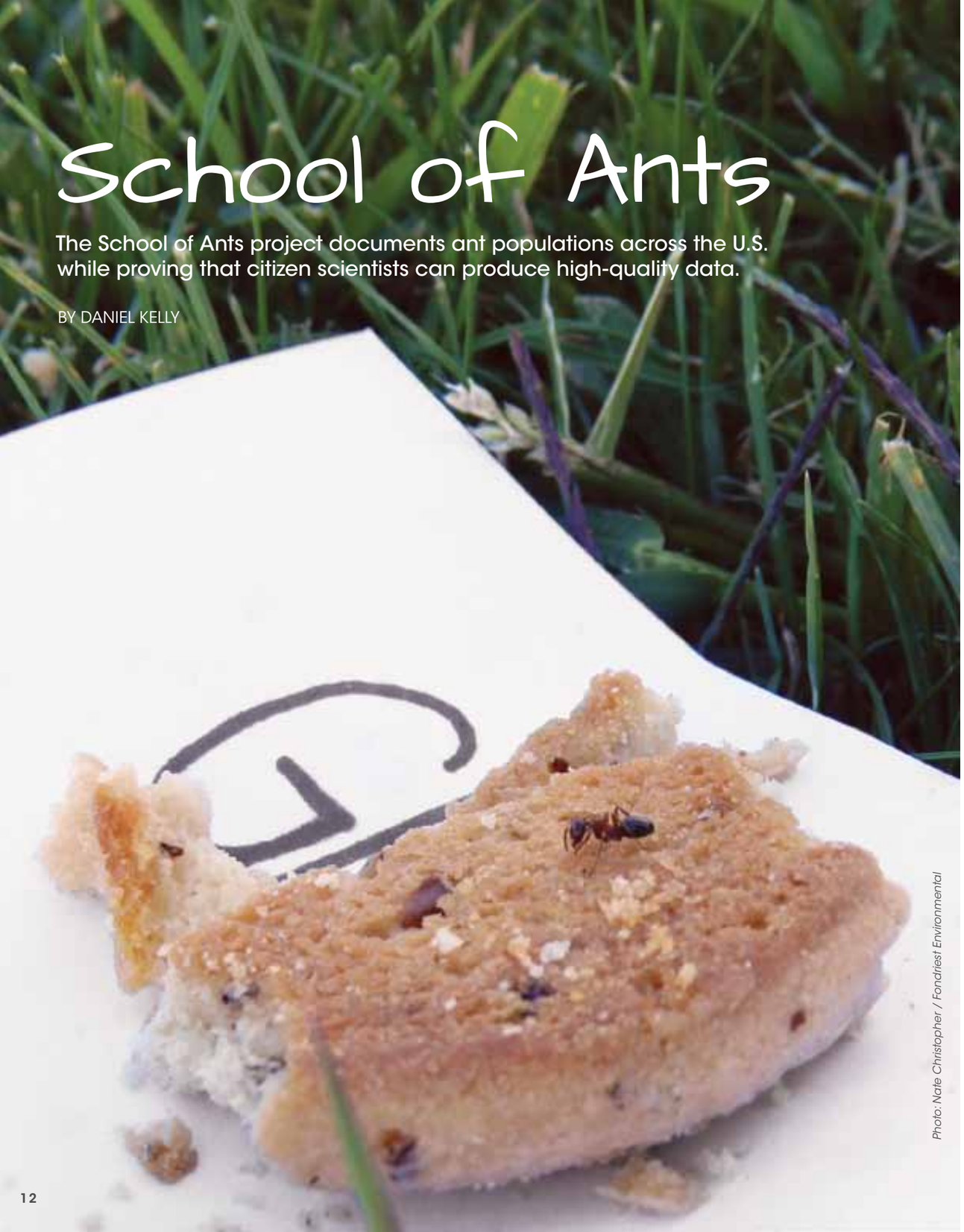


Photo: Nate Christopher / Fondriest Environmental

When it comes to ants, myrmecologists know the best techniques to capture them. To draw them in, cookies are used as bait. But not just any cookie will do. It has to be a pecan sandie.

"There's a historical reason. Pecan sandies have been used for a long time in myrmecology (the study of ants)," said Andrea Lucky, assistant research scientist in the department of entomology and nematology at the University of Florida. The common shortbread cookie is essentially the perfect food to attract them because it hits all of what ants might be needing in their diet at a given time: protein, fat, salt or sugar. Lucky has seen a lot of pecan sandies in her time.

"One of these days, I should get in touch with the Keebler company to see if they'll sponsor a student," said Lucky.

The little cookies played a major role in a massive citizen science effort that Lucky and colleague Amy Savage of N.C. State University helped oversee called School of Ants. Working alongside researchers from their schools and Italy's University of Parma, they documented ant populations across the U.S. while dispelling a misconception that data gathered by citizen scientists aren't as good as those collected by professional ones.

Lucky and Robert Dunn, an associate professor at N.C. State, developed blueprints for ant-catching kits and made them available on the project's website. Each kit used pecan sandies, a few pieces of paper and Ziploc bags. While ants gorged themselves on the cookies, typically resting on top of the paper, volunteer scientists put the whole thing into a bag, froze it and then sent it to researchers for analysis.

At labs in Florida and North Carolina, scientists checked the ants and logged their findings in an effort to map the distribution of ants in the United States. From July 2011 to December 2012, ants from 500 unique sites across the country were studied. And there wasn't a lack of willing participants.

"When we first got our website up and running, we didn't know if people would do it," said Lucky. "But in the first two weeks, we got 10,000 requests to participate." The team had to go back to the drawing board to accommodate so much interest, Lucky says, but it was encouraging to see that people weren't deterred by the prospect of building their own kits.

The other big issue their work attempted to address was making sure data collected by citizen scientists was as trustworthy as those collected by the pros.

"We wanted to make a case to the scientific community that this way of doing science was really valuable," said Savage, a postdoctoral scholar in biological sciences at N.C. State University. So they set up a comparison between data collected by School of Ants volunteers and those gathered by a group of undergraduate students. Each group used the same methods and collected data at the same time. "When we compared the results, it was one of the best correlations I've ever seen," said Savage. The mathematical correlation was nearly perfect.

"The reality is that we didn't find any difference," said Lucky. "People are smart collaborators and they can be integrated into programs if you're thoughtful in how they participate."

Photo: Lauren Nichols

Children use School of Ants kits to capture ants for study.

Those smart collaborators helped researchers find exotic and novel ant species from coast to coast. A group of schoolchildren at a camp in North Carolina found a species of ant there that is only known to exist in parts of northern Florida. Likewise, an exotic Asian needle ant, which typically lives in parts of North Carolina, was found all the way across the country in Washington state.

Those kinds of discoveries are incredibly valuable from a management perspective, says Savage. Oftentimes, it's not until a population of invasive ants has exploded that control measures begin. At that point, non-target species can also be affected by the treatments, sometimes in negative ways. By starting control measures sooner, it may be possible to avoid some of those negative consequences.

All of the discoveries have been posted online, and the ongoing project wouldn't have been workable without the world wide web.

"There are easy ways for people to access information," said Lucky. "We're pretty encouraged to see citizen science coming into full flower right now." DK

PRODUCT INNOVATION

YSI ProDSS

Multi-Parameter Water Quality Meter

BY DANIEL KELLY

Because of its state-of-the-art features and rugged construction, YSI's new ProDSS handheld is one of the most advanced instruments available for water quality spot sampling and profiling studies on the market today.

YSI launched the new ProDSS handheld in fall 2014 and it is a major leap for meter technology, with enhancements including an auto-corrected depth measurement, integrated GPS, color display and a long-life rechargeable lithium-ion battery.

The ProDSS is capable of measuring dissolved oxygen with an optical-based sensor, turbidity, depth, pH, ORP, temperature, conductivity, ammonium, nitrate, and chloride plus other calculated parameters such was water density, salinity, TDS and TSS. The cable, which comes with or without a depth sensor, has a universal port design that supports any four sensors. The ProDSS recognizes the digital sensors when installed and automatically displays them on the screen for quick instrument startup.

The digital sensors are recognized by the instrument when installed and automatically display on the handheld for quick instrument startup. "We are excited to be able to offer our standard sensor payload: dissolved oxygen, pH, ORP, temperature and conductivity with the addition of depth and turbidity, both very valuable parameters to water quality studies," said Laura St. Pierre, senior product manager of water quality systems at YSI. "We were able to do this while maintaining a small, easy-to-hold handheld and compact cable and sensor assembly, keeping true to a small, portable instrument."

The compact ProDSS is ruggedized for field work and the driving force behind making it so robust was customer feedback. "Our customers put equipment through its paces in harsh applications and we want our instruments to be able to hold up to the rigors of field work and provide reliable data," said St. Pierre.

Field testing to prove the handheld's ruggedness has included submerging it for an hour and dragging it along a gravel road. All-titanium sensors, which feature EXO technology, made the cut. And the ProDSS also packs an IP67 rating and military-spec connectors.

"We don't use plastic connectors. We use metal, military-style cable connectors and titanium retaining nuts mated into stainless steel for the sensors," said St. Pierre. "It's a truly ruggedized instrument that also provides very accurate measurements."

The ProDSS' auto-corrected depth measurement is one that stands out. "We use the handheld's barometer in real time to correct data in the depth sensor," said St. Pierre. "So you don't have to worry about vent tubing, desiccants or vented cabling to get accurate depth measurements."

The option to integrate GPS makes the ProDSS more flexible for users with different application needs. It's now possible for data to be mapped with KorDSS PC software which is included with the instrument, St. Pierre says.

For data management, the ProDSS communicates with YSI's KorDSS software via micro USB - an improvement over snap-on communication saddles. The micro port can also be used for charging the meter's lithium ion battery or for data transfer to a jump drive on the go.

Rounding out the ProDSS are features that reduce ownership costs, like LEMO sensor connectors and a classic Pro Series design. When maintenance needs arise, YSI offers a 3-year warranty for the meter. ProDSS cables are covered for 2 years, while most common sensors are warrantied for 12 months. DK

MAINE BUOYS

The lakes are a little clearer in Maine, or at least they're supposed to be. Water quality buoys are keeping an eye on lakes across this state, where small shifts in water quality can be a big deal.

BY JEFF GILLIES

HIGHLAND LAKE

The non-profit Lakes Environmental Association has gathered water quality data on around 40 lakes in western Maine for a decade or two, but its record for Highland Lake goes back 40 years. The extra years of data and active community around Highland Lake made it a clear choice for the LEA's water quality buoy, which hit the water for the first time in July 2014. Plugging in to that invested public paid off when the group was able to rely on donations to cover an additional six sensors to track oxygen depletion in the lake. The group wants to know if stratification is breaking down in the summer and releasing phosphorus from the bottom sediments up into the water column where it could fuel algae growth. A bloom in 2002 dropped the visibility in much of the lake from a standard 6 or 7 meters down to just a foot or two.

GREAT POND

Academy Award-winning film On Golden Pond was based on the screenwriter's time spent on Great Pond in Belgrade, Maine. That made "Goldie" a natural nickname for the bright-yellow buoy that has floated on the lake for the past two field seasons. Great Pond is one of the Belgrade Lakes, seven hydrologically connected lakes that have come to serve as something of a natural laboratory for scientists at nearby Colby College. Judged by national standards, the lakes would be considered pristine, according to Whitney King, chemistry professor at Colby. But by the Maine standard, they're in slow decline — a trend that can be punctuated by a rapid switch to a eutrophic state. The buoy helps the college's faculty keep track of deep oxygen, stratification, surface productivity and changes in the lake's stability over time. In the meantime, they're working on a custom website to communicate the data to the public in a way that inspires the watershed community to take collective action to reduce their impact on the lake.

Photo: (top) Colin Holme; (bottom) Alex Wall

LAKE AUBURN

The water in Lake Auburn in Southwest Maine is so clear that drinking water managers don't have to filter it before sending it through the faucets in the cities of Auburn and Lewiston. But a recent uptick in algae blooms — including one in 2012 that resulted in early fall anoxia and the death of more than 200 trout — has the water district concerned it could one day lose the waiver that exempts it from filtering requirements. A collaboration between the Auburn Water District and Bates College this summer brought a water quality monitoring buoy to the lake that should bolster scientific understanding of how the waterbody functions. The continuous data from the sensors will open the door to a study of the lake's metabolism, the balance between oxygen-producing primary production and oxygen-consuming respiration. Eventually, they'll be able to connect the dots between the lake's metabolism, thermal structure and drinking-water related issues like transparency and turbidity.

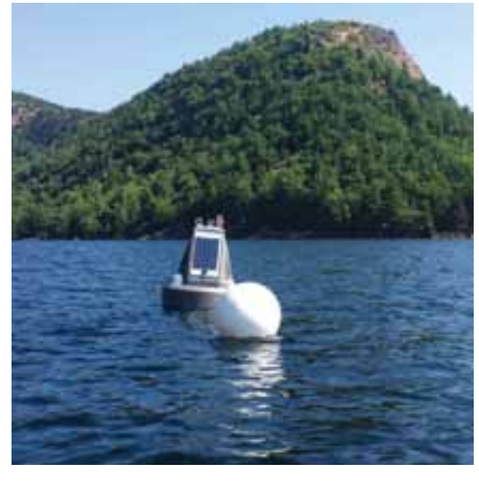
DOLBY POND

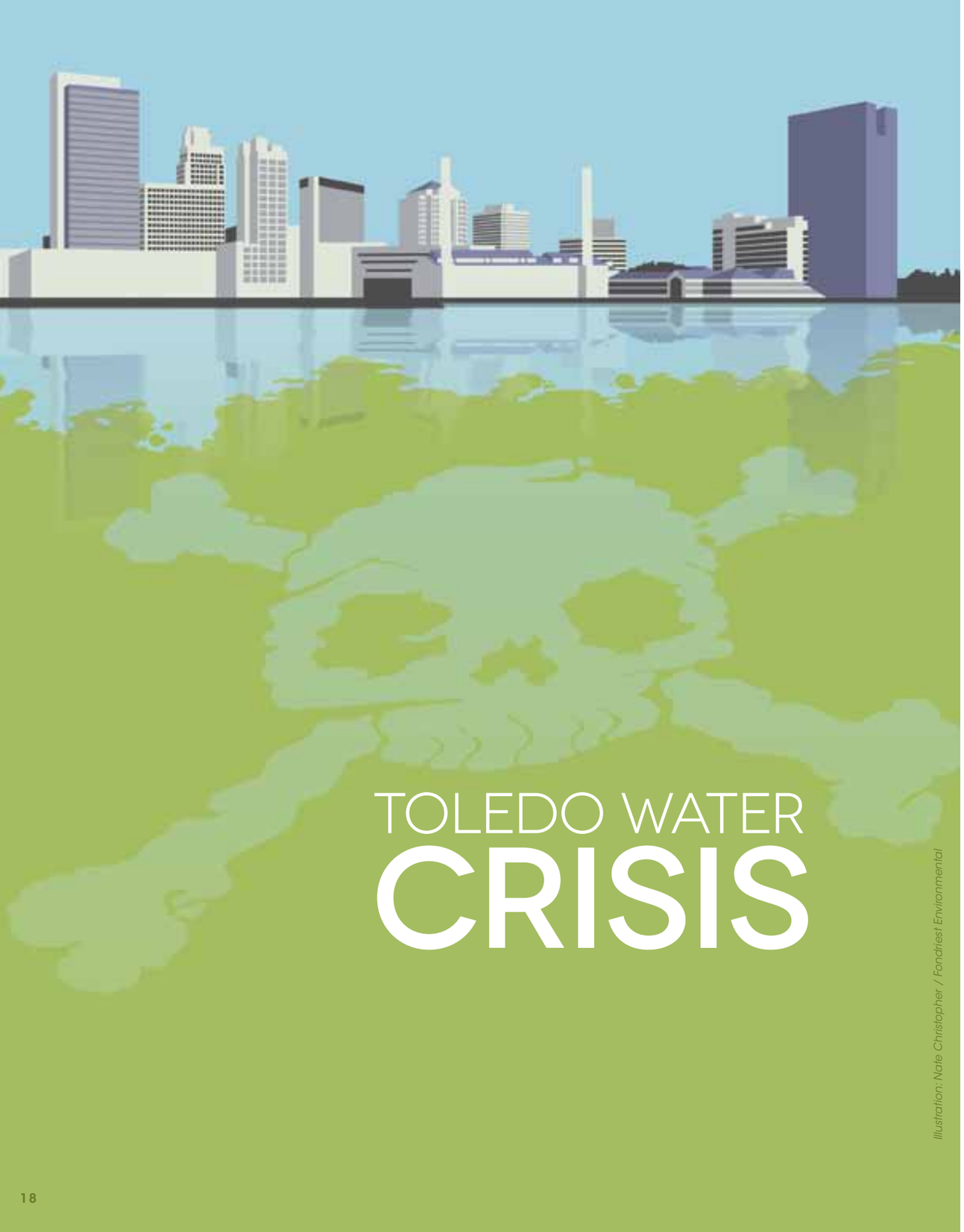
The Penobscot Indian Nation's water quality platform — more of a pontoon than a buoy — is helping to protect and restore the heart of their culture. The platform floats in Dolby Pond, an impoundment on the Penobscot River and one of the more than 110 sites on rivers, streams and lakes that the Penobscot Nation's Water Resources Program has been monitoring since the early `90s. In the past 15 years, blooms in the main stem of the Penobscot River have gotten more severe and have shifted from green algae to cyanobacteria. The platform project began after a particularly bad cyanobacteria bloom in 2007 led the state of Maine to fine an upstream paper mill for excess phosphorous discharges. It includes a weather station, multi-parameter sonde and a fluorometer, the last of which provides chlorophyll a and phycocyanin measurements that will hopefully give an early warning if another bloom starts to form.

Photo: (top) Kate Paladin; (center) Angie Reed; (bottom) Nora Theodore

JORDAN POND

Around 60 percent of visitors in Maine's Acadia National Park stop at Jordan Pond, which has historically been one of the most transparent lakes in the state — or so the claim goes, according to Nora Theodore, a master's student in the University of Maine's Ecology and Environmental Sciences Program. But that clarity has been in decline, and a buoy on the lake is helping researchers like Theodore test a few theories about why that's happening. The lake could be responding to reductions in acid rain, which may have inhibited water-clouding productivity until national legislation hole curbed the issue. The other idea, which scientists think is more likely, is that the lake could be dealing with a rise in inputs resulting from more frequent storms. The pond has a fairly wild watershed, so those inputs aren't the typical nutrients from fertilizer or wastewater. Instead, the uptick in storms may be flushing more dissolved organic matter into the pond. The buoy supports two photosynthetically active radiation sensors at 1 and 3 meters deep to track light attenuation, and an fDOM sensor will follow organic matter.





TOLEDO WATER CRISIS

Illustration: Nate Christopher / Fondriest Environmental

The Toledo water crisis that cut off water to 500,000 people also fast-tracked a new water quality data buoy near the city's water intake in Lake Erie.

BY JEFF GILLIES

Before Toledo residents this summer lost access to tap water drawn from Lake Erie, the city had been working with water engineering firm LimnoTech for a few months on a sensor system that could better inform treatment plant managers of water quality conditions near the offshore intake crib, according to Ed Verhamme, project engineer with LimnoTech.

When residents were told on Aug. 2 not to drink or bathe in the water from their taps because it carried dangerous levels of a toxin produced by a blue-green algae blooming in Lake Erie, the planning process sped up.

"The water crisis made them walk the contract down to the mayor's office the next day," Verhamme said.

By Thursday, Aug. 7, the buoy was in the water publicly reporting on wind, waves, currents and water quality from a single location in real time. It's one of the first buoys in Lake Erie to make that claim.

Perhaps the most important instrument onboard is the YSI EXO total algae sensor that measures both chlorophyll a and phycocyanin, the pigment in the toxin-producing blue-green algae. Live data from the sensor will give plant operators an idea of algae levels at the intake before the water gets to the plant.

"They would eventually see those water quality trends, but the time from when the water enters the intake crib until they measure it in the treatment plant can be up to 24 hours lag time," Verhamme said. "This buoy provides them with, 'What's the quality of the water coming into our intake right now?'"

In addition to the algae measurements, the buoy's EXO2 is collecting data on water temperature, conductivity, pH, oxidation-reduction potential and turbidity. A Nortek AWAC acoustic instrument mounted on the lake bed measures wave heights and water currents, making it the only station reporting those variables in real time from the lake's Western Basin. A camera mounted on the buoy delivers 5-megapixel photos and 720p video clips every hour.

"The webcam doesn't give you data you can plot," Verhamme said. "It just gives you a general feel of conditions that helps validate what the instruments are measuring."

The weather and water data are available on a web portal maintained by the Michigan Tech Research Institute and the Great Lakes Research Center and. The data are also shared with the NOAA National Data Buoy Center and National Weather Service and are available to help improve weather forecasts in the region. Researchers working on predicting the movement of harmful algal blooms will also benefit from data from a new location in the Western Basin. JG

Photo: Ed Verhamme

SYSTEM DESCRIPTION

NexSens CB-950 Data Buoy: Floating platform with 950 lb. buoyancy. Includes three 30-watt solar panels and two 28 A-Hr batteries for power. Also houses data logger and cellular modem.

Campbell Scientific CC5MPX Camera: Captures 5 MP images and 720p video clips.

Lufft WS501 Weather Sensor: Measures wind speed, direction, gust, air temperature, relative humidity, dew point, barometric pressure and solar radiation. Deployed 6 feet above the water.

YSI EXO2 Water Quality Sonde: Measures water temperature, conductivity, pH, ORP, turbidity and total algae (chlorophyll and blue-green algae). Deployed 2 feet below the surface.

Nortek AWAC Current Profiler: Measures water speed and direction at 1-meter increments, wave height, period and direction. Deployed on the bottom looking up.

ABOUT LIMNOTECH

LimnoTech is a leading environmental engineering consulting company headquartered in Ann Arbor, Michigan, with regional offices in Washington, D.C., the Minneapolis-St. Paul region, and Southern California. Their more than 70 employees work across the Great Lakes, the United States and internationally on a broad range of water-related environmental issues. They have a particular interest in providing services that require special expertise, and buoy projects fit that description. Outside NOAA itself, LimnoTech deploys and maintains more real-time data buoys than any public or private organization in the Great Lakes.

Additional information on LimnoTech can be found on their website at www.limno.com.

FRAPPE

The Front Range Air Pollution and Photochemistry Experiment is studying ozone levels near Denver that have recently risen above quality standards.

BY DANIEL KELLY

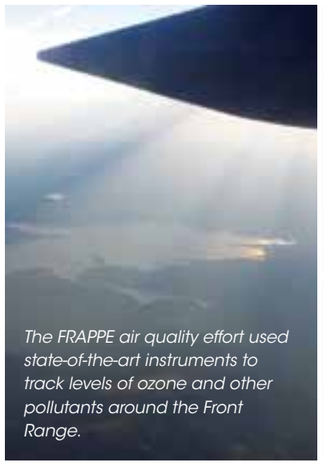
Frappes are foam-covered, icy drinks made with a little cream, sugar and instant coffee. Taken separately, their ingredients aren't that savory. But when they're all mixed up, the result can be quite delicious.

Because of its good combination, the icy coffee drink is the namesake of a study bringing together many different sets of expertise and technologies to study air quality near Denver. FRAPPE, or the Front Range Air Pollution and Photochemistry Experiment, was headed up by scientists at the National Center for Atmospheric Research, or NCAR. They completed the study to learn more about summertime ozone levels in the Denver area, which have recently risen above air quality standards.

"Most of the instruments (we used) are state-of-the-art, custom-built instruments that measure things we're interested in looking at," said Frank Flocke, scientist at NCAR and a principal investigator on the project.

The large-scale effort brought together some 200 scientists, students and support staff using five research aircraft equipped with sensors and other sophisticated tech to measure ozone, carbon dioxide, methane, hydrocarbons, nitrogen oxides, nitrates, ammonia and all sorts of other smog builders. Those airborne data sets were combined with others from ground stations, mobile radar and balloon-mounted sensors.

Photo: Barbara Flocke



The FRAPPE air quality effort used state-of-the-art instruments to track levels of ozone and other pollutants around the Front Range.

Photos: Frank Flocke

"The Denver area is a very diverse area as far as emissions go. Some come from transportation, oil and gas, extraction activities, industrial plants, animal feeding operations, agriculture and other sources," said Flocke. "And the northern Front Range is the main receptor for all these emissions."

"Any models of the Front Range have issues getting the air quality right," said Gabriele Pfister, a scientist at NCAR and a principal investigator on the project. "This study will help us to improve ozone and air quality models near there. Simulating that near the mountains is a challenging thing."

That's where NASA came in. The space agency made research flights over the Front Range through its ongoing DISCOVER-AQ effort that has dissected air quality in regions across the country. Its stint near the Front Range coincided perfectly with FRAPPE, which continued into mid-August. "We worked very closely with the DISCOVER-AQ folks and we tried to fly our craft at the same time," said Flocke.

There are other areas around the United States with similar mountainous terrain influencing their air quality, like Sacramento, Salt Lake City and places east of the Appalachian Mountains. When a place is situated just right, Flocke says, mountains can sometimes control air flows.

Near Denver, those flows may be contributing to higher ozone levels. Flocke and Pfister are still going through data from the expedition, but have so far noticed ozone pollution making it all the way to the Continental Divide. And ozone levels near the mountains, they've found, are similar to or greater than those found at lower elevations.

They hope to make data from the study available to the public by the end of the year so the state of Colorado can determine where practical steps can be taken to cut emissions that later form ozone in the atmosphere.

"Even with the state agencies that do surface monitoring, many areas have no measurements at all," said Pfister. "With these data, we can fill the gaps. And we can also capture what is coming in from outside the region to get measurements that cover a larger area." DK

OIL & WATER

Oil palm plantations are rapidly replacing tropical forests in Southeast Asia. A new study adds degraded stream water quality to the list of consequences.

BY JEFF GILLIES

Vast swaths of tropical forests across Southeast Asia have been cleared to make room for oil palm plantations, destroying habitat for rare species and releasing carbon dioxide into the atmosphere. A new study adds degraded water quality to the list of effects, showing that the plantations warm locally important streams and cloud them with sediment.

The island of Borneo has been a particularly hot spot for deforestation, losing nearly a third of its forest cover over the past 40 years. Much of that has been replaced by oil palm plantations, which are harvested to produce ubiquitous oil found in products from peanut butter to shampoo.

The region has drawn attention and concern of the global conservation community, though it has mostly focused on the loss of carbon tied up in the forests and habitat for the region's many endemic species. A study recently published in the Journal of Geophysical Research: Biogeosciences is among the first to look at the effects on Borneo streams, comparing water quality in those running through pristine forests, as well as recently cleared land and mature plantations.

Some of the results weren't surprising. A stream draining a recently cleared and planted oil palm plantation was nearly 4 degrees Celsius warmer and carried an average of 550-times more sediment than a stream draining an intact forest. That's an expected, classic result of deforestation, said Kim Carlson, lead author of the study and a postdoctoral scholar at the University of Minnesota's Institute on Environment.

"What we were surprised about was the fact that these mature oil palm plantations, which do appear to be forests when you drive around in them, produced pretty high temperatures and really high sediment loads," she said. "In fact, their sediment yields, once we controlled for precipitation, were higher than the young oil palm plantations."

Photo: Kimberly Carlson

The mature plantations, which Carlson said have nearly full canopies and 20-meter tall trees, also have dense networks of roads for the trucks that pick up the palm fruit during harvests. Those are likely sending sediment into the stream during the region's regular and intense rain storms, though the study didn't investigate a specific cause, Carlson said.

The streams running through plantations were also worse off than streams running through land used for local agriculture and subsistence farming. Farmers generally clear a few acres of land and plant rice to feed themselves. Following that crop, they might plant fruit trees or let the land go fallow, resulting in a patchwork of land use.

"You can be walking through a beautiful fruit garden with amazing durian trees, and then the next moment you're in a one-year-old, shrubby area," Carlson said.

The fact that community-farmed land fostered healthier streams than plantations is a concern because policies are going into place that deter oil palm plantations from replacing intact forests. That's good for forests, but it could also push more palms onto locally farmed land that is still more protective of streams than plantations.

"It could have huge benefits for carbon, but it's probably still going to have a large impact on water quality," Carlson said.

That's important because stream water is a crucial resource for daily life in the region. They use it for drinking water, to bathe and wash their clothes. Fish from the streams are a major source of dietary protein, though the study didn't trace the effects of temperatures and sediment on local fish populations.

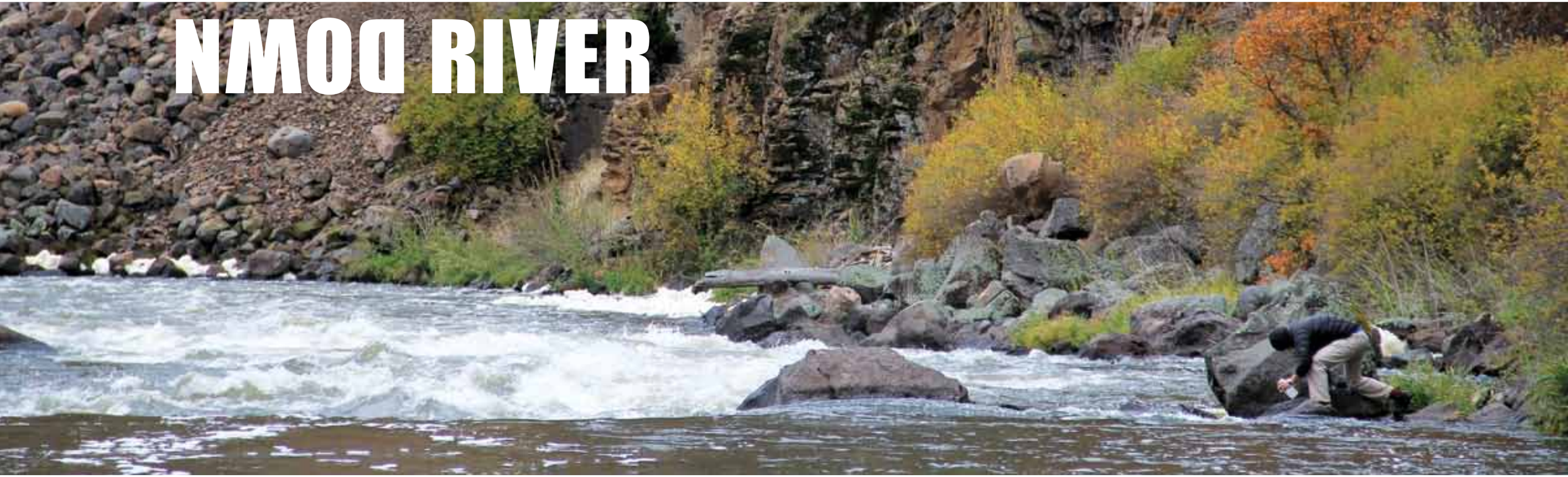
Carlson conducted the research while a doctoral student at the Yale School of Forestry and Environmental Studies. She worked under the supervision of Lisa Curran, a professor of environmental anthropology at the Stanford Woods Institute for the Environment with a long history of research in the region. Curran played an important role in setting up Gunung Palung National Park, the site of the study's pristine forest stream.

Carlson was in the field for around a year setting up the five study sites, and members of the non-governmental organization Living Landscapes Indonesia picked up the data collection after that. Carlson recalled spending up to 8 hours a day on a motorbike, cautiously traversing the park with a YSI 6600 multi-parameter sonde in her pack. They often stayed in villages and got help from the locals with identifying streams that drained the land uses they were interested in.

"We'd either get on a motorbike and drive through a plantation to find the stream or hike for four hours through a forest, complete with leeches and orangutans," Carlson said. "We couldn't have done it without the people who actually live [in Kalimantan]." JC

Photo: (top) Kimberly Carlson; (bottom) Yadi Purwanto

UPSIDE DOWN RIVER



A new study looks at nutrients in the Klamath River, which rises among farms before flowing down into mountainous canyons as its water quality improves.

BY JEFF GILLIES

Compared to most coastal river systems, the Klamath River is upside down. It starts slow, wide and high in nutrients among farmlands of eastern Oregon. As it flows through northern California toward the Pacific, its basin narrows and turns mountainous, its bed steepens and its water quality improves.

A recently published study tracked water quality in the Klamath River as it followed its backward path. It's among the first year-long records of how the river changes from season to season as it flows through farm fields, five reservoirs and forested canyons.

A plan to restore the system's formerly prolific salmon runs seeks to remove dams on four of those reservoirs along the Upper Klamath River. The new study could serve as a baseline for understanding how future work affects nutrients and algae blooms that plague the river.

"The goal was to describe the conditions on a seasonal and longitudinal basis with the dams in place," said Allison Oliver, study author and post-doctoral fellow at the University of Alberta. "It wasn't to make predictions about dam removal or track how dams in and of themselves were causing algal blooms."

Oliver, who conducted the research as a doctoral student at the University of California, Davis, collected monthly water samples at eight sites along the river from May 2010 to June 2011. Sampling in the winter sometimes got a little hairy, but it was important because there was otherwise very little data available on nutrients and water quality during that time of the year. The weather turned some three-hour drives between sampling sites into six-hour drives and made access a chore.

Photo: Allison Oliver

"Some of the sample sites are down a four-wheel-drive road that gets wet and turns into two feet deep of muck," she said. "Then you have to climb out on icy rocks. It was pretty gnarly sometimes.

"A couple of them I did on crutches. That required some recruiting of additional help."

The researchers sampled sites upstream and downstream of most reservoirs to get an idea of how each affected nutrient levels in the river. The results showed that, for the most part, the upstream reservoirs acted as sources of nutrients while the downstream reservoirs acted as sinks.

"As you moved downstream from the headwaters, the reservoirs had a increasingly ameliorating effect on water quality," she said. "They basically acted like processing units, consuming nutrients."

But that wasn't always the case, as each reservoir's behavior changed throughout the year. In the high flows of winter, for example, some reservoirs appeared to add to the nutrient loads of downstream segments.

Though the study doesn't make any recommendations on restoring fish populations, Oliver said it's a good segue to a closer look at how nutrients could fit in to restoration goals on the Klamath. Managers want to reintroduce salmon above the lowest dam, where water temperatures routinely stay warmer than the species prefers. Lowering temperatures is a common goal in the fish habitat restoration world of the West, but the Klamath has few cold water sources (springs, for example) to cool the river above the site of the lowest dam.

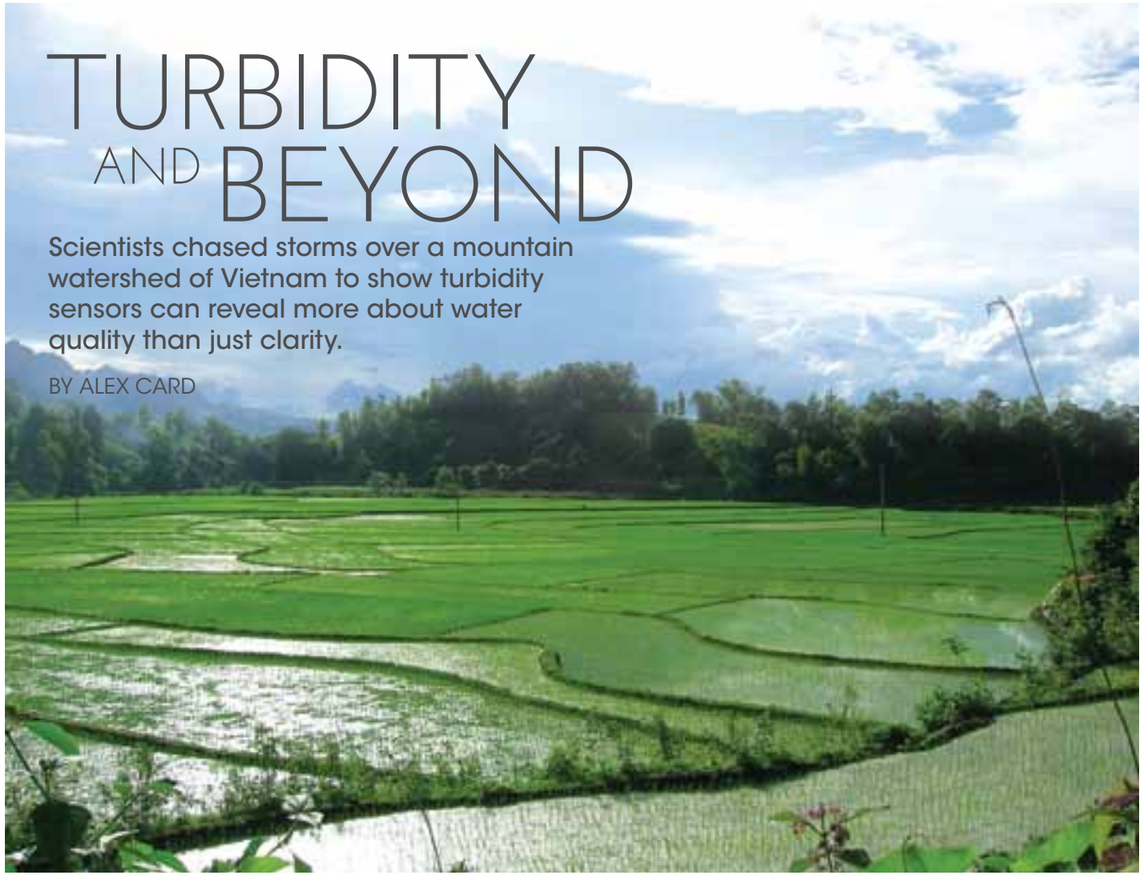
Instead, restoration managers could exert greater control on the system by looking to nutrients, which combine with high temperatures to create the eutrophication effects that are bad for fish.

"I think it's important to show that in some places if you want to do successful fish restoration, you also need to focus on things beside temperature," Oliver said. JC

TURBIDITY AND BEYOND

Scientists chased storms over a mountain watershed of Vietnam to show turbidity sensors can reveal more about water quality than just clarity.

BY ALEX CARD



Monitoring water quality near agricultural land helps farmers know what's coming in and out of their fields, but many sensors and probes are expensive, or — in some parts of the world — simply inaccessible.

An international team of researchers developed a method to monitor sediment, carbon and nitrogen flows using just a turbidity sensor alone, potentially opening the door to cheaper, more efficient monitoring solutions. They conducted a study using the method in a mountainous watershed in Northwest Vietnam.

"There's been a lot of population increase there and a lot more demand on the land, and this is leading to not-so-sustainable practices," said Johanna Slaets, a doctoral student at the University of Hohenheim in Germany. She led the study as part of her doctoral education.

As Vietnam's population grows, farmers are hastily plowing ancient forests into fields for corn and rice. The researchers wanted to quantify the effects of such a rapid transformation, something that Slaets said had not been done on small headwater basins in the region. To properly do so, they would need to examine the type and amount of sediment entering the watershed, as well as carbon and nitrogen levels.

While this could have been accomplished with a small suite of sensors, the researchers found that they could achieve the same results using just a turbidity sensor, using the haziness of a fluid as a proxy.

A soil particle's reflectivity is partially determined by its shape and size, two features that also indicate its composition, whether silt, sand or clay. Calibrating the turbidity sensor's signal allowed the researchers to measure carbon and nitrogen, too.

"This is the interesting part for a farmer, because it matters what kind of material is disappearing (into runoff)," Slaets said. "If it's very fertile, it's very bad for the place where it's disappearing, but very good for the place it's going."

The study took place over two rainy seasons in 2010 and 2011. The researchers only took samples during periods of rain to obtain the best runoff readings. When the weather was dry, the researchers were left to read meters and wait for a shower. This requirement, Slaets said, made the fieldwork a particularly unique experience.

"Whenever it's raining, you go out to the field and try to take a sample," she said. "It sounds exciting, but most of the time it means you spend a lot of time on the balcony looking at the clouds, hoping that rain will come."

All Photos: Johanna Slaets

Researchers sampled streams from bamboo bridges like these, often during thunderstorms.

"The whole storm-based thing is kind of challenging because you end up rushing out at lunch — or 6 a.m., when one of your colleagues wakes you up and says, 'It's raining, it's raining!'" Slaets noted that some of the locals found humor in announcing a rain shower when there wasn't one, sending the researchers into a scramble that would inevitably end in disappointment.

The need for rain wasn't the only challenge, Slaets said. Lack of infrastructure made traversing the rugged terrain difficult. Motorbikes served as the primary mode of transportation between sample sites, and equipment breakages were not uncommon on the bumpy rides.

Furthermore, frequent power outages put the samples at constant risk, as they had to remain frozen until the researchers could bring them to Hanoi for analysis.

Slaets said the method outlined in her research could be valuable in many applications, from freshwater eutrophication to the study of nutrient depletion in upland areas — any situation where turbidity, nutrient and sediment information is necessary.

"That's the great thing: you need the same sensor," she said. "Everyone knows we have limited time, we have limited budget, so the more you can measure with one sensor, the better." AC

Photo: Doug Nguyen / NexSens Technology

EYES ON ERIE

Pennsylvania community embraces data buoy on their Lake Erie waters.

BY JEFF GILLIES

Data buoys are becoming a more popular investment for coastal communities that want wind, wave and water quality information delivered straight to their computers and phones. But the buoy floating in Lake Erie off of Erie, Pennsylvania, might be the only one with its own T-shirt design.

And its own business cards. And window clings.

"It's a fun project and people have been very positive and very excited about it," said Jeanette Schnars, executive director of the Regional Science Consortium based at the nearby Presque Isle State Park.

The buoy, nearing the end of its first season in the water, is the first to deliver real-time measurements of wave height and frequency on Pennsylvania waters of Lake Erie. That's important information for the people who flock to the area every summer for boating, fishing and swimming.

Though the state claims only about 6 percent of the Lake Erie shoreline, it makes good use of it. Presque Isle State Park, with its sandy, lagoon-spotted point that juts out into the lake, draws 4 million visitors a year. That rivals and even surpasses the totals for some national parks, and many of those visitors take to Presque Isle's sandy beaches. The region's perch, walleye and bass fisheries draw recreational anglers and fishing tournaments year-round.

"I was born and raised in Erie, so it's funny to think of Erie as a tourist town," Schnars said. "But we really do have a lot of people that come up here for vacations."

And it's those people, as well as the locals who make use of the water, who are meant to benefit from the buoy. While other moorings tend to supply data to scientists for studies and forecasts, the Regional Science Consortium has made a big public awareness push to teach people how to access the buoy's readings to stay safe on the water. Hence the T-shirts, business cards and window clings, all of which sport a QR-code that sends scanners to the buoy website.

The push appears to be working. The buoy was on the front page of the Erie Times News the day after it was deployed, and Schnars says the local TV stations feature its data and video clips almost daily during their weather forecasts. The traffic to the website grew throughout the summer to around 48,000 sessions in both July and August.

Stirring up some wake to test the buoy's wave measurement capabilities.

Photo: Doug Nguyen / NexSens Technology

> "IT'S A FUN PROJECT AND PEOPLE HAVE BEEN VERY POSITIVE AND VERY EXCITED ABOUT IT."
>
> **-Jeanette Schnars**
> Executive director, Regional Science Consortium

Visitors to the website can see a recent 10-second video clip recorded by a camera atop the buoy, as well as a full suite of meteorological, wave and water quality variables. The wave data can help charter captains plan for additional fuel costs when the waters are rough or save recreational boaters the hassle of trailering up to the lake only to find unsafe conditions.

The wave heights will also be worth watching in October and November as the fall storms blow in. The consortium's people at the Tom Ridge Environmental Center can walk down to the Presque Isle beach to see those big waves crashing over the breakwaters, but the buoy lets them know what's going on a few miles offshore.

"It's interesting to see what the waves are doing out there," she said. "We did have a couple of significant storms where we saw waves that exceeded 9 feet."

Jeanette Schnars takes spot measurements to check against buoy data.

Beyond just keeping people informed of lake conditions, the data are also going to the National Data Buoy Center, where they're picked up by the National Weather Service to improve their forecasts. The Pennsylvania Fish and Boat Commission is using the information for fish studies, while local water authority Erie Water Works is watching the temperature and turbidity readings.

But the boaters, anglers and beachgoers are likely the most important group of users, especially because the buoy's future is in their hands. A grant from the Great Lakes Observing System will cover the buoy through the 2015 season. But after that, they'll rely on donations and, of course, T-shirt sales. The consortium is launching a new website soon to make it simple to donate to an account that will exclusively fund buoy operations. Prior to the 2016 season, they hope to have enough to cover deployment, maintenance and retrieval in November before the lake ices up.

"We don't want to get it out there and not be able to get it back in," Schnars joked. JG

ABOUT REGIONAL SCIENCE CONSORTIUM

The Regional Science Consortium is a collaborative non-profit based in Presque Isle, Penn., that coordinates educational and research projects for Lake Erie and the Ohio River Basin. The Consortium's members include colleges and universities, state and federal agencies, K-12 school districts and other non-profits. They work out of the Tom Ridge Environmental Center located at the gateway to Presque Isle State Park, where their facilities and amenities include multiple labs, classrooms, a theatre and research vessels. Consortium members research topics span from beach erosion and Lake Erie phytoplankton to brown bullhead tumors and turtle consumption of zebra mussels.

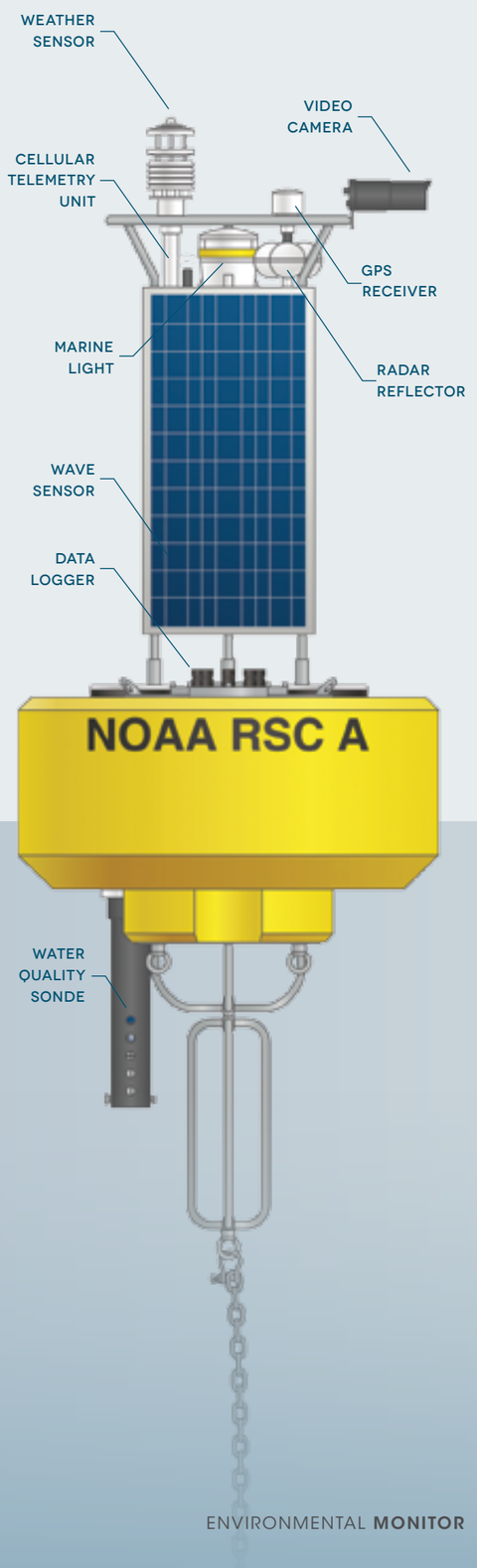


Photo: Regional Science Consortium; Diagram: Fondriest Environmental

MISSING FISH

Surveys of drought-weakened Sierra Nevada streams are turning up sparse numbers of fish, as well as insights that could aid in conservation efforts.

BY DANIEL KELLY

In the parched hills of the Sierra Nevada, researchers are surveying drought-weakened streams to see what effects long-term dryness is having on fish populations in the region. Their findings so far have been less than stellar, with sparse numbers of fish being counted.

Still, as data collection is progressing, the researchers, who work out of the University of California, Davis' Center for Watershed Sciences, are gathering insights that could aid in conservation efforts that are expected to grapple with coming climate changes.

The purposes of the investigation are two-fold. "If we ever get rain again, we want to see how well these areas are recovering from drought," said Rebecca Quinones, a postdoctoral researcher at the center and leader of the project. Then, by comparing how the habitats differ from before and after, "can we predict how well they'll do going into climate change simply by differentiation?"

Quinones is building on considerable work by Peter Moyle, who has studied Sierra Nevada streams and fish for decades. He is one of the group that is going out to sample the streams for temperature, pH, conductivity and dissolved oxygen using a YSI Pro Plus multi-parameter water quality meter. Researchers are looking at concentrations of phosphorus, nitrogen and ammonia as well. For fish counting, the group relies on seine nets for threatened species and electrofishes for others.

"The goal is not to kill anything, and we try to minimize mortalities as much as we can," said Quinones. "The ones that we do collect for teaching purposes are kept in conditions similar to the ones where we find them."

And by comparing those conditions to the ones that Moyle documented in the past, researchers can see changes in recent years: Warmer water temperatures have been recorded in some areas, while others have shown water losses with ongoing drought conditions.

Quinones is comparing findings to those from studies dating back to the 1970s as a baseline, and though data collection is still underway, there are some findings to report.

"We're seeing that drought is exacerbating what's been going on," said Quinones. Spring-fed systems, which keep more stable flows, are doing better. Some points in the north are also doing better, all the way down to Bakersfield. "But the San Joaquin Basin is much drier than the rest of the state."

The findings so far are more California-centric, she says, and her research group is partnering with scientists at the University of Evora in Portugal who are studying streams there to give the work more international applicability. So in addition to comparing past conditions in California to present-day changes, data will also be used to see what role land-use plays in affecting stream health.

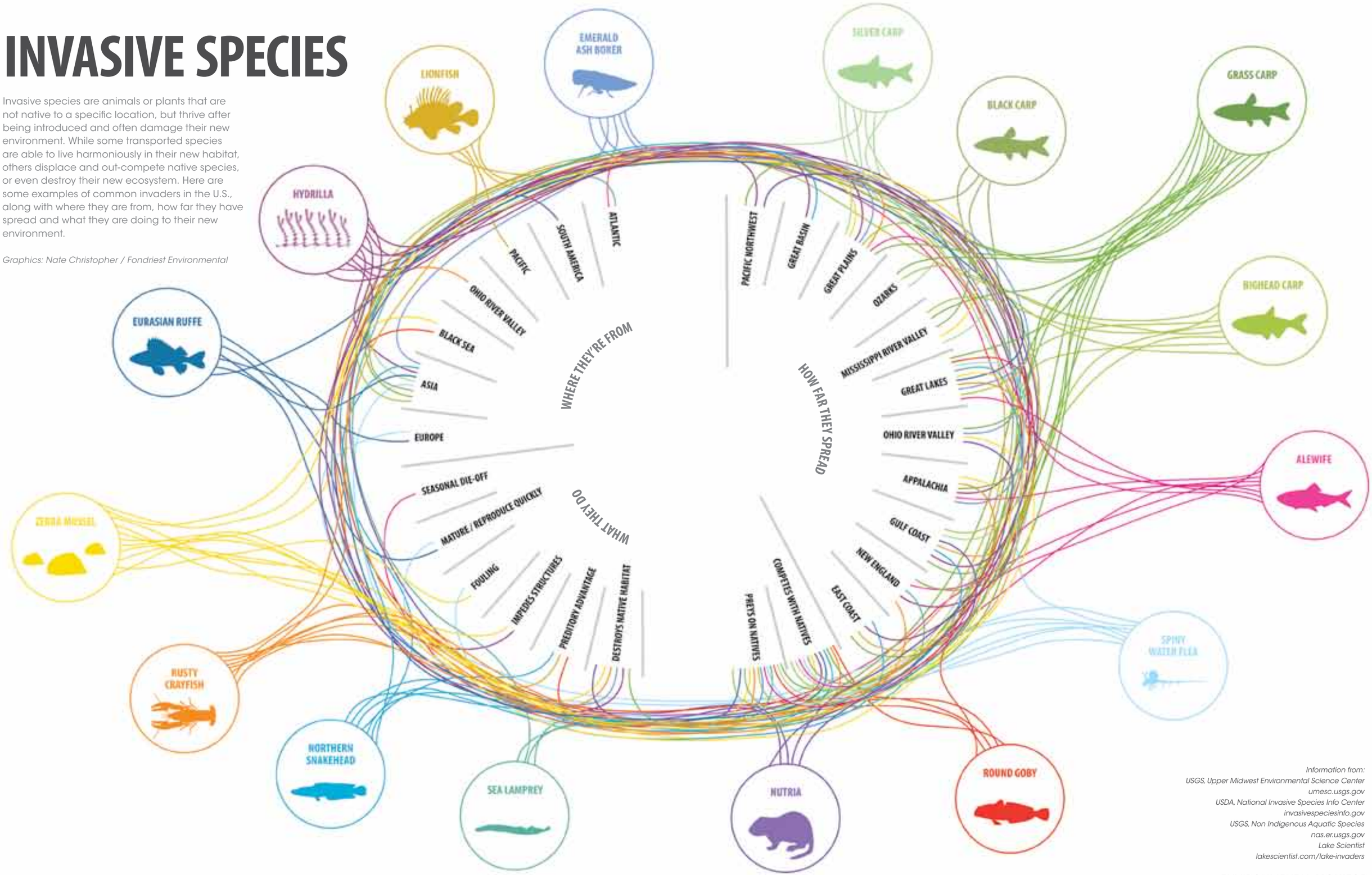
"The (Mediterranean) climate is very similar (to California's). There are wet springs, dry summers and early falls," said Quinones. What is different is how the land is used. In Portugal, the agricultural operations are much smaller, usually family-oriented farms that grow crops like cork and olives. Population centers are smaller too. "And that's fascinating because that's what shapes the habitat." DK

All Photos: UC Davis Watershed Sciences Center

INVASIVE SPECIES

Invasive species are animals or plants that are not native to a specific location, but thrive after being introduced and often damage their new environment. While some transported species are able to live harmoniously in their new habitat, others displace and out-compete native species, or even destroy their new ecosystem. Here are some examples of common invaders in the U.S., along with where they are from, how far they have spread and what they are doing to their new environment.

Graphics: Nate Christopher / Fondriest Environmental



Information from:
USGS, Upper Midwest Environmental Science Center
umesc.usgs.gov
USDA, National Invasive Species Info Center
invasivespeciesinfo.gov
USGS, Non Indigenous Aquatic Species
nas.er.usgs.gov
Lake Scientist
lakescientist.com/lake-invaders

All Photos: Kunuk Lennert / Greenland Climate Research Center

ADRIFT IN GREENLAND

Drifting sensors address one of the "golden problems" of glaciology near the Greenland ice sheet by measuring what happens when meltwater meets the ocean.

BY ALEX CARD

The Greenland ice sheet is climate change's frozen hourglass: As the world warms, the ice sheet melts away, slowly dripping into the Atlantic where it influences oceanic circulation.

If the entire Greenland ice sheet were to melt, the global sea level would rise by 7.2 meters, drowning most coastal cities. For decades, scientists have studied the glacier and its meltwater in an effort to track the effects of global warming, and better understand the chemical and thermal reactions that occur when meltwater meets the ocean.

Their efforts, however, have not gone without challenge.

"One of the golden problems in glaciology and oceanography is trying to measure the end result of accelerated melting in Greenland," said Peter Winsor, associate professor of oceanography at the University of Alaska. "When all that freshwater hits the ocean, we have trouble measuring where it's from and where it's going."

Attempting to distinguish between the meltwater and ocean water is only part of the issue. The narrow, winding fjords of Greenland's glacial coast are dotted with icebergs capable of destroying most small craft and autonomous measurement platforms, forcing scientists to study from deeper waters. Use of larger, sturdier vessels only complicates things further.

"Even if you go out there with a research vessel, you're kind of destroying the signal you're trying to measure by ploughing through that water," said Winsor, co-author of a study in the journal EOS detailing an innovative meltwater monitoring technique.

The solution to these problems came in the form of small, satellite-tracked drifters designed to monitor water conditions and float through fjords while withstanding a hefty serving of blunt trauma. Resembling a floating Roomba, the domed devices recorded conductivity, temperature and depth at surface level, 7 and 15 meters of depth. The data and GPS coordinates were then transmitted to an Iridium satellite every hour, a real-time process that afforded better research than earlier deploy-and-collect methods.

"It enables adaptive sampling," Winsor said, explaining that real-time data allows researchers to respond to significant readings. "It's a much more dynamic way of measuring meltwater from the ice sheet."

Researchers from the University of Alaska and the Greenland Climate Research Center in Nuuk used a helicopter and boat to deploy 14 drifters between 2011 and 2013. The project, funded by the Research Center, revealed a number of interesting features of the fjord system and the glacial meltwater coursing through it.

"This freshwater moving around in the system…can go from sitting around, to having these very direct movements where it's moving multiple meters per second down the fjord, which is very fast in oceanography," Winsor said.

Winsor listed three other surprising discoveries about glacial meltwater in Greenland's coastal fjords: "It looks like the system is pulsating, it's more stratified than we thought it was, and the changes between low and high salinity are much greater than we thought."

Initially, the researchers had believed that the transition from low to high salinity took place over a long stretch of ocean. But data gathered by the drifters showed that the gradient was in fact rather steep, spanning only a few kilometers. Vertical profiling revealed an unexpected level of stratification: a difference in salinity of 20 or greater occurring over 70 meters below the surface.

Although the drifters were durable, they weren't fully foolproof. Winsor said the drifters occasionally tangled their tethers and drogues, or became lodged in ice. Lucky for the researchers, the residents of Nuuk were often willing to help free the devices. One brave soul even dove into the frigid water to unstick a drifter.

Winsor said he and his co-authors are proposing a continuation of the study that would expand its scope with the inclusion of underwater gliders.

"We're hoping to do this again, but scale it up with more drifters and gliders and nail down in better detail how this system undergoes change," Winsor said. "We're excited about that." AC

> “...THEY’RE THERE WITH YOU IN ONE MOMENT AND OFF IN THE BLUE IN THE NEXT.”
>
> **-Douglas McCauley**
> Assistant professor at the University of California, Santa Barbara

Photo: Gareth Williams

MANTA RAY HIGHWAY

To learn more about the popular yet enigmatic manta ray, scientists led a study of the species in one of the few places where large numbers still gather.

BY ALEX CARD

The manta ray glides through the water with a grace matched by few other fish. For centuries, these mysterious creatures have drawn the attention of humans, provoking a range of responses from fear to awe to intrigue. Hunted into modern times for food, leather and purported medicinal properties, the manta wasn’t protected as a vulnerable species until 2011.

In spite of its relative popularity, the manta ray remains an enigma in many ways. That’s why Douglas McCauley, assistant professor at the University of California, Santa Barbara, led a study in one of the few places where this endangered species still gathers in large numbers: Palmyra Atoll.

“We were really shocked to find how little scientists know about such a popular, such a conspicuous and elegant animal,” McCauley said. “I’m trying to understand how the loss of large animals influences the function of the rest of these ecosystems.”

Briefly occupied as a U.S. naval base in World War II, Palmyra now houses a small, temporary complement of rotating scientists employed by the U.S. government, The Nature Conservancy and the Palmyra Atoll Research Consortium. The atoll features a large reef, 50 partially connected islets and two shallow lagoons.

“Isolation has afforded de facto protection for the reefs there,” McCauley said. “It’s been kind of doing its own thing in the middle of the Pacific.”

But mantas aren’t there for the getaway. The lagoons at Palmyra and other atolls provide a perfect spot for mantas to munch on zooplankton floating in the warm, shallow water.

McCauley and his colleagues employed several techniques to study the elusive manta rays, from high-tech to admittedly outdated. But McCauley sought a comprehensive understanding of the fish, and one method in isolation wasn’t going to cut it.

The first part of the study took advantage of the atoll’s geography to observe mantas where they gather on their way into the lagoon.

“The main passageway into Palmyra lagoon is a single channel,” McCauley said. “It’s sort of like a manta highway…as they come from the great blue yonder, the pelagic ecosystem. Often we’d see trains of mantas, nose-to-tail, passing in and out of the field of view of this passageway.”

Using a Sound Metrics DIDSON 300m sonar camera, the researchers set up a “sound gate” across three-quarters of the channel. Anything passing in front of the instrument over the next month — whether manta, turtle, shark or swimmer — was caught in near-video clarity. With no power on that end of the atoll, the researchers used a Navy piling from World War II as a base for a makeshift power station.

To get a better sense of the mantas’ movements, the researchers used a method that McCauley called “a step back in technological time.” They affixed acoustic pingers onto some rays, then, with only their eyes and a hydrophone to guide them, followed the tagged creatures for hours in a boat while GPS units recorded their movements. Though the technique afforded an intimate glimpse into the mantas’ lives, it was far from easy.

“It requires being with the fish at all times, which is a mind-numbingly wonderful experience,” McCauley said. “As is the case with a lot of highly mobile marine animals, they’re there with you in one moment and off in the blue in the next.”

Researchers took 6-hour shifts tracking the mantas around the clock. Sometimes, McCauley said, this meant weathering squalls through the night, taking shelter beneath a tarp or lifejackets for warmth.

In the end, the researchers discovered manta behavior that could lead to improved conservation efforts. While the manta’s propensity for long-distance travel is known, the researchers found that the creatures return to their favorite spots — specifically lagoons — time and time again.

“If you can actually figure out where the favorite spots are for an animal…then we stand a much better chance of being able to protect them,” McCauley said. AC

MONITORING GEAR

YSI Pro10

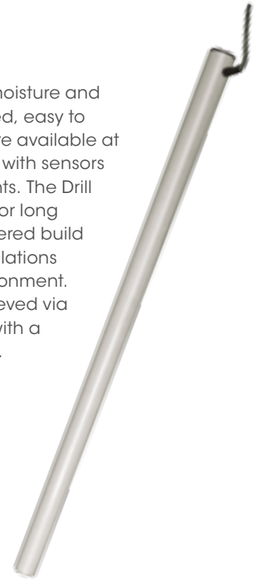
The YSI Pro10 measures pH, ORP and temperature in field and laboratory applications. This high-performance meter features a simple interface, 50 data set memory capacity, user-replaceable cables ranging from 1 to 30 meters, and field-rugged sensors. pH or ORP laboratory cable assemblies are also available in 1- and 4-meter lengths. Military spec connectors, an IP67 waterproof rating, and a rubber over-molded case make the Pro10 a tough field meter.

Spectrum WatchDog 1120

This self-emptying tipping bucket rain gauge and data logger provides years of accurate and reliable precipitation data. The internal data logger records accumulated rainfall in metric or U.S. units during each interval, which can be set between 1 and 60 seconds. A PC interface cable included with the SpecWare software enables data download and report creation in Excel format. The WatchDog 1120 meets NWS guidelines with an 8-inch diameter orifice.

Sentek Drill & Drop

The Drill & Drop measures soil moisture and temperature in an encapsulated, easy to install profiling probe. Probes are available at 60 and 120 centimeter lengths, with sensors fixed at 10 centimeter increments. The Drill & Drop can be buried for short or long term applications, and the tapered build allows for extremely quick installations without disturbing the soil environment. Communication output is achieved via SDI-12 protocol for integration with a variety of industry data loggers.



Solinst Levelogger Junior Edge

The Solinst Junior Edge is a compact and fully submersible transducer that measures water level and temperature in both groundwater and surface water applications. Sample intervals are user-defined between 0.5 seconds and 99 hours, with an extensive memory capacity of 40,000 data sets. The logger can be installed via wire suspension or direct-read cable assembly. Data collection is achieved via USB interface cable or App Interface module for Bluetooth transmission to a compatible Apple device.

Thermo Orion ROSS Ultra

ROSS Ultra pH electrodes incorporate an internal reference system that provides superior measurement stability with low drift and fast response. The double junction reference is ideal for complex samples such as biological media, foods, pharmaceuticals, TRIS, sulfides and proteins. The ROSS Ultra line features glass or epoxy electrodes, refillable or low-maintenance design, flat surface and semi-micro designs. Refillable ROSS Ultra electrodes have a 2-year warranty while the low-maintenance triode has an 18-month warranty.

LI-COR LI-1500

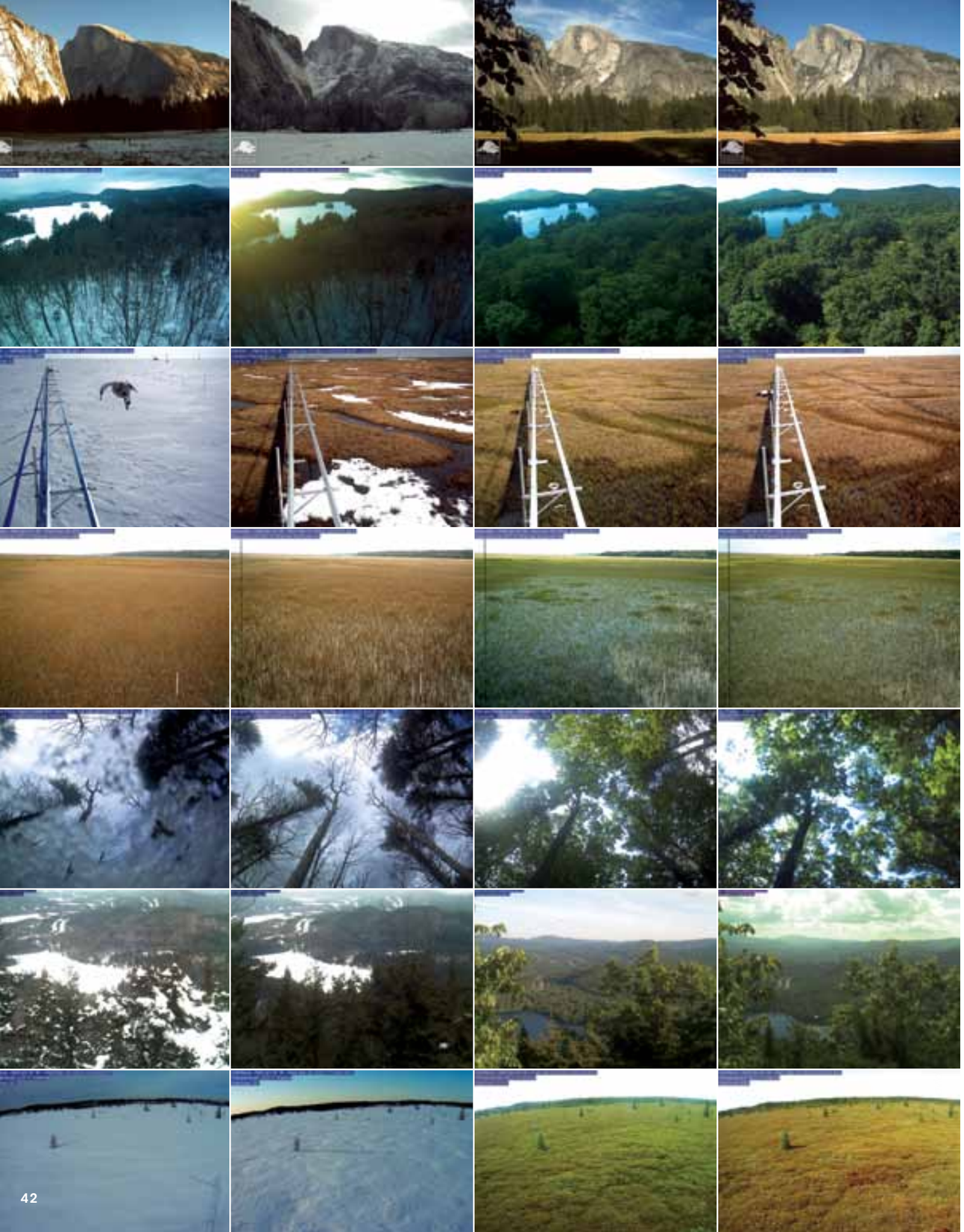
LI-COR's LI-1500 handheld light sensor logger is ergonomically designed and constructed from weather-resistant materials. As many as three LI-COR terrestrial and underwater light sensors can be connected to the BNC input ports at the bottom of the meter. The LI-1500 is equipped with 1 GB of memory stored on an internal SD card. The mini USB port serves as the data transfer and power connection to the AC power supply adapter. An optional GPS-enabled model records the exact location of measurements.

NexSens CB-50

Small but mighty, the NexSens CB-50 data buoy is designed for emergency responders who seek immediate data after a natural disaster. This buoy platform supports a range of water quality sondes and sensors, and can be deployed from a small boat, large vessel, or helicopter. Once in the water, data are transmitted via Iridium satellite, cellular, or radio-to-shore telemetry. Power is supplied through the NexSens SDL500 submersible data logger, which operates for weeks on eight D-cell alkaline batteries.

YSI ODO200

The ODO200 is a cost-effective sampling instrument for measuring dissolved oxygen and temperature. Utilizing optical technology, this meter requires very little to no maintenance during its lifespan. Optical dissolved oxygen sensors are highly accurate, hold their calibration for several months, sample instantly with no warm-up time, and have no dependency on stirring to get a reading. Weighted cables are available in 1-, 4- and 10-meter lengths to best fit the application. The meter stores up to 50 data events in a reviewable memory.



All Photos: PhenoCam

PHENOCAM

A camera network constantly snapping pictures of ecosystems across North America is collecting data on the shifts in seasonal timing.

BY JEFF GILLIES

From a Hawaiian grassland to a few New England forests, dozens of landscapes across the world are under constant surveillance by a scientific network of automated cameras.

The PhenoCam network is capturing seasonal shifts in all manner of ecosystems to better understand and predict climate change's effects on the timing of phenological events, from leaf-out in deciduous forests to the general greening up of savannas.

The 80-some camera sites across North America aren't just producing a gallery of pictures from local and far-flung locales. The network produces quantitative data that could one day back sophisticated research into ecosystem processes like carbon uptake and hydrology.

It's also a powerful way to show everyday people how climate change is playing out in their backyards, according to Andrew Richardson, associate professor of organismic and evolutionary biology at Harvard University and the principal investigator on the PhenoCam project.

"It's one really good way of communicating climate change to the general public," Richardson said. "If people know that spring is coming 10 days earlier than it was three decades ago, that's much more tangible than saying temperatures have warmed 3.6 degrees."

The sites are equipped with networked security cameras that snap photos every half-hour and upload them to the PhenoCam server. The photos are compiled and analyzed by an automated image processing system that pulls a quantifiable level of greenness from the images.

With a long enough time series, a plot of the greenness data reveals patterns in how each system responds to seasonal environmental cues like temperature and rainfall.

Data from a camera overlooking the canopy at Harvard Forest in Massachusetts, for example, shows a regular cycle of greenness climbing in the spring with leaf-out and dropping in the fall with the changing colors.

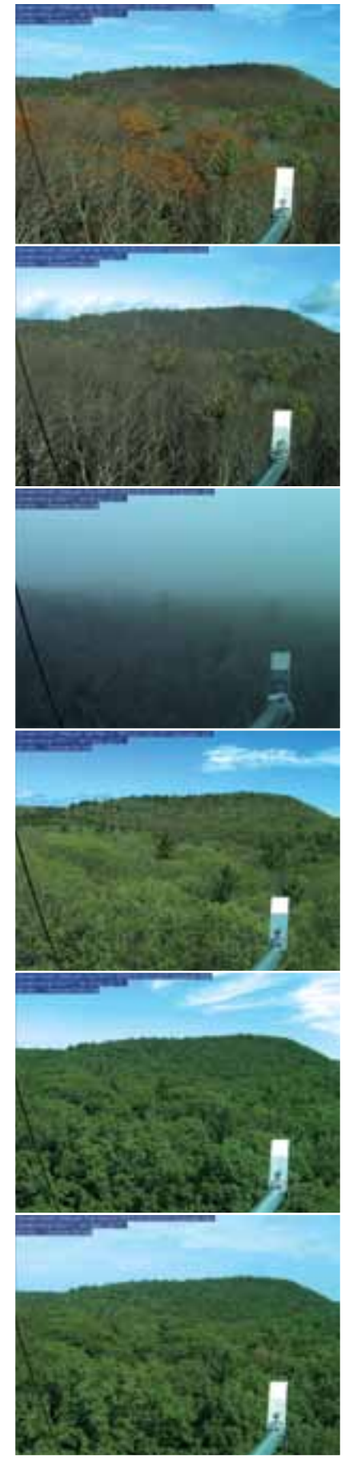
The data from a grassland in Waimea, Hawaii, however, are much less predictable.

"The site is very dependent on pulses of rainfall," Richardson said. "Those just don't occur on the same regular seasonal cycle as the deciduous forests in New England."

Vegetation measurements from satellite instruments have been an important tool for tracking phenology. Richardson co-authored a recently published study that tied satellite measurements to other data to show that earlier springs brought on by climate warming in the Northeast have led to increased carbon uptake in forests. In another 10 or 15 years, similar studies will be possible with PhenoCam data, Richardson said.

Scientists on the PhenoCam project are also hoping to use the data to build mathematical models to predict phenology in different ecosystems, as well as how these events might shift in a changing climate. That includes the less technical aspects of phenology that Richardson says the general public understands intuitively.

"They're seeing their daffodils or crocuses earlier. Maybe autumn colors weren't quite what they were in the past," he said. "That's the kind of stuff we can monitor and track, and then forecast with the data from this network." JG



A year's worth of photos from Harvard Forest station.

One Fish, Two Fish

A new study shows the utility of underwater video cameras for counting fish in dense cover for population estimates.

BY ALEX CARD

In the business of fishery management and conservation, numbers count. But fish aren't keen on filling out census forms, and even small ponds can house thousands of individuals among dozens of species. Assessing those populations isn't easy, but a University of Florida study shows that underwater video can accurately enumerate the relative abundance of fish, even in obscured environments.

"Before the use of underwater video, you'd be trying to net fish or use a hook and line, neither of which are very efficient methods of sampling," said Kyle Wilson, lead author of the study.

Part of a larger project that examined the invasive plant Hydrilla, the study addressed the challenge of sampling fish populations in ponds fraught with the pervasive waterweed. In those ponds, Hydrilla grows so thick that it forms a canopy, making it near-impossible to successfully cast a line or net.

Wilson and the other researchers considered two alternative sampling methods: divers, who could observe and tally fish the old-fashioned way, and waterproof cameras capable of capturing underwater scenes in digital video.

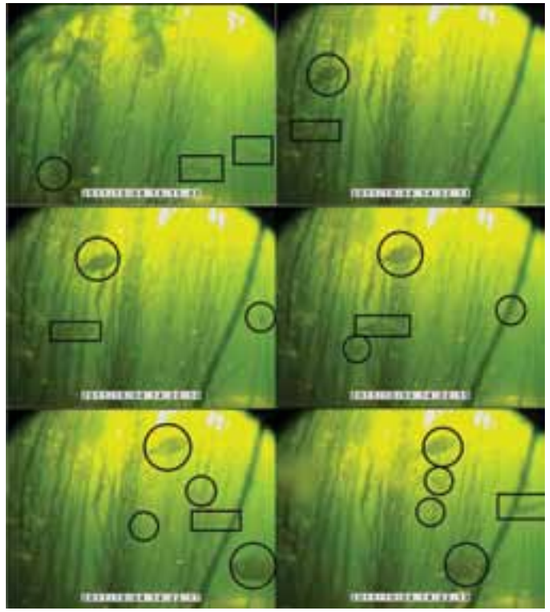
The divers were quickly vetoed.

"A snorkeler is just as likely to get snagged as any other instrument," Wilson explained. "In the best situation they get a good view, but they still have to write everything down."

So the team opted for the camera. Small, sleek and lightweight, it seemed apt to peer through the submerged thicket. An Australian research group had proven the usefulness of video sampling in the Great Barrier Reef's crystalline waters, but whether the technique would work in a murky Florida pond remained to be seen.

Over 13 weeks in 2011 and 2012, the researchers studied three experimental ponds that, when necessary, could be "drained like a bathtub," Wilson said. This would allow the researchers to verify their population estimates at the study's conclusion.

Each day, Wilson took a jon boat to one of the ponds and paddled out until he came across a particularly dense patch of Hydrilla — often thick enough to hold his boat in place — then tossed the camera into the water. After recording for 10 minutes and measuring dissolved oxygen with a YSI probe, Wilson hauled the camera in and repeated the process 19 times more.



Although the sampling went relatively smoothly, Wilson said the thick plant cover caused its share of nuisance.

"It's like trying to parachute through the rainforest: You're not necessarily going to reach the bottom," Wilson said. He recalled one attempt to improve the camera's performance:

"We tried making a camera that would pierce the canopy like a broadhead arrow," Wilson said, laughing. "That didn't work."

With the sampling complete, the team analyzed each recording in 30-second intervals, counting the maximum number of individuals on screen at once during that interval. Then they compared those figures to the known population counts of each pond. The results showed a strong positive correlation between the on-camera counts and the actual population, indicating that underwater video can be used to determine proportionately accurate population densities.

While video sampling could simplify fishery researchers' jobs, Wilson cautioned that the method is less likely to produce meaningful results in natural settings where long-term population counts can be hard to establish.

"If you don't know how many fish are there, if you don't know how they're using the habitat, then how can you make a recommendation to the fishery managers that maintain it?" Wilson said.

Now a doctoral student at the University of Calgary, Wilson sees video sampling as an opportunity to build relationships with the tech-savvy anglers who especially stand to benefit from well-kept fisheries.

"Maybe we could bridge a gap between researchers and the anglers who are using this technology already," Wilson suggested. "We have limited staff, limited funds, so we can't do all this ourselves." AC

Photo: Kyle Wilson

SondeCAM

The FishSens SondeCAM line of submersible cameras helps anglers and fishery researchers identify underwater structures and scope out fish habitat.

BY ALEX CARD

A set of eyes above the water certainly helps when fishing, but a view beneath the surface can provide an edge unlike any other. The FishSens SondeCAM line of submersible cameras achieves this by helping anglers and fishery researchers identify underwater structures and scope out fish habitat.

"The SondeCAM initially started with a thru-hull camera in mind," said Trevin Fondriest, SondeCAM product manager. But hull cams have limited usefulness, Fondriest said, and it didn't take long for a more versatile product to emerge. "It kind of just developed into the drop cam it is now," he said.

At the core of every SondeCAM model is a low-lux, ultra-wide image sensor from Sony that captures visuals in sharp, clean color. An impact- and scratch-resistant lens ensures continued performance in a variety of underwater conditions.

All SondeCAM models connect directly to compatible on-board fishfinders and chartplotters, displaying underwater video directly on the top-line electronics that anglers swear by. The optional SondeCAM in-line DVR unit records video without complicated wiring or hardware configurations, allowing users to study fish habitat off the water, or relive exciting encounters.

"The Lowrance fishfinder connectivity really keeps you from having to carry all that extra equipment on the boat," Fondriest said.

Designed to provide years of service, the SondeCAM is protected by front and rear bumpers and a marine-grade anodized aluminum body rated for depths up to 100 meters. Competing submersible camera models sacrifice durability for a slim profile, making body damage and cable breakage a common issue.

The SondeCAM camera cable incorporates high-flex coax, power and signal conductors, abrasion-resistant polyurethane jacket and an internal Kevlar braid for added strength. A topside quick-connect allows the SondeCAM to be deployed and stowed in a snap, and adapters allow the device to be freely towed behind a boat or controlled with an attached pole.

SondeCAM's unique design, Fondriest said, makes it "a little more expensive, but a lot more durable." And out on the water, its reliability is going to be on anglers' minds more than its price tag.

Whether conducting research or hunting for a lake's sweet spot, the SondeCAM WQ model improves upon the features of the original SondeCAM with water quality profiling capabilities. A precision temperature sensor offers at-depth measurements. Users can connect a YSI dissolved oxygen or pH probe for further functionality and swap between probes on the fly. A magnetically activated switch simplifies sensor calibration into a one-click process.

The last product in the SondeCAM line is one of Fondriest's favorites. The SondeCAM mini incorporates a small-yet-robust camera into a truly tiny body. Unlike other similarly sized cameras, the mini features an aluminum body just like its bigger brother, improving stability and eliminating the need for added weights. The downward-looking video sensor and small footprint could make this version of the SondeCAM perfect for ice fishing, Fondriest said.

High-quality video, convenient electronics integration and a built-to-last design set the SondeCAM line apart from competitors. Whether you're catching bass or researching walleye habitat, SondeCAM will give you the view you need beneath the boat. AC

SondeCAM mini

SondeCAM

SondeCAM WQ

All Images: FishSens Technology

FIND STRUCTURE. FIND FISH.

WHAT THE PROS ARE SAYING

"There is finally a camera that allows you to view depth, temperature, and water quality live on a high quality video feed from below the surface.

Now you can view fish habitat and also monitor parameters that are important to the species you're targeting."

TRAVIS HARTMAN
Pro Walleye Fisherman

Water Quality Integration
Built-in precision temperature and depth sensors combined with optional pH and dissolved oxygen sensors provide video and water quality monitoring in a single platform.

High Quality Imaging
The latest low-lux, ultra-wide dynamic range camera offers clear color visuals through an impact- and abrasion-resistant lens.

Built-in Connectivity
Connect directly to on-board fishfinders and chartplotters with simple plug-and-play cables or record video with the FishSens DVR.

Rugged Design
A marine-grade anodized aluminum body stays protected by front and rear bumpers while remaining compact and lightweight.

Made in USA
Domestic production at the FishSens fabrication lab ensures quality and local product support.

IN THE GREAT LAKES

RESEARCH FROM AROUND THE BASIN

SUPERIOR

The daily vertical migration of the shrimp-like Mysis diluvia in Lake Superior is one strand in the system-wide food web that links the seemingly separate worlds of the nearshore and offshore habitats in the largest freshwater lake by area on the planet. A recently published study describing these food web links in Lake Superior is one of the first to show cross-habitat interactions in a such a large lake. They identified chemical signatures associated with the lake's various habitats and performed stable isotope analyses, and detected the signatures in most organisms regardless of their habitat preference.

Michael E. Sierszen, et al. (2014) Depth gradients in food-web processes linking habitats in large lakes: Lake Superior as an exemplar ecosystem, Freshwater Biology, 59 (10), 2122-2136.org/10.1016/j.jglr.2014.03.015.

MICHIGAN

A study of Milwaukee's Bradford Beach on Lake Michigan, the city's most popular swimming beach, shows that high concentrations of E. coli in sand are correlated with standing water. The beach is tested for bacteria six times a week during the summer and commonly sees closures or swimming advisories. The research from the University of Wisconsin-Milwaukee surveyed the beach's hydrology and geophysics and found that rainfall was the main cause of the standing water. Rain gardens installed above the beach that capture runoff also contributed to brief raises in the level of the water table, which facilitated standing water on the beach. Erosion also appears to play a role. Beach managers will consider the results when looking into measures that could decrease fecal indicator bacteria concentrations across Bradford.

Marcia R. Silva, et al, Effect of hydrological and geophysical factors on formation of standing water and FIB reservoirs at a Lake Michigan beach, Journal of Great Lakes Research, Volume 40, Issue 3, September 2014, Pages 778-789.

HURON

A combination of dropping water levels and shoreline development appears to have ruined a set of southeastern Georgian Bay coastal marshes as muskie nursery habitat, according to a study from McMaster University in Ontario. In 1981, the Ontario Ministry of Natural Resources documented 16 nursery sites in the Severn Sound area that supported young-of-the-year muskie. When the McMaster researchers returned to those sites in 2012 and 2013, they found absolutely none remaining. Surveys showed the plant communities have changed significantly, with fewer of the species that young muskie depend on for cover. More marinas, cottages and docks have been built in the area. Development has been strongly linked to declining muskie reproduction.

John Paul Leblanc, J. Daniel Weller, Patricia Chow-Fraser, Thirty-year update: Changes in biological characteristics of degraded muskellunge nursery habitat in southern Georgian Bay, Lake Huron, Canada, Journal of Great Lakes Research, Available online 18 September 2014.

ONTARIO

A new U.S. Geological Survey Research Vessel, Kaho, was recently christened and commissioned in Oswego Harbor on Lake Ontario. The new boat replaces an older vessel with the same name used on the lake since the 1970s. Officials with the USGS say the new vessel will provide a more reliable platform for scientists and researchers to study Lake Ontario. It is equipped with marine instruments, hydro-acoustic systems for detecting fish, gear for taking water and contaminant samples and wet and dry labs. The R/V Kaho, built in Cleveland, has an aluminum hull that should lighten its weight and make it easier to maneuver in the water. It joins four other research vessels the agency operates on the Great Lakes. These include the Grayling, Kiyi, Muskie and Sturgeon.

David Figura, "A $4.1 million USGS research boat for Lake Ontario gets christened at Oswego Harbor," Syracuse.com, August 6, 2014.

ERIE

NASA is making research flights over Lake Erie with some of the same equipment used to study space rocks on Mars, according to Popular Science. The space agency is using hyperspectral imagers and mini spectrometers to capture what's happening in Lake Erie's basins from thousands of feet away. The plane carrying the instruments, NASA Glenn Research Center's S-3 aircraft, is making passes below the clouds, capturing data to help local water treatment facilities prepare for future threatening blooms. During the flights, NASA scientists say they check existing algal blooms, sediment in the water and monitor for developing blooms.

Sara Novak, "NASA Flies Over Lake Erie To Scan For Dangerous Algae Blooms," PopSci.com, September 16, 2014.

MAKING WAVES

BY DANIEL KELLY

Data from a new wave buoy deployed off the Marshall Islands' Majuro Atoll is helping to keep islanders safe from high ocean swells. It also alerts fishermen to when they need to stay off the water.

Wave forecasting is particularly difficult in the region, and researchers at the Pacific Islands Ocean Observing System say the new buoy, named "Kalo," will also help them to inform safe transit and recreation near the atoll. The buoy was deployed in July and is transmitting data on wave height, wave direction, wave period and sea temperature through satellite telemetry.

"'Kalo' is the name of a Marshallese bird that flies only near land," explained Kimball Millikan, Marine Research Engineer with PacIOOS at the University of Hawaii. "Whenever a sailor sees a kalo, the sailor automatically knows that land is near."

The buoy's location not too far from shore was chosen so that it could focus on the movement of waves traveling from the north, south and east. It was deployed with help from islanders after acoustic survey equipment made sure that its anchor would reach a secure hold.

Deploying a buoy near Majuro has its challenges due to the steep, sloping seabed, says Millikan. "But as our small vessel coughed and sputtered to our (deployment) destination, the Marshallese crew chewed their betel nut with a smile and were always eager to help with prep," said Millikan.

In addition to providing critical safety data for the atoll and its residents, the buoy's data will be used by weather forecasters and researchers working to develop flood forecasts for Majuro. It joins 11 other buoys in the PacIOOS network that monitor conditions in the Pacific Islands.

"All the buoys (in the network) are tethered to the bottom with an acoustic release," said Millikan. "This allows recovery of the complete mooring line if cut by pelagic fish, debris, entanglement or fishermen's lines and hooks." DK

Photo: Karl Fellenus

INDUSTRY PROFILE

Q&A

John Halfman

On monitoring the Finger Lakes

John Halfman has been studying the Finger Lakes in New York for two decades. He's a professor of geolimnology and hydrogeochemistry at Hobart and William Smith Colleges, where he also helped develop the Finger Lakes Institute. His work there includes running a weekly monitoring program that began collecting data on the Seneca Lake and several tributaries in the 1990s. The data reveals trends that are moving in unhealthy directions, showing a lake growing more turbid. The causes are familiar: Runoff from rain events bring in suspended sediments and algae-fueling nutrients.

Environmental Monitor: What's going on with the Finger Lakes that makes them unique?

John Halfman: All the Finger Lakes have glacial origins, which make them very long and skinny and — especially Seneca Lake — very, very deep. Because there's such huge volume and small surface area, it's really hard to freeze these lakes unless things are really cold. Even last winter didn't freeze Seneca Lake. Last winter was pretty cold.

EM: You've had a water quality profiling buoy on Seneca Lake since 2006. What brought that project on?

JH: If you have the time and the patience, going out on the lake once a week is probably about as frequent as you can during the spring, summer and fall seasons. Having a buoy out there, you can actually collect water quality information two times or three times or four times a day. You can get out there much more frequently and see things I would miss by going out by boat and sampling that way.

For example, in the warmer surface waters, you can get algal blooms. But sometimes they don't last more than three, four days. So a routine weekly monitoring program would miss some of the algal activity. Whereas if you have something sampling every day, you'll detect it and note it in your studies.

EM: We've recently learned about a large, internal wave that sometimes develops in Lake Champlain, another long, skinny lake with a north-south orientation. Do those waves also show up in the Finger Lakes?

JH: There can be internal waves in all the Finger Lakes as well. The longer and bigger the lake, the bigger the internal wave will be.

EM: Have the buoy data captured that?

JH: If you look at the temperature record in particular, you'll notice that the boundary between the warm surface water and the cold bottom water bounces up and down and up and down. That bounce up and down is the internal seiche.

The buoy also collects meteorological information so that you can look at some of the forcing functions as far as the air is involved in some of the wave processes that we see.The seiche activity needs a really strong southerly wind or a really strong northerly wind to set it up. Otherwise there won't be any tilting of the thermocline.

EM: The Finger Lakes Institute has recently launched another buoy on Owasco Lake, the sixth-largest Finger Lake. What's the goal there?

JH: I've been involved in nutrient loading studies in the Owasco watershed and the goal is basically to detect any changes in water quality over time.This is the first year, so I can't say there have been any year-to-year changes yet, but hopefully after five or 10 years down the road we will be able to see the lake change one way or the other, and hopefully for the better.

All the watershed stuff I've been doing around that lake has been looking for sources for primarily phosphorous getting into the lake. Because if we can turn off those phosphorous sources, then we have a really good chance of letting that lake get more and more clear.

THE RISE AND FALL OF THE WEST

BY ALEX CARD

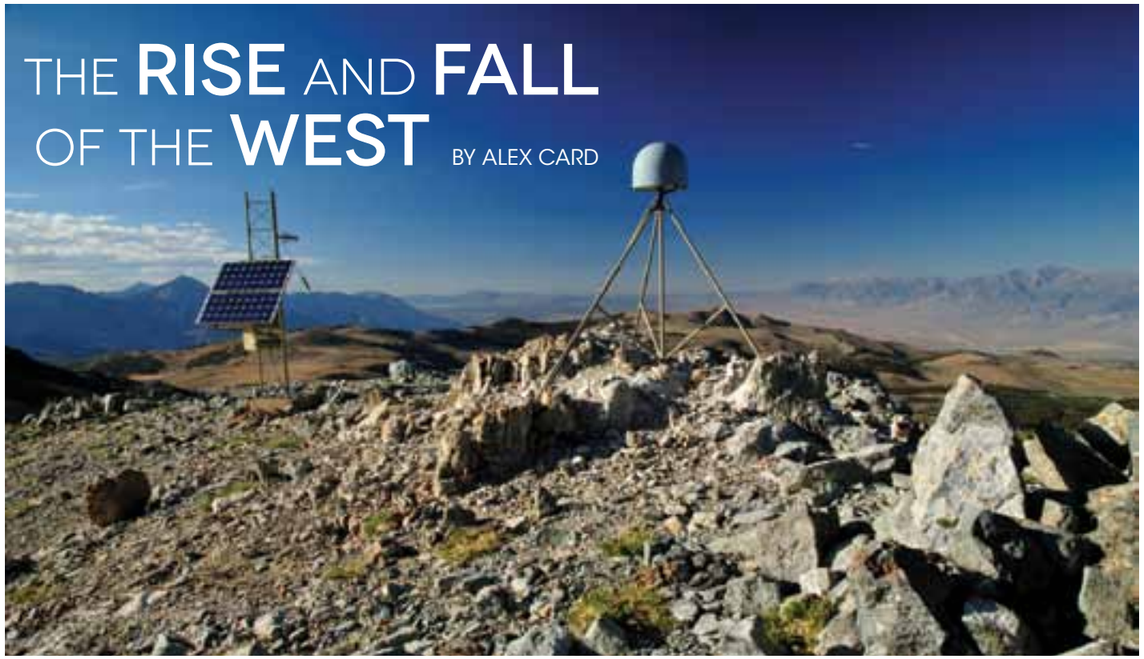


Photo: UNAVCO

Wracked by drought for the third consecutive year, California agriculturalists and water managers are increasingly tapping into the state's diminishing groundwater supply to meet needs. But this activity is placing additional stress on the volatile San Andreas Fault and causing the nearby Sierra Nevada mountains to grow.

As California drains groundwater from the San Joaquin Valley aquifer, the floor of the entire Central Valley sinks. Known as sediment compaction or subsidence, this geological effect has been researched for decades. A new study, published in Nature, shows that this process is also responsible for other, potentially problematic phenomena.

Researchers from the University of Ottawa; University of California, Berkeley; Western Washington University and the University of Nevada, Reno, conducted the study using a series of models to understand what groundwater loss might have on the vertical motion of the Earth's crust. The scientists confirmed their suspicions: pumping groundwater from the Central Valley is causing the region's floor to rise and fall.

A statewide network of GPS stations, capable of tracking vertical movement down to the millimeter, provided data for the study's models. The University NAVSTAR Consortium installed the stations to monitor seismic activity at the San Andreas Fault.

"We observed that around the Central Valley of California, the GPS stations show an uplift of about one to three millimeters per year," said Pascal Audet, professor of geophysics at the University of Ottawa. "We noticed that this also coincides with the region where groundwater is being pumped for irrigation."

"The fact that human activity can actually produce motions of the Earth's crust is something that is quite an eye opener," Audet said. "We were quite surprised that such a continuous effect could be seen in the rock record."

The elastic response of the Earth's crust explains the growth of the Sierra Nevada. The vast volume of water stored in the San Joaquin aquifer weighs heavily on the crust, forcing it downward. As that water is pumped out of the ground, it lessens the load on the crust, allowing it to rise again. Winter rains reverse the process to some degree, leading to further fluctuations.

Over the past century and a half, the Sierra Nevada has grown by about a half-foot, while the same activity has caused the Central Valley floor to sink several meters over only a few decades.

More pumping near the fault could lead to greater seasonal fluctuations, raising the risk of small earthquakes in the area. In seismically sensitive areas, even a small quake could act as a catalyst for a much larger, more destructive event.

"It's obvious that if we take more groundwater out it's going to have a major effect on the San Andreas Fault," Audet said. But the study's implications reach far beyond California. Audet said that "any sort of resource extraction could produce similar effects."

In addition to further monitoring of the Central Valley region, Audet said that the next step for the researchers might involve observing the phenomenon in other parts of the world, such as northern India where huge agricultural operations could exhibit similar groundwater use characteristics.

"It's hard to tell what effect this is going to have," Audet said of the study's findings. "It certainly adds to a long list of things that policy makers need to take into consideration… especially in periods of drought where there's a lot more stress on the aquifer." AC

Photo: Finger Lakes Times

NEW TECHNOLOGY

Keecker Home Robot

It looks like an egg, moves like a Roomba and can do pretty much anything you ask of it. The Keecker is a robot that combines home monitoring with home entertainment, available for a tidy sum of $4,000, Yahoo Tech reported.

Developed by Pierre Lebeau, the Keecker can measure temperature, carbon dioxide, humidity, air quality and noise as it zips around a house, memorizing the floorplan. Its 360-degree camera can serve as a webcam or a motion detector. A smartphone app puts the Keecker's owner in control of it — though it's just as happy to navigate on its own — and offers remote monitoring of the user's home from anywhere in the world.

Not content to just be a home-monitoring automaton, the Keecker can also project — in 360 degrees, no less — video from a smart device or computer on any surface, stream and play music, and learn to perform any of its functions in a particular room by voice command. Built on the Android operating system, the Keecker can run any Android app available on a smartphone or tablet. The Keecker can operate for several days on a single charge, after which it automatically returns to its base station to recharge.

A Kickstarter campaign funding the Keecker had received over $200,000 in pledges as of the end of October. The campaign ends on Nov. 18, and any supporter contributing $1,990 or more will receive one of the first Keecker models in April 2015. AC

ROUGHIE Gliders

Autonomous underwater vehicles only operate on their own after they've been programmed, following the plan and survey course they've been given. This is good for monitoring and data collection, but existing AUVs are less ideal for locating items lost underwater.

Researchers at Michigan Technological University are working to solve that problem by developing gliders that operate more independently and are capable of knowing what their search target is. If the new AUVs work well, scientists and disaster-response teams could use them to pinpoint the locations of pipelines, cables or sunken vessels more quickly than is possible today.

Nina Mahmoudian, an assistant professor of mechanical engineering at Michigan Tech, has spearheaded the gliders' design. Along with graduate and undergraduate students from her lab, she is getting ready to test gliders named with the acronym ROUGHIE, for Research Oriented Underwater Glider for Hands-on Investigative Engineering.

Key to making the devices capable of searching underwater environments on their own is an integrated navigation sensor system that allows them to use situationally aware search algorithms. The team is working out the kinks with a functional prototype before building a fleet of four. With the gliders' advanced tech, they're still aiming to keep costs down to about $10,000 each. DK

Photo: (top) Keecker; (bottom) Sarah Bird / Michigan Tech

Photo: (top) Edyn; (bottom) Alex Nemiroski

Edyn Garden Sensor

A new garden sensor looks to make planting and growing food easier and more precise, according to CNET. It combines with a water valve to monitor soil and air quality near plants to water them as needed.

The devices were developed by Edyn, a startup company that wants to make gardening more enjoyable for the average person. In line with that mission, the company has tried to make the sensor and water valve precise enough for professionals but simple enough to use for amateurs.

An accompanying smartphone app puts control of the system at users' fingertips. It allows for checking current soil moisture, temperature and pH, as well as suggesting plants that thrive in differing soil types.

The sensor-valve combo is the product of a Kickstarter campaign that successfully reached its funding goal in early July. For a donation of $100, those contributing to its development will receive a device from one of the company's first production runs. Representatives from Edyn plan to fulfill those orders before making devices available to the general public. The first delivery dates are estimated for March 2015. DK

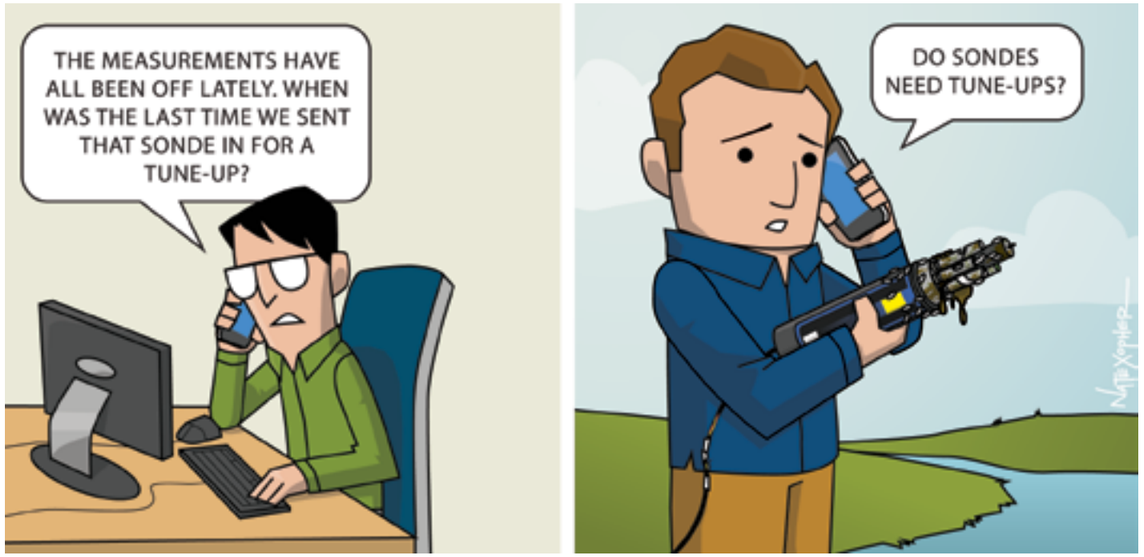
uMED Electrochemical Detector

Inspired by fax modems and blood-glucose meters, Harvard University researchers have developed a new handheld electrochemical detector that could potentially bring the benefits of reliable chemical analysis technology and expertise to billions of people around the world.

The universal mobile electrochemical detector, or uMED, is compatible with a number of electrodes and test strips, and can detect thousands of chemicals. This versatility combined with a low price tag make the device ideal for in-field agricultural and environmental monitoring, and initial trials that detected heavy metals in water samples showcase its capability for water quality applications.

The most unique feature of the uMED, however, is its ability to transmit analysis data to the cloud through any cellular phone or network. Much like a fax machine, the uMED converts digital data through a headphone jack into a series of tones that transmit via cellular voice channels, eliminating the need for smartphones or high-speed data connections — an important factor with nearly 3 billion people still using low-end phones on 2G networks. Scientific and medical professionals can then aid in data analysis remotely.

Built off the inexpensive Arduino microcontroller board, the uMED costs about $25 to manufacture. The researchers are working with partners at home and in India to conduct field tests and develop the uMED as a commercial product. AC



Tune-Up

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Quality data can be directly correlated to the condition of your monitoring equipment. Instrument check-up, characterization, and certification by a factory-authorized service center are recommended on a regular basis to help ensure data accuracy and maximize the instrument's usable life.

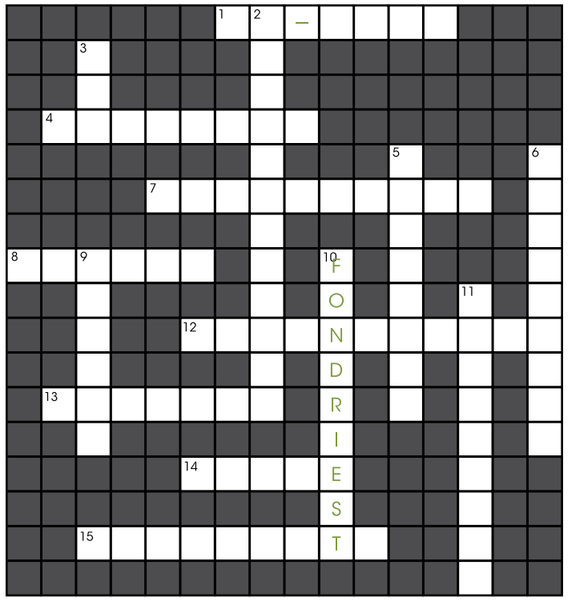
Water Clarity

Across

1. Instead of removing samples, sensors can be used _____
4. Turbidity can inhibit photosynthesis by blocking _____
7. Microbeads, effluent and other _____ affect water clarity
8. Black and white disc used to measure visual clarity
12. Loss of light intensity between source and light detector
13. The further sunlight can reach underwater, the better the _____
14. TSS can be affected by organic material like bacteria or _____
15. Measure of clarity or cloudiness of water

Down

2. Method of measuring turbidity by light scatter at 90°
3. Units for a turbidimeter with a monochrome/near-IR light source
5. High levels of TSS can _____ water temperature
6. CDOM affects turbidity, but not _____ solids
9. Jackson _____ method measured visible light through a tube
10. Your source for precision turbidity meters and sensors
11. Particles under 2 microns are considered _____ solids



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