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SPRING 2013
APPLICATION AND TECHNOLOGY NEWS FOR ENVIRONMENTAL PROFESSIONALS

WETLAND WATCH

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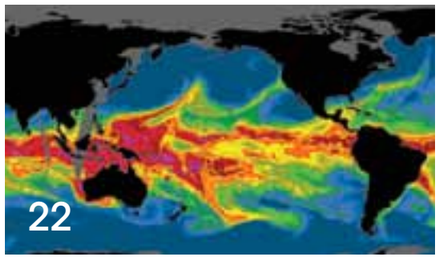

WELCOME…

Welcome to the Spring Edition of the Environmental Monitor. This issue, we check with a group of Central Michigan University researchers approaching the halfway mark of a five-year project to monitor Great Lakes coastal wetlands. We're double-dipping on ocean acidification, looking first at a pH-monitoring buoy network on the Alaskan Coast that will help study the phenomenon effects on the region's valuable fisheries. Then we head 4,000 miles south west to the Line Islands. Researchers there pitched small tents on coral-covered seafloors to capture small-scale observations of the organisms' regulating effects on increasing acidity.

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Cover Photo: CMU Wetland Ecology Lab

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Big Floods Built Lousianna Wetlands

The floods along the Mississippi River in 2011 were among the most damaging ever seen in the watershed. But a University of Pennsylvania study found a silver lining. By hopping to 45 wetland sites via helicopter, the researchers found the floods deposited plenty of nourishing sediment in Louisiana's coastal wetlands, which have been sinking due to sea level rise, soil compaction and hydrological engineering.

Photo: University of Pennsylvania

Hawaii's Manned Submersibles

As robotic monitoring vehicles become more popular, the Hawaii Undersea Research Laboratory's manned submarines let researchers check out deep sea habitats in person. The lab is the the only U.S. facility in the Pacific operating subs with human crews for marine science and exploration. Scientists use the subs to track deep-water species and examine ocean chemistry and thermal events.

Photo: Hawaii Undersea Research Laboratory

Instrumenting the Conifers

A monitoring network in Nevada's Great Basin is helping fine tune tree ring studies by linking instruments that measure tree growth to sensors for environmental parameters like sunlight and soil moisture. The data could help dendrochronologists more accurately reconstruct what the climate looked like thousands of years ago and model how it might change in the future.

Photo: Scotty Strachan

Smart Greenhouse

Sensor helps Ohio State greenhouse manage light levels and produce plants for research

BY DANIEL KELLY

Photo: Arabidopsis Biological Resource Center at The Ohio State University

The Arabidopsis Biological Resource Center at Ohio State University was established in 1991 with funding from the National Science Foundation. Part of the center's job is to meet demand for seed of the arabidopsis plant, which is widely used for genetic modeling.

"A lot of the plants we're growing are for seed production," said Joan Leonard, greenhouse coordinator. "Arabidopsis is a good example. We call it the 'fruit fly of the plant world,' and it takes about six to eight weeks to go from seed to plant."

Arabidopsis is one of the many plants that will benefit from a new LI-COR PAR sensor being installed on campus. It will help manage light schedules for greenhouse plants. By changing out a 20-year old sensor, Leonard says the facility will gain energy efficiency and continue growing many types of plant seeds used for research.

"The LI-COR is part of a weather station and will be used to monitor light levels," said Joan Leonard, greenhouse coordinator. "We have 10 different growing rooms and each runs independently."

Accounting for ten different rooms and needs of different plants is important, including making sure each plant gets just the right amount of light.

"Some plants need 12, 14, or 18 hours of light each day. Some need lower levels," said Leonard. "But if you take a plant like corn, which has a high light threshold, you might just leave the lights on."

Leonard says the sensor will help the facility to manage and conserve electricity by turning on and off supplemental lighting when necessary.

"We can also program shade curtains to run on light levels," said Leonard. "That's good for heat retention in the winter and shade in the summer. Basically, we're trying to make it a smarter system." OK

Gathering Dirt

When Pennsylvania Sea Grant ecologists needed a tool to continuously collect sediment in local streams, they commissioned engineering students at a nearby college, gave them a tight budget and let their inventive minds do the rest.

"The idea was to have a device that could be installed and left in the stream and, at any time, the sediments collected by the device could be retrieved," said Sean Rafferty, senior outreach specialist at Pennsylvania Sea Grant. "The sediment would then be sent for chemical analysis. This would allow me to model contaminant inputs to Presque Isle Bay from its tributaries."

Sediment in the bay once trapped heavy metals and tailings from historical industrial activity in Presque Isle, Pa., on Lake Erie. Sediment quality there has since improved, but ecologists asked Gannon University students to construct a device that would collect suspended sediment so it could be analyzed for pollutants.

A team of mechanical engineering students took on the project as freshman as part of Gannon's Scholars of Excellence in Engineering and Computer Science service learning program. Students started with a blank slate and a $500 budget. They worked in their spare time for two years to complete a working version. Once a week, they met to discuss designs and ideas.

Sheldon Addis, a junior mechanical engineering student at Gannon, said the team looked at some large-scale sediment samplers for ideas on how to create their mobile version. Their sampler consists of two Plexiglas boxes, steel baffles and mesh filters. The baffles slow down water as it passes through and the mesh traps sediment.

A test run in Presque Isle's Cascade Creek shows a mostly successful design that filters and traps sediment. "We were happy that we came in under our budget and completed the project in two years," Addis said.

Gannon's persistent mechanical engineers-to-be are getting their first lesson in real world design, helping with monitoring that will help keep their community and Lake Erie healthy.

Gannon students Erika Schmidt, Sheldon Addis, Stephen Cox, Benjamin Thompson, Nichole McGuire and Sean Herron all contributed to the device. AV

Karinna Vernaza, Barry Brinkman and their students work to install the sediment sampler.

Big Creek on Campus

The creek that flows through the Marist School's Atlanta campus is an educational asset, even if it is prone to flash floods that wreak a little havoc on school grounds.

"In '09 when we had really bad flooding, it picked up a dumpster and dumped it 500 feet down the creek," said Amelia Luke, a teacher and director of sustainability at the Catholic high school. "It's still there. We can't get the dumpster out."

Luke, a student at the Marist School in the late '90s, remembers when Nancy Creek would flood the grounds almost every time it rained. Drainage upgrades have made those events less common, but the creek can still rear up and make a mess of things.

A stream gauge system now broadcasts live data on the creek's height, warning of rising flood waters that mean it's time to evacuate vulnerable buildings and clear the grounds of debris.

It's also an educational tool for the students and an outreach tool for the community. The creek and the stream gauge are especially important for Luke. She co-teaches the school's environmental science classes.

"When I took over those classes, they were taught primarily inside, which I just find ridiculous because we have such a great campus for being outdoors," Luke said. "We have a nice little beach on our property that has easy access to the creek, and we're down there all the time."

The creek gives students a chance to get their hands dirty with water quality testing and macroinvertebrate surveys. Though the creek has something of a bacteria problem, Luke said the macroinvertebrates they've collected suggest that the creek is reasonably healthy for an urban stream.

Even the floods are eye-opening for students, Luke said. The beach is often a new shape after the high water recedes.

"Every time it floods you can see the deposition of sediment," Luke said." It's a real life lab for the kids, for them to see erosion and all of that stuff."

It's not just the science classes, either. The creek has become the setting for English and religion classes too, Luke said. That's a change from when she was a Marist student.

"It just used to be that thing over there on the edge of campus. Now it's become an asset to the school." JG

Nancy Creek floods the Marist School's soccer fields.

Photo: (top) Marist School, (bottom) The Boat-of-Knowledge in the Science Classroom

Photo: Andrew Lapiska

Virtual Boat

For most Ohio high school students, getting the opportunity to spend their school days navigating a boat is about as realistic as a "dog ate my homework excuse" getting them out of a missed assignment.

With the help of a $45,000 state grant, some computer programmers and around 30 iPads, Ohio University is changing that.

Tiao J. Chang, professor of civil engineering at Ohio University, has since 2010 led a research initiative that takes high school students down the Ohio River by boat to analyze water quality. But time, weather and boat space constraints limit the number of students who get the experience.

Thus, the Virtual Boat for Environmental Education was born. The program is a software-based simulation of Chang's ongoing efforts to help teach Athens-area high school students about water pollution through scientific testing of the Ohio River.

The Virtual Boat app offers a digital research cruise down the Ohio River.

Three Ohio University computer science students created the computer-based virtual boat program to simulate real-life testing in the Ohio River. They incorporated actual chemical and power plants found along shore into the interactive experience through GIS data. The virtual measurements are based on real data collected by the Ohio River Valley Water Sanitation Commission.

Working on one of the 30 iPads provided by the program or on the school's desktop computers, students will navigate their boat through the Ohio River while testing the water for temperature, dissolved oxygen, E. coli, pH, total phosphate, nitrate and turbidity to gauge the water quality and find specific sources of fish kill.

Chang is optimistic that the virtual program will instill both a sense of environmental responsibility and an appreciation for scientific research in the high school students.

"We hope that the high school students will be able to learn about water quality measurements in the Ohio River, and hopefully, students will get interested about water quality close to home." AR

QUEST for Stream Data

BY DANIEL KELLY

The West Virginia Water Research Institute has expanded a monitoring program from the Monongahela River to include the upper Ohio and Allegheny Rivers. After it was successfully implemented to reduce total dissolved solids in the Monongahela River--known locally as the Mon--a grant from the Colcom Foundation fueled expansion of the program.

"We started the QUEST program in 2009 when the Mon had high levels of dissolved solids, so it created problems with industrial issues, especially power plants and those that make steam," said Dave Saville, outreach coordinator at the research institute. "The Marcellus shale drilling was just getting started and people were worried about how things would be affected.

"We received a grant from the (U.S. Geological Survey) to start on the main stem of the Mon. We put together a program to monitor dissolved solids, because no one knew what was the cause of such high levels."

The institute is located at West Virginia University, but the new QUEST program - Quality Useful Environmental Study Teams - will operate in multiple states, including parts of New York, Ohio and Pennsylvania, and be called Three Rivers Quest.

"We took field measurements with YSI data sondes and looked at things like conductivity, pH, dissolved oxygen and had lab samples analyzed. We were able to identify the sources of the dissolved solids," said Saville.

Coal mines are the biggest source of dissolved solids in this river system, according to Saville.

Identifying where the elevated levels were coming from was important as the Monongahela River is a source of drinking water for close to a million people. So the team went out every two weeks to collect samples, amassing many miles and long hours.

West Virginia Water Research Institute Environmental Technician Jason Fillhart collects water quality data from the Tygart Valley River as part of QUEST program.

"It was an expensive program, so we wrote a grant proposal to Colcom and were able to expand it to include local watershed programs. That one-year program was successful, so Colcom gave us more funding to expand," said Saville.

To identify partners for the expanded program, the institute put out a request for proposals which identified Duquesne University, which will manage the Southern Allegheny; the Iron Furnace Chapter of Pennsylvania Trout Unlimited, which will monitor the Northern Allegheny; and Wheeling Jesuit University, which will be responsible for the Upper Ohio.

"They'll be doing sampling on the main stems and work with watershed groups in their areas, basically mimicking our successful program," said Saville.

As proof of that success, Saville said total dissolved solids in the Monongahela River haven't gone above 500 milligrams per liter in years. Using the data generated in the monitoring program, the research institute negotiated a managed discharged system used by the deep mines in the area. These active mines pump out water to allow miners and machinery to continue extracting coal.

"The managed discharge system is a volunteer program," Saville said. "The coal companies agreed that when the flow is low, they don't pump as much. They have mines that are mined out so they keep pump water there." DK

Photo: West Virginia Water Research Institute

All Photos: Katherine Strickler

eDNA Detectives

BY AUSTEN VERRILLI

When researchers from the University of Idaho set out to track amphibians, they ran into a problem.

"One of the big issues with trying to monitor amphibians is that they can be difficult to find," said Katherine Strickler, a research scientist in the department of Fish and Wildlife Sciences at UI. "If you are not there at the exact time, you can miss them."

Idaho researchers turned to a new method for biologically detecting which species call a habitat home. They sample bodies of water and test them for environmental DNA unique to each species of fauna.

Environmental DNA results from any bit of matter an animal leaves in an ecosystem, from eggs, to molted skin, to feces or any other cell loss. Strickler said eDNA persists for as long as three weeks after the animal leaves the water, giving scientists a greater window for biological detection.

Collecting eDNA is less stressful for amphibians, which can be sensitive to dipnetting and other traditional survey techniques.

The method is incredibly precise and should not produce false positives, as long as samples remain uncontaminated. UI researchers identify sequences of DNA specific to one amphibian that differentiate it from others that are very similar. Then they collect a water sample from an area where they suspect a particular amphibian would live. Samples are preserved in ethanol so that bacteria don't break down the DNA.

Researchers separate and replicate a specific eDNA sequence from the samples and test it for specific sequences to verify a species match.

The researchers now use a Pegasus Athena peristaltic pump to make sampling easier and more efficient.

Caren Glodberg pumps a water sample through an eDNA filter.

Researchers collect their water samples with a simple rig consisting of a vacuum flask, filter funnel and a Pegasus Athena peristaltic pump.

They pump four 250 milliliter samples from each pond or four 1 liter samples from each stream. A special filter collects DNA from the sample.

Strickler said they tested several peristaltic pumps before purchasing the Pegasus model. "The Pegasus is great because it allows us to filter water a lot more quickly, a lot more efficiently and it gives us less wear and tear on our bodies," Strickler said.

The pump's compact design also makes it ideal for sampling in remote locations where the scientists have to hike in equipment.

Strickler and Caren Goldberg, a UI biological research scientist, monitor ecological areas in military bases under a U.S. Department of Defense grant. They're working in southeast Arizona, Washington state and Florida's panhandle.

So far they have had success sampling in ponds and small streams, and are working to verify if their sampling method will work in larger bodies of water.

They are using their work to establish a general protocol for eDNA sampling to guide researchers and managers who want to use eDNA to monitor aquatic species. AV

Just in Time

Beached Kulluk Oil Rig forces early release of Alaskan 'data clearinghouse' to aid response

BY AUSTEN VERRILLI

Photo: Sara Francis / U.S. Coast Guard

On New Years Eve, Shell's Kulluk oil drilling rig broke free of its tow line and headed for a small island in the Gulf of Alaska. Responders began to plan out retrieval operations as powerful waves battered the rig, which carried 140,000 gallons of diesel fuel and 12,000 gallons of lubricating oils and hydraulic fluid.

Meanwhile, the release date for the Alaska Ocean Observing System's new interactive data portal, compiling high-definition data and multimedia was a week, away. But the scientists, programmers and managers at AOOS knew this was no time wait around.

AOOS worked closely with the Cook Inlet Regional Citizens Advisory Council to make sure responders to the beached rig had access to the digital Cook Inlet Response Tool even before its official release. The council wasn't part of the official recovery operation, but they made a point to get responders access.

Susan Saupe, the advisory council's director of research and science, said responders on Kodiak Island from Shell and Alaska Department of Environmental Conservation confirmed they looked at high resolution video to assess Sitkalidak Island even before the rig beached there.

"What we have is this great imagery of what the Alaskan coast looks like when the tide's way out," Saupe said.

Location-based, high-resolution streaming video and photographs gave responders a way to view the island at low tide when they were first notified on the night of New Year's Eve. It was still dark and U.S. Coast Guard fly-overs were hours away.

"If something's happening and you're in an emergency response situation, you don't want to start from ground zero," Saupe said.

She said the response tool gives responders a compellation of easily accessible data, so they never have to start from scratch on coastal areas affected by spills, or even beached oil rigs.

The Cook Inlet Response tool is based on an interactive map with layers of location-based data, photos and video. Twenty types of sensors feed real-time information such as wave and wind conditions. Historical biological data and oil spill response plans are also on tap for responders.

More than 30 state, federal and local agencies contribute data to the tool. "The big crux of our program is working with partners who are collecting data out in the field or sharing real-time data," Dugan said.

Data is uploaded to the interactive portal through open source software that allows the AOOS tool to tap into other organizations' databases and source information automatically. This creates an environment of collaboration on a "data clearinghouse" with minimal legwork, Dugan said.

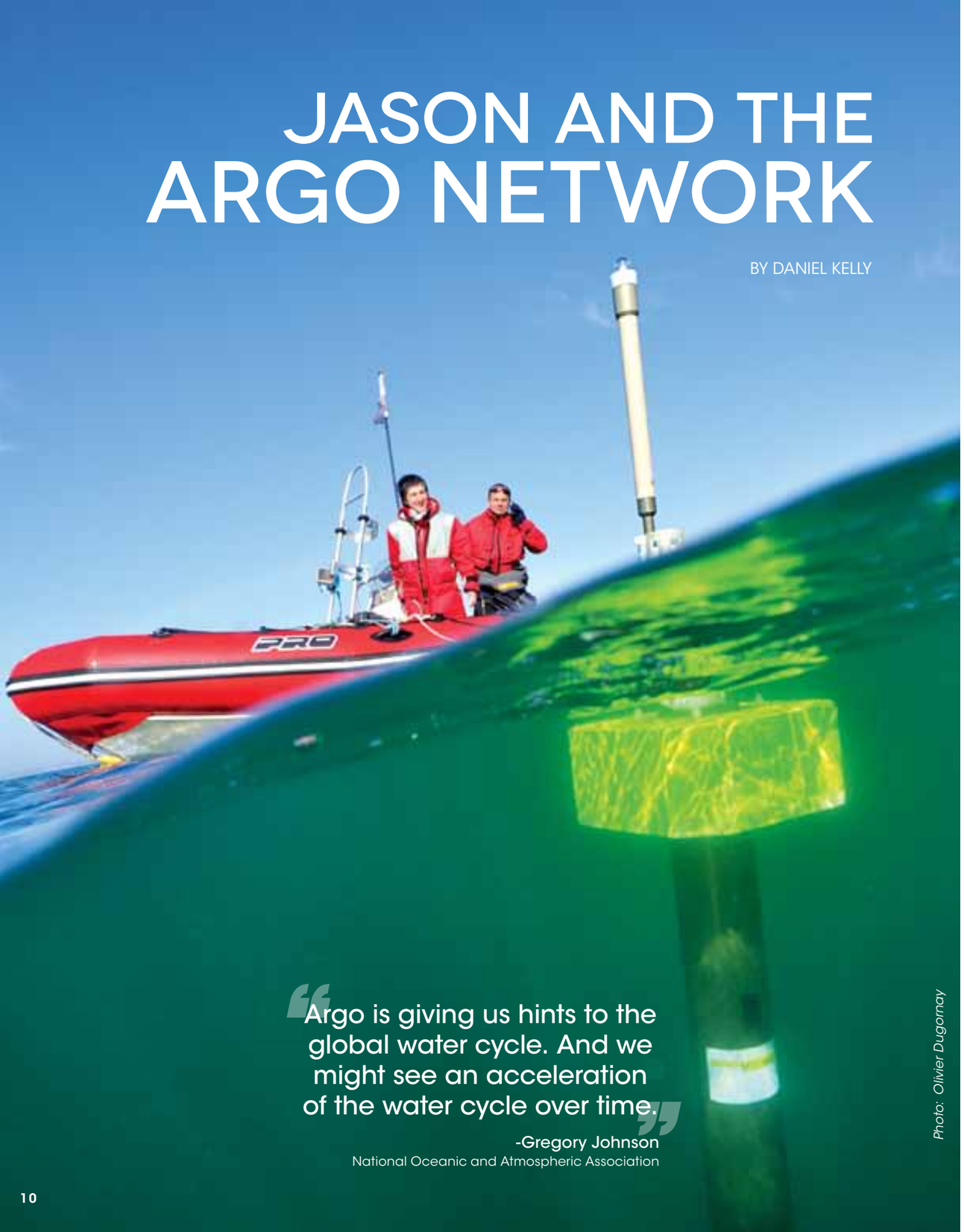
One parameter the inlet response tool does not cover is hydrocarbon content of water. Dugan said there were no models or sensors available that AOOS could tap into for the interactive map.

Luckily, responders haven't needed to use the oil spill response plans on the Kulluk. Tugboats successfully towed the rig off Sitkalidak Island to a safe harbor where the barge can be examined for damage.

A close call for the Kulluk meant a strong start for the Cook Inlet Response Tool. AV

JASON AND THE ARGO NETWORK

BY DANIEL KELLY



> "Argo is giving us hints to the global water cycle. And we might see an acceleration of the water cycle over time."
>
> -Gregory Johnson
> National Oceanic and Atmospheric Association

Photo: Olivier Dugornay

In Greek mythology, the hero Jason sailed the Argo in search of a golden fleece that would prove he was the rightful king of Lolcos, an ancient city. His crew members were called the argonauts.

Today, the Jason satellite looks down on the world's oceans, overseeing the Argo network. His argonauts are data-broadcasting floats, and his search is not for a fleece but the effects of rising oceans.

NASA and the French space agency launched the first satellite in the Jason series in 1992. All three iterations of the satellite have had an altimeter - a range-finding instrument - to measure distance to the ocean's surface.

The current satellite can measure ocean topography down to a few centimeters' height. Combine that with a network of 3,600 monitoring floats and scientists can get a very accurate view of ocean change.

But the tale of how today's extensive Argo monitoring network came about is a bit of an odyssey.

"Scientists have been using floats since the 1960s," said Gregory Johnson, an oceanographer at the National Oceanic and Atmospheric Association's Pacific Marine Environmental Laboratory. "The floats were sound sources and mooring stations were set up to listen to them. Then we decided to have the floats listen, triangulate their locations after the sounds bounced back and get data on currents."

Photo: (left) Kara Lavender, (right) Polarstern Bremerhaven

Argo drifter deployed between Honolulu and San Francisco.

Johnson said it wasn't long after those developments that the Scripps Institution of Oceanography decided to have its floats surface every 20 days or so and transmit their locations. Scientists began equipping floats with sensors and technological advances made a network possible - a grid of floats constantly monitoring all over the world, requiring international cooperation.

The first floats were deployed in 1999 by Australia and then the U.S., Johnson said. Their number had reached 3,000 by 2007. Many partnering countries help by giving access to their territorial waters. Some have even offered space on their ships for float deployments.

Other contributing countries include China, India, Japan, and many in Europe. Independent researchers, usually from universities, have deployed floats and volunteered the data collected for inclusion in Argo's publicly available database.

Johnson said the data have been used by climate scientists, military interests, fisheries and meteorologists. The data have also contributed to weather forecasts, search-and-rescue missions and responses to oil spills.

Each float is about 3 degrees longitude or latitude from the next one and operates by drifting with the currents at a depth of 1,000 meters for 10 days, then sinking to 2,000 meters before rising to the surface while taking readings. Most floats have been equipped with sensors to monitor conductivity, temperature and depth.

"The newer floats are more efficient. Some are smaller," Johnson said. "We are transferring to a new system using Iridium satellites. We used to transmit 100 points, but now we can transmit 1,000 points in 15 minutes."

Johnson said the entire array, with each float monitoring on a 10-day cycle, needs only 60 watts of power, or about as much as a standard incandescent light bulb. Its efficiency is impressive, but so is the system's role of providing information important to understanding global warming and how the oceans are changing.

A German-deployed Argo drifter in the South Atlantic.

"Argo is giving us hints to the global water cycle," Johnson said. "And we might see an acceleration of the water cycle over time."

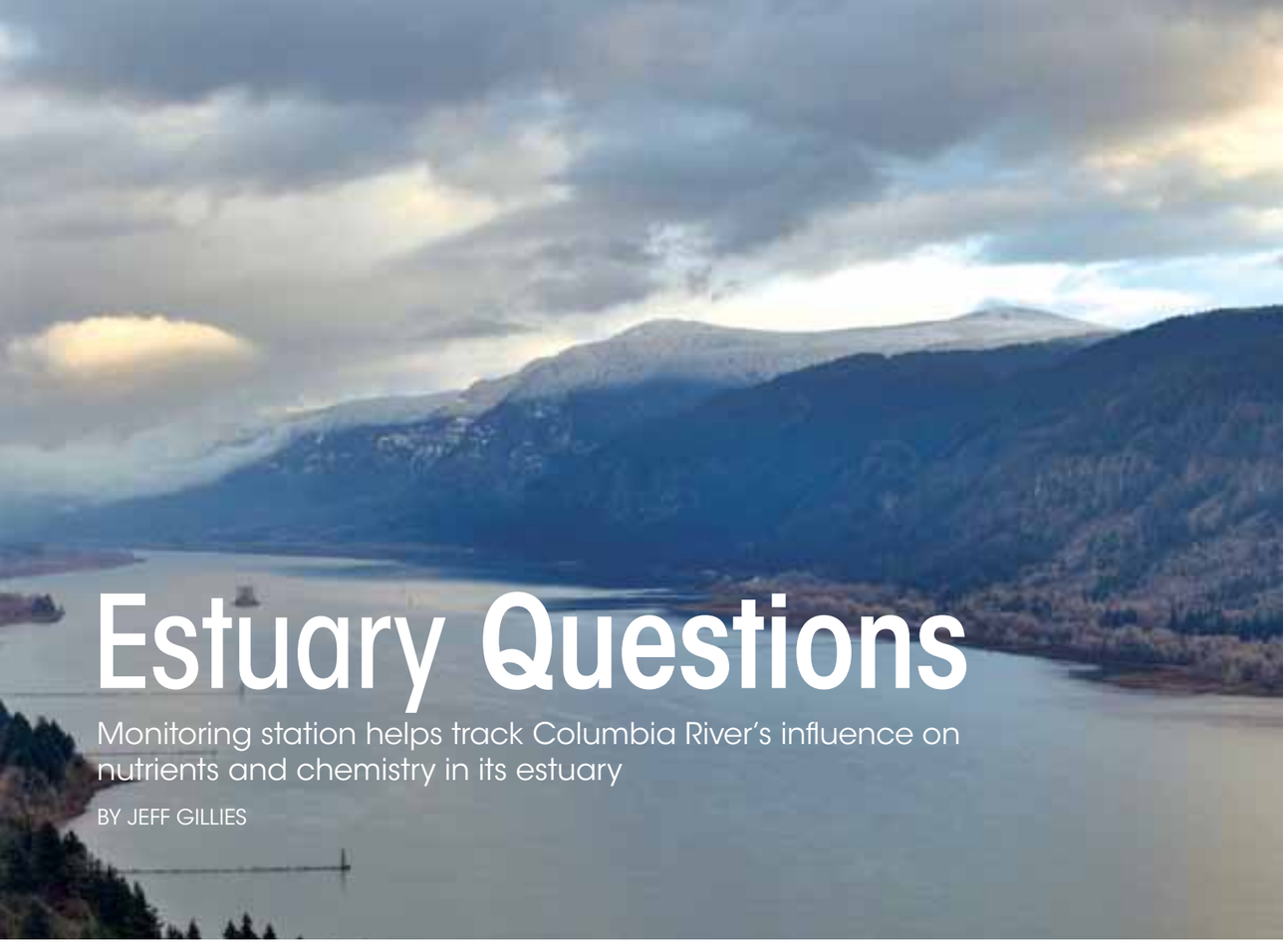
Looking at data over time is a key advantage the network provides to researchers.

"With 130,000 profiles a year taken all over the ocean, it allows us to compare historical data, which are sparser," Johnson said. "We've found that over the decades, salty water has actually become saltier while fresh water has become fresher. Sea water is warming and ice is melting, with sea levels rising about six centimeters over the last 20 years."

Johnson said the world's oceans play a larger role in climate circulation than many people realize.

"When you're talking about global warming, you're talking about ocean warming," Johnson said. "About 93 percent of the total heat is absorbed by the ocean, around 170 terawatts. That's equivalent to three Hiroshima bombs detonating every second."

NOAA, the Scripps Institution of Oceanography, University of Washington and the Woods Hole Oceanographic Institution work together to maintain the U.S. portion of the Argo network. As of December 2012, the worldwide network had collected more than one million data profiles and provided data for more than 1,250 research papers. DK



Estuary Questions

Monitoring station helps track Columbia River's influence on nutrients and chemistry in its estuary

BY JEFF GILLIES

Each summer, an ocean current pushes water from deep in the Pacific up to the surface waters on the Oregon coast. This upwelling of low-oxygen, high-carbon dioxide water contributes to hypoxia and ocean acidification on the coast and in the Columbia River estuary, which gets a pulse on every tide.

The severity of those problems depends on the chemical and biological characteristics of the estuary, according to Joseph Needoba, an assistant professor with Oregon Health and Science University's division of environmental and biomolecular systems.

"If you have more primary production than you have respiration, then you're effectively adding oxygen to the water and removing carbon dioxide, and that makes both the hypoxia and acidification better," Needoba said. "But if it's the opposite—if you have more respiration on a 24-hour period than you have primary production—then you're actually making the problem worse."

Which of these scenarios is unfolding depends on the material that the Columbia River delivers to the estuary. The chemical fluxes that occur in water as it flows from rivers to estuaries to the coastal ocean among the research interests of the Beaverton, Ore.-based Center for Coastal Margin Observation and Prediction, where Needoba is an affiliate scientist. The center is a collaboration of several university and industry partners with core funding from the National Science Foundation.

"Our approach for those types of questions has been to use the observatory system where we get these high-resolution measurements of many of these biogeochemical parameters," Needoba said. "Not just nutrients, but chlorophyll concentration, and if possible, estimates of primary production and respiration."

Accordingly, a system of sensors launched by the center has been continuously recording turbidity, temperature, chlorophyll, dissolved oxygen, colored dissolved organic matter and nitrate levels in the Columbia River since June 2009. The data is shedding new light on what's going on in the river, as well as what that means for the estuary and Oregon's coastal water.

The data so far have given researchers new insight into the river's plankton blooms. Though scientists already knew the river had periods of high chlorophyll concentrations, the sensors have helped paint a clearer picture of recurring, seasonal blooms.

Photo: CC-BY 2010 Daniel Parks, via Flickr

"There have been studies dating back decades that show that diatoms are there and chlorophyll is high during these times of low river discharge," said Michelle Maier, an Oregon Health and Science University doctoral student who studies the Columbia's plankton ecology. "But, from the sensors, we can see exactly when the timing of the blooms are and the magnitude of the blooms."

The sensors have also helped Maier determine the species composition of the river's plankton. Targeting sampling trips during the times when data show that chlorophyll levels are high helps make sure that no effort is wasted by heading out to the river when the plankton aren't blooming.

Uncovering which phytoplankton species make up the river's seasonal blooms could play a role in calculating how much carbon the river is sending to the estuary. For example, the Asterionella diatoms that make up the spring bloom are particularly susceptible to a parasitic infection. Those infections could have important implications for whether the carbon bound up in the spring bloom flows out to the estuary or is integrated in the river's foodweb.

Maier is looking into how much of this Asterionella carbon is being taken into the parasites and then being eaten by zooplankton. "Knowing the species composition and how many infections are occurring might give you a good idea of how much of the diatom carbon is going into the foodweb in the river versus being flushed out into the estuary," she said.

A calculation of the Columbia's net ecosystem metabolism is a key measurement in determining the effects of the river's payload on the estuary's hypoxia issues. The method requires adding up the change in oxygen over a 24-hour period. During daylight, some increase in oxygen is attributed to primary production, and oxygen decreases at night are attributed to respiration. This has shown that, during its spring, summer and fall plankton blooms, the Columbia is producing more carbon than is being respired. In the winter, it's respiring more carbon that it's producing.

"That has real implications for calculating carbon fluxes in the coastal zone," Needboa said. "If the river produces more carbon than it's consuming, the fate of that carbon is to be respired in the coastal ocean. It's essentially what contributes to making the hypoxia conditions worse, if there was a big load of organic carbon coming down the river."

But there's still work to do to figure out whether that's the case. One matter left to consider is timing. The extra carbon from the river's large blooms will only exacerbate the issues brought on by the upwelling ocean water if the two events happen at around the same time.

"If they do, you end up with these worse conditions. If they don't, then nothing happens. It changes from year to year," Needoba said. "We're hoping, over time, that we're going to start capturing enough of those dynamics to get a better handle on what's really happening in the Columbia River estuary." JG

The Land/Ocean Biogeochemical Observatory sensor station in the Columbia River.

Photo: Michelle Maier

Standing Guard

Thomas More College Biology Field Station keeps an eye on the Ohio River

BY DANIEL KELLY

A small field station along the Ohio River has a big mission. In addition to educating students, Thomas More College's Biology Field Station provides research on the river's toxicity and monitors the waterway in case of biowarfare events.

The former lock house, built in 1919, was operated by the U.S. Army Corps of Engineers into the 1960s. The wicket dam it overlooked was removed to make way for the larger towboats and barges just beginning to use the river in those days. When the college moved in near the late 60s, some renovations were needed to turn the field station into the hub for research and learning it is today.

"We use fathead minnows to look at the river's toxicity," said Meghann King, laboratory manager at the station. "Fatheads are kind of like the white mice of water studies."

Students work with faculty at the station to keep a culture of fatheads growing for research purposes.

"The minnows are reproductive at six months old. We use breeder raceways and put tiles in to mimic rocks," said King. "The new eggs hatch in four days."

Young fish are transferred into a tank of river water within 24 hours after hatching. They take up water from the river, absorbing the chemicals and nutrients it contains.

"We're interested in pharmaceutical drugs and other things entering the water that wastewater plants can't remove," King said. "So we want to see the effects on fish and effects on humans down the road."

Regulating the fatheads' reproductive cycle is an extensive process, requiring quality control checks along the way. The fathead culture system is checked once a month by the EPA so the more reliable that data is, the better, King said.

The station recently secured new monitoring equipment to help keep pace with the needs of this and other projects, including sondes, a pyranometer and a weather station that plugs into a NexSens data logger.

"The weather station will be used for teaching K-12 groups - it's a teaching tool to show them what weather is like," said King. "The data will also be available on our website so the community can use it."

King says one sonde is for the fathead culture system while the other is for a river tank, which is part of another project with the EPA.

"The whole point of that is to keep an eye on the river in case of a biowarfare event," said King. "We're several miles upstream from Cincinnati, so there would be time to respond if we found anything."

Asiatic clams grow in the tank that is connected to the Ohio River and each one is equipped with a sensor that monitors when it opens and closes its shell.

"Ordinarily, they're open. If the clams shut, there's something wrong," said King. "I don't think there's anyone else really monitoring the Ohio River regularly like that."

Data from the weather station and sondes is transmitted on a flat screen at the station's entrance, letting visitors see first-hand the results of the station's work.

"The goal is to put our data up and pique interest in learning about the environment, our weather station or tank systems," said King. "A scientific person would definitely see that data and might want to get involved in research." DK

SYSTEM DESCRIPTION

Walking along the field station's front bridge, visitors are greeted by a Vaisala WXT520 weather station and LI-COR pyranometer. Together, the devices monitor atmospheric parameters outside the station like barometric pressure, temperature, relative humidity, wind speed and solar radiation.

Inside, YSI multi-parameter water quality sondes monitor conditions in the fathead minnow culture system and a river tank. The sondes are key in monitoring the Ohio River's toxicity, and provide data on parameters including its pH, temperature, dissolved oxygen and conductivity.

Each sensor is wired directly to a NexSens iSIC data logger, which pulls readings into iChart software every 10 minutes.

A flat screen television connects to the system through an HDMI cable and displays data reports in a user-friendly format for visitors to see. The readings are also uploaded to WQData, a data hosting service, and are shown on the station's website.

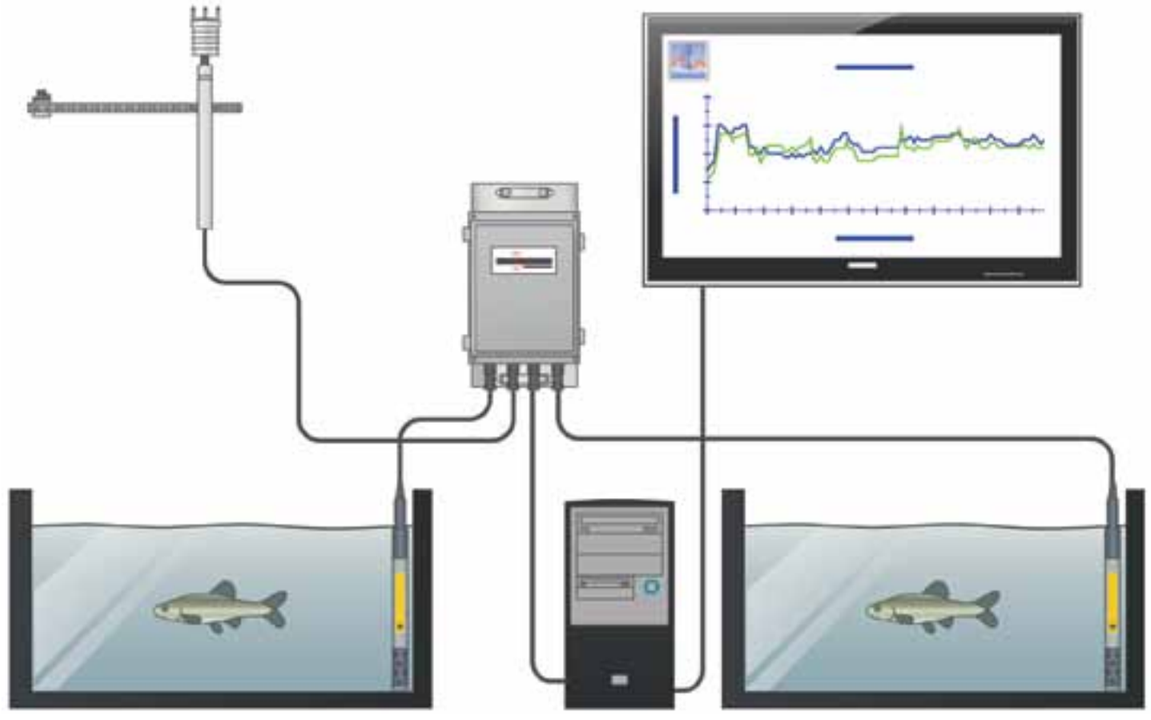


Photo: Manish Sharma

system Diagram: Nate Christopher / Fondriest Environmental

Photo: Jeremy Mathis

Alaska's Acidifying Coast

New NOAA Alaska buoy network to monitor ocean acidification in the North Pacific

BY AUSTEN VERRILLI

National Oceanic and Atmospheric Administration scientists detected signs of ocean acidification in the waters that hold the vulnerable and valuable fisheries of the North Pacific off the coast of Alaska, but they only had a snapshot of the action.

"We know that in this place were important commercial and subsistence fisheries that could be at risk from ocean acidification," said Jeremy Mathis, a NOAA Pacific Marine Environmental Laboratory researcher and professor at the University of Alaska Fairbanks.

To understand how ocean acidification affects the North Pacific, NOAA scientists created a mooring network that collects constant in situ data on parameters contributing to acidification. They hope it will reveal seasonal trends and patterns left out by their snapshots. The monitoring buoys will also act as an alert system for threatening pH levels, which have potential to degrade the vitality and diversity of Alaska's fisheries.

In the North Pacific, upwelling brings thousand-year-old water, which just crossed the world, to the surface. The water is high in carbon dioxide and low in aragonite and calcite, the two bicarbonates from which shellfish build their exteriors.

Ocean acidification, resulting from increasing carbon dioxide in the ocean, lowers pH and carbonate even more. Mathis said that can have economic impacts on everyone in country.

At the dock, Alaskan-caught North Pacific fish bring about $1.5 billion to fishermen each year, according to the Alaska Department of Fish and Game. Alaska's fisheries also fuel 78,500 Alaskan jobs.

About 8 percent of fish caught are shellfish, which are the hardest hit by acidification. NOAA's new buoy network will provide real-time data to scientists and fishermen through the Alaska Ocean Observing Systems Cook Inlet Response Tool so that they can learn and react to pH conditions.

NOAA has installed two monitoring buoys. One is off the southeast coast of Alaska near Port Conclusion and the second is in the northern Gulf of Alaska near Seward. "The next three will go close to Kodiak Island, in the Bering Sea west of Bristol Bay and the Arctic-Beaufort Sea east of Point Barrow," Mathis said.

Each mooring in the monitoring network has two sensor packages. The first is suspended one meter beneath the water's surface. The second sits on the ocean floor, which ranges from 30 meters deep to 275 meters deep.

Sensors track pH, carbon dioxide, chlorophyll, nitrate, oxygen and temperature. Sensors from Battelle and Sunburst track pH and carbon dioxide levels. Seabird instruments handle the other parameters.

The sensor package at the ocean's surface broadcasts data every three hours via satellite telemetry. The package on the ocean floor collects real-time data and stores it in a data logger. Mathis said NOAA technicians and scientists retrieve the data every six months.

Given Alaska's rugged terrain and harsh weather, visiting the remote mooring may not always happen on schedule. Mathis said weather is the greatest limiting factor hindering deployment or data retrieval. The Bering Sea is especially unforgiving. "We have twice a year. That's our only opportunity to get out there and do anything," Mathis said. And there are no guarantees that things will go smoothly even during those ideal times.

Seawater also makes maintaining accuracy a chore for the Alaska monitoring team. Mathis said the team takes discrete samples seasonally to double-check the sensor readings. They also pull sensor packages every six months to a year to have them serviced and calibrated.

The biggest challenge to maintain calibration, Mathis said, is biofouling. He described a monitoring package recently pulled by one of his technicians. "It looks like a botanical garden," he said. "It's just a big stable platform that stuff can grow and stick to."

In a presentation at the Alaska Marine Science Symposium in January, Mathis explained the gravity of ocean acidification trends and their long-term impact. "We're obviously going to lose the oysters and the clams if we keep going on these trajectories," he said.

Mathis continued by quoting Beth Fulton, a scientist at Australia's Commonwealth Scientific and Industrial Research Organisation specializing in marine ecosystem modelling. "We will still have fisheries, if we're willing to eat different fish." AV

Dust in the Wind

Scientists couple automated cameras and environmental sensors to safely track Mojave dust storms

BY JEFF GILLIES

Dust storms in the Southwest U.S. affect the region's climate, air quality and ecosystems. It's important for scientists to know how often the storms happen, but they don't necessarily want to stand around in the Mojave Desert with a tally sheet, waiting for the wind to whip up a massive cloud of dirt.

A novel approach to tracking the storms developed under the U.S. Geological Survey has helped scientists get a handle on how often and under what conditions the storms occur. Now researchers are applying the method to studies as far flung as the coral reefs of Hawaii and the sandbars at the bottom of the Grand Canyon.

Around a decade ago, scientists studying the storms wanted to know not only how often the storms occurred but also whether they were happening more often than indicated by satellite imagery.

"What we really wanted to do, short of sticking somebody out there to count dust storms or just rely on anecdotal evidence from people who would happen to report them to us, was to actually put cameras out there to take pictures on a regular basis," said Rian Bogle, lead physical scientist with the USGS Flagstaff Science Center in Arizona. "That way we could get a count so we could actually quantify, month to month, how many visible dust events happened in certain locations."

One way to capture pictures like that would be to set up a time-lapse camera that automatically shoots a photograph every so many minutes, hours or days. But Bogle and his colleagues went a step further. They developed a system that connects the camera and a variety of environmental sensors to a programmable data logger. This setup allows the camera to lie dormant until the wind speed sensor says that the wind is blowing fast enough to kick up a dust storm.

"For the dust applications, the research is pretty solid on what wind speeds need to exceed in order to start moving soil on the ground," Bogle said. "We calculated what that would be for the height of our anemometer, and then we check that every ten minutes to see if we're exceeding that threshold. Then that starts the camera shooting."

Bogle has since helped deploy imaging systems for monitoring sediment on the coasts of Hawaii and Guam. On the floor of the Grand Canyon, automated cameras are tracking whether controlled floods from the Glen Canyon dam can help rejuvenate the formation of sandbars, an important habitat for plants and native fish that has diminished since the dam was built.

"Because (the data logger) has a whole host of other sensor inputs, it's sort of wide open as to what you would want to trigger that camera with," Bogle said. "You could easily do that for flood stage if you had a sensor that was measuring a river gauge station. You could easily start taking pictures based off of that."

The USGS recently published a guide on the methods and equipment to help other researchers assemble similar systems.

The guide lists the specific camera and data logger used for the dust storm setup, but Bogle said the system is not brand specific. Some basic circuitry knowledge is necessary, but it's nothing beyond what might be covered in a high school electronics class. Some coding is also involved, but data logger manufacturers tend to offer plenty of support in generating programs, Bogle said.

Though a background in software development like Bogle's isn't required, it's worked out for him. It certainly hasn't kept him stuck behind a desk, hunched over a keyboard.

"One of the joys of my job is doing field work and getting out deploying these things and testing them," he said. "I've been super lucky. I've got a graduate degree in applied mathematics and I'm probably one of the few applied mathematicians who actually does field work and gets his hands dirty." JG

A wind sensor triggered the remote camera that captured this Mojave dust storm.

All Photos: Rian Bogle / U.S. Geological Survey

Pursuing Ecology's
'Digital Revolution'

Stringing it Together

BY PAUL NIEBERDING

Buoy based sensor strings offer water column profiling data in real-time. NexSens T-Node FR water temperature sensors simplify the setup and operation of these strings.

The NexSens T-Node FR water temperature sensor is a titanium-housed, precision thermistor for deployments in fresh, brackish or seawater. The sensors can be connected in a series with submersible cables and suspended vertically in a water column or horizontally along a stream or riverbed. Double O-ring seals ensure reliable and waterproof connection to 100 meters. An additional O-ring prevents over-tightening and secures the connection for long-term deployments.

The T-Node FR's accuracy of +/- 0.075 C and fast response time are significant performance improvements over first generation T-Nodes. Long-term stability is specified at 0.002 C over five years of continuous deployment at 25 C.

Temperature data is transmitted via the RS-485 interface using Modbus protocol. Pass-through signals for SDI-12 and RS-485 allow users to connect other water quality sensors along the string. With this architecture, researchers can build and customize temperature strings and expand the system to more powerful monitoring networks. A full line of splitters and accessories are available to accommodate third-party sensor integration.

The T-Node FR sensors feature a plug-and-play interface to NexSens SDL500 submersible data loggers and offshore buoys. Data collection options include standalone, radio, cellular and Iridium satellite telemetry. Interfacing with SDL500 data loggers is facilitated by Windows-based NexSens iChart Software. The T-Node FR sensor string can integrate directly with other data collection platforms via RS-485 Modbus RTU. EN

U S Army Corps of Engineers Temperature Monitoring Buoys

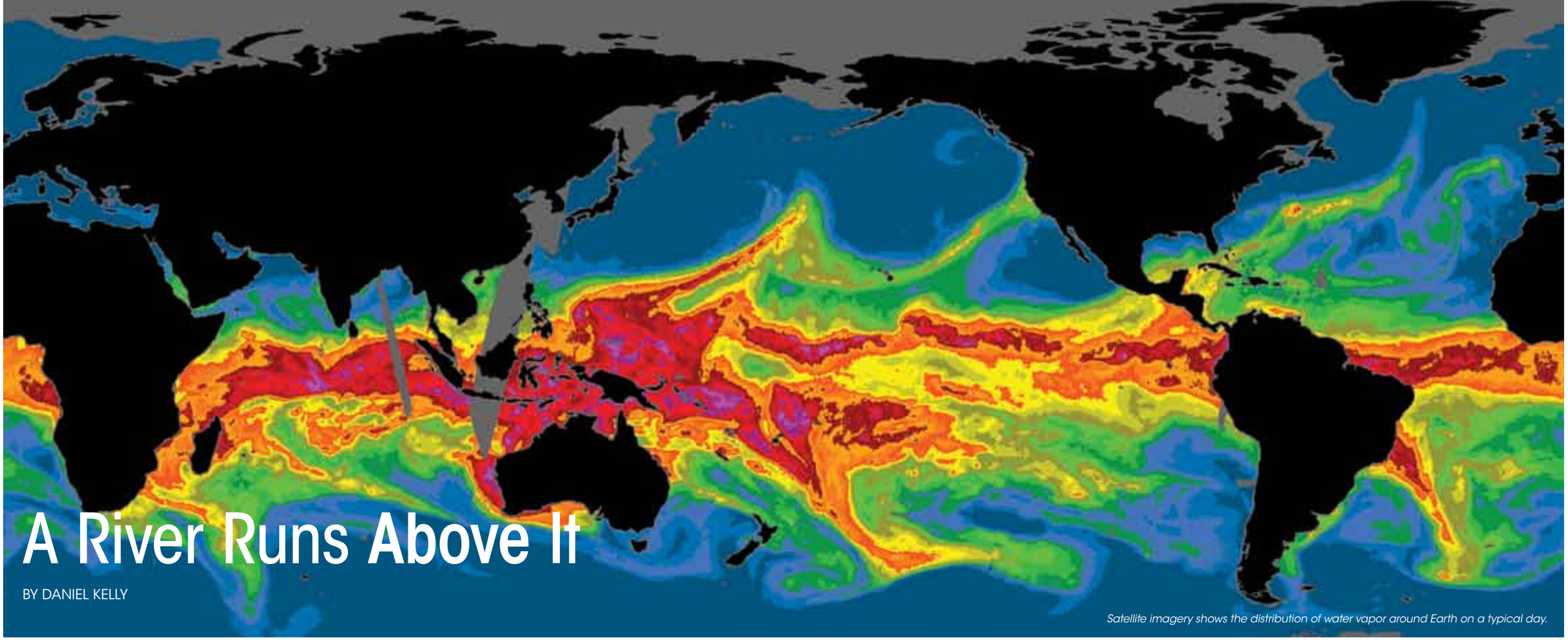
Lake stratification develops seasonally as increasing sunlight in the spring and summer heats up surface water while deeper water remains cool. Temperature-dependent density differences develop and result in isolated layers of water, each with its own distinct chemistry. In the fall, the temperature and density gradient weakens as surface waters cool and sink. The resulting isothermal conditions restore water circulation and oxygen to the deeper layers of the lake.

Monitoring the yearly evolution of temperature stratification is a critical component in many lake management and research programs due to its pronounced effects on aquatic chemistry and biology. The release of overly warm surface water, or oxygen-depleted bottom water, at selective withdrawal dams could devastate downstream fish populations.

At a number of reservoirs across Pennsylvania, the US Army Corps of Engineers Pittsburgh District obtains real-time, online temperature stratification data using NexSens T-Node temperature strings suspended from buoys. Using the data, dam operators and reservoir managers are able to selectively release water from different depths in order to maintain acceptable water quality conditions downstream of the reservoirs.

A River Runs Above It

BY DANIEL KELLY



Satellite imagery shows the distribution of water vapor around Earth on a typical day.

Scientists have long studied "pineapple express" storms that originate near the Hawaiian Islands and bring heavy rain or snow to the West Coast of the United States.

But a breakthrough in understanding these storms, which contain strong flows of atmospheric moisture, didn't come until advancements in satellite technology made it clear that the powerful storms were being fed by long bands of water vapor circling the earth.

Known as "atmospheric rivers," these bands can stretch from California all the way to Japan and can contain more water than the Amazon River, Earth's largest by waterflow.

"It turns out that water vapor in the atmosphere has an unexpected tendency," said Michael Dettinger, a research associate at the Scripps Institution of Oceanography. "It doesn't move around in vast bubbles of moist air. About 90 to 95 percent of water vapor moving toward the north pole is actually moving in a half dozen bands covering about 5 percent of the area of the earth."

In most cases, atmospheric rivers move from west to east, continually forming or disintegrating. One of Dettinger's current projects is to find ways to improve forecasts of pineapple express storms caused after atmospheric rivers reach the West Coast of the U.S.

"When these rivers encounter western coasts or mountain ranges, they get lifted up, the water vapor condenses and strong rainfall events occur," said Dettinger. "About 80 percent of damaging floods in California rivers are a result of these atmospheric river storms."

To improve current forecasting models, Dettinger, other researchers at the Scripps Institution and a team from the National Oceanic and Atmospheric Administration are deploying four land-based observatories.

"Others have used weather balloons that you send up twice a day," said Dettinger. "It's rare that you'd encounter the jets with those, and you wouldn't know how wide one was if you did."

Improving forecast capabilities may become more important as warmer temperatures become more prevalent.

"Warmer air can cause more water vapor to form," said Dettinger. "Going into the projections of climate change in the 21st century, the number of atmospheric rivers that were arriving and the amount of water vapor they were carrying - in both cases - was increasing by 10 to 15 percent."

Photo: Allen White

Each new observatory has upward-looking radar at its core, acoustic sounders, specialized rain gauges and high-end GPS antennas, along with other instruments. The cost for each one runs around $1 million.

The radar is the most expensive component, able to measure in great detail the composition of winds, rain, sleet and snow at different levels in the atmosphere. Acoustic sounders on the units give an insight into storm turbulence, while the rain gauges measure rate and size of water droplets as they fall. The GPS antennas can record location and altitude down to a centimeter.

"We want to develop a growing understanding of these storms, to observe and track them in real time, and better predict where they're going" said Dettinger. "Advances in technology have given us those new possibilities."

New technology may have made the project possible, but partnerships helped get it off the ground.

"Some of us at Scripps and NOAA started talking a few years back about what a network could look like to monitor the storms," said Dettinger.

Those conversations eventually led to a presentation to the flood management division of the California Department of Water Resources.

"We felt like it was our duty to make them aware of the options. In the end, they told us this kind of network was exactly what they were looking for," said Dettinger. "The state agreed to provide half the funding and NOAA put up the other half."

In addition to the four new observatories, which are being deployed in Bodega Bay, Eureka, Point Sur and Goleta, there are 100 other sites where smaller-scale measurements are taken.

"This is a really unique network. There's nothing like it yet in the world," said Dettinger. "California has a long tradition of devastating floods and this is the latest in a long history of dealing with them. We're taking the latest science and ramping up our ability to manage these storms better."

MONITORING GEAR

Zebra-Tech Hydro-Wipers

This simple sensor attachment prevents bio fouling conditions from disrupting data collection in extended deployments. The wipers are fitted on various optical sensors, such as turbidity, OBS, fluorometer, PAR sensors and radiometers.

This reliable technology is highly effective in both marine and freshwater environments. Time intervals range from 15 to 720 minutes between swipes, reducing the need for numerous site visits to service sensors.

Wiper models are customizable to integrate with sensors from various manufacturers, including Seapoint, LI-COR, Turner Designs, Satlantic, Greenspan, WET Labs and more.

Airmar 200WX Weather Station

This weather station features seven sensors in one handy instrument to measure apparent wind speed and direction, barometric pressure, air-temperature, relative humidity, dew point and wind chill temperature.

This cost-effective system is a permanent or portable solution to accurately monitor weather conditions in meteorology or marine applications. Easily installed to collect real-time data, the weather station offers a three-axis solid-state compass with dynamic stabilization for 2 degree compass accuracy, and better than 1 degree static compass accuracy.

Thermo Orion Aquamate Spectrophotometer

Designed to meet multiple laboratory needs in water and wastewater applications, the Aquamate spectrophotometer is a compact instrument that provides flexible and accurate results. Preprogrammed methods are stored on a USB stick for easy retrieval of over 260 tests for analysis via computer or hard copy. A wide array of vials can be used, including square, rectangular, and round vials.

Wavelength accuracy and dependability are ensured through the internal lamp or external calibrated standards. The device allows for a one-point adjustment to correct for variations in chemical reagents. Each verification report includes the time, date and instrument serial number, in accordance with GLP and GMP regulations.

Trimble Yuma 2 Tablet Computer

The Yuma 2 is a mobile and rugged solution for jobs in the field. Complete with an IP65-rating, the tablet survives anything from high altitudes, humidity and temperature extremes to vibration, shock, dust and water.

The tablet holds up to 4GB of DDR3 DRAM, and can handle any documents or data brought from the office. Bluetooth, Wi-Fi and optional dual-mode GSM or CDMA 3.75G cellular data modules make for easy connectivity. Two USB host ports and an HDMI output are included, as well as matched set of long-life batteries for all day use in the field.

A Gorilla Glass display minimizes glare and is responsive to gloved fingers. The five-megapixel camera with video and photo capture makes it ideal for a wide variety of management functions.

FloWav Area Velocity Sensor

This innovative area velocity sensor uses proven pressure depth and continuous wave Doppler velocity technologies to provide accurate flow measurements in partially filled round pipes. The ceramic pressure level sensor endures through corrosive sewer systems and reduces the effects of hysteresis and sensor drift. The small-diameter sensor cable minimizes obstructions to flow in the pipe.

The Pipeline PSA-AV sensor offers a plug-and-play interface to NexSens iSIC and SDL500 data logging & telemetry systems. The sensor can also be integrated into other industry data loggers and SCADA systems via RS-485 Modbus output.

YSI 900 Chlorine Colorimeter

Quickly, easily and accurately measure free and total chlorine in laboratory and field testing environments, such as wastewater and groundwater. This rugged and waterproof colorimeter includes an innovative light shield that avoids moving parts or separate pieces from breaking or getting misplaced. Resolution can be improved for custom range requirements.

The instrument features automatic data storage, which retains up to 16 data sets with time and date stamp. Connect via PC or USB to save in an Excel file, or transfer data to the Data Hub to continue making measurements. Compatible with government or organizational standards, the colorimeter is N.I.S.T and ISO traceable.

WETLAND WATCH

A wide-ranging Great Lakes coastal wetlands monitoring effort enters its third year

BY JEFF GILLIES

The Great Lakes' coasts are often depicted as sugar-sand beaches sloping into gin-clear water, but Jessica Sherman has seen a less glamorous side of what can happen where the water meets the land.

All Photos: CMU Wetland Ecology Lab

While playing her part in a five-year effort to asses the quality of coastal wetlands across the Great Lakes basin, Sherman has slogged through shoreline areas that are less sand and more swamp.

"Some of them can be just like that, and they'll be really silty, muddy sediment," she said. "And you'll step down and the plume of smell that hits your face is sometimes intolerable."

But it's not always so bad.

"And then you get to other wetlands that are just absolutely pristine, beautiful, very sandy," she said. "So we kind of see the whole gamut when it comes to aesthetics."

Sherman is a wetland technician with the Institute for Great Lakes Research at Central Michigan University. The school is at the center of a five-year, basin-wide wetland monitoring project funded by a $10 million grant from the U.S. Environmental Protection Agency grant under the Great Lakes Restoration Initiative.

The project builds on the the work of past initiatives like the Great Lakes Coastal Wetlands Consortium. That seven-year project, which concluded in 2008, emphasized the importance of coastal wetlands to the Great Lakes environment and economy and established monitoring protocols to collect standardized wetlands data across all the lakes.

Now that monitoring is underway, the resulting data could help target restoration resources to the habitats that are the most degraded and conservation resources to the pristine environments that need protection. Data collection and analysis is still underway, but the information will ultimately be made publicly available.

"Data will be available for scientists, decision makers and nonprofit groups to use, whether its for grant writing or surveying the habitat before or after some sort of restoration service," Sherman said. "That is the biggest goal, to make the data available."

Crews from around a dozen universities and agencies are gearing up for the third year of data collection. Researchers at

Jack Distel sets a trap net in the wild rice of a Great Lakes coastal wetland.

Central Michigan University oversee the entire project, and crews from the school are responsible for assessing wetlands along the Michigan Great Lakes coast. The monitoring includes assessments of fish, birds, amphibians, vegetation, invertebrates and water quality.

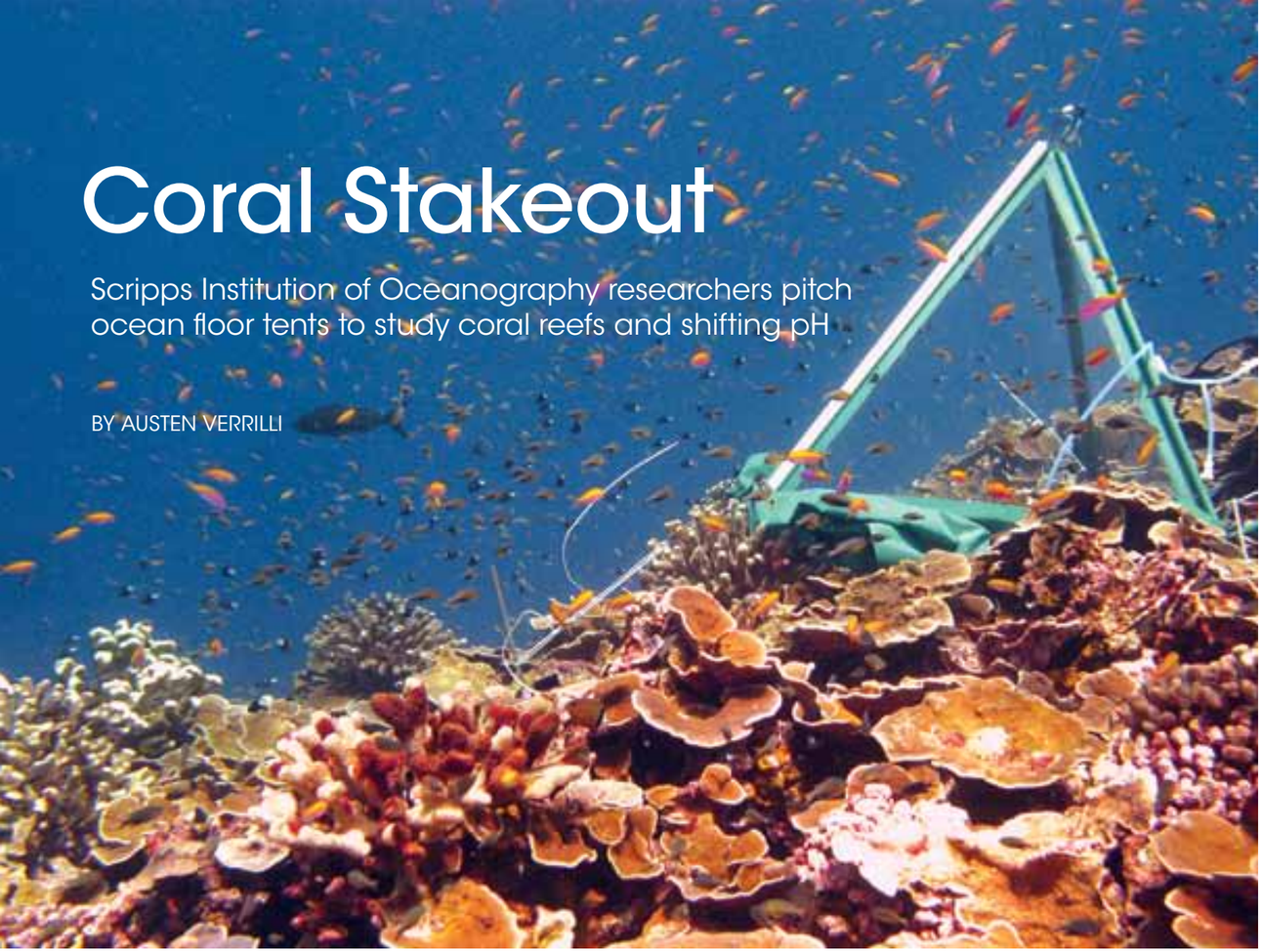
The water quality assessments visiting a wetland once a year for five years, collecting water samples for lab analysis and spot sampling with data sondes for parameters like pH, turbidity and dissolved oxygen.

"It's kind of a snapshot of what that wetland was like the day that we were visiting it," Sherman said.

Collaborators include the University of Notre Dame, Grand Valley State University, University of Minnesota Duluth, University of Wisconsin-Green Bay, University of Wisconsin-River Falls, Lake Superior State University, University of Windsor, SUNY Brockport and Oregon State University. The Michigan Department of Environmental Quality, Environment Canada and Bird Studies Canada are also participating.

The size and scope of the binational monitoring effort reflects the importance of coastal wetlands to the Great Lakes ecosystem.

"Coastal wetlands are such a huge part of the whole lake biology, especially when it comes to filtering and blocking what's coming off that terrestrial environment and into the aquatic environment," Sherman said. "It's supporting a lot of nursery habitat and breeding habitat for the fish that are coming into the lake like the pike and the yellow perch and bass." JG



Coral Stakeout

Scripps Institution of Oceanography researchers pitch ocean floor tents to study coral reefs and shifting pH

BY AUSTEN VERRILLI

A team of researchers from the Scripps Institution of Oceanography examined small patches of coral reef to understand how the organisms help regulate an ocean becoming increasingly acidic.

The researchers honed in on several small patches of reef using 24-hour, small-scale observations. Each dive, they isolate six areas the size of a school desk with small tents that seal in a small volume of water. Then they monitor the water to observe how coral reefs interact with the surrounding waters.

"We swim down and it's just like pitching a tent when you go camping," said Nichole Price, a Scripps post-doctoral researcher.

It's like camping, but the site is a vibrant coral reef, sharks coast around investigating who's in their territory and the scientists are in full scuba gear.

The Scripps researchers conducted the study on the remote northern Line Islands in the Central Pacific. Coral reefs there shelter and build the coastlines surrounding a string of small, low-lying atolls just north of the equator. Three islands visited during the expedition are inhabited and part of the Republic of Kiribati; another three islands are unpeopled and are protected under the Pacific Remote Islands Marine National Monument.

The team started traveling to these reefs in 2005 to find pristine, untouched reefs to study. "These Islands provide an excellent juxtaposition of different levels of human impact for a research purpose," Price said.

They surveyed the area and found pristine coral reefs near uninhabited islands, but reefs near inhabited islands were disrupted. The contrasting reefs acted as foil habitats for the researchers, who monitored pH, dissolved oxygen, salinity and temperature for a 24 hour period with Eureka sondes. A custom Scripps sensor package autonomously measured pH as well.

A circulation pump kept water moving in the tents and extracted water samples. The system sampled when the tent was pitched and again 24 hours later.

The data shows a vivid picture of coral respiration and calcification. "(The reefs are) so built up with living structure that you can visualize the reef accreting, inhaling, and exhaling," Price said.

All Photos: Scripps Institution of Oceanography

Coral reefs, like any other photosynthesizing organism, operate on a daily schedule. When it's light, they photosynthesize, consuming carbon dioxide and raising ocean pH levels.

"At night the various breathing organisms are exhaling carbon dioxide," Price said. "And because it's dark there's no longer photosynthesis to consume it."

Nightly carbon dioxide increases contribute to lower nightly ocean pH levels among all reefs. However, the researchers noticed that reefs near populated islands had more extreme pH lows at night.

The ocean works to maintain chemical equilibrium as pH fluctuates, but increased atmospheric carbon dioxide is moving the equilibrium point toward a more acidic ocean.

The oceans' acidity increased by 30 percent since the industrial revolution, according to the National Oceanic and Atmospheric Administration.

Increased ocean acidity is bad news for coral: It can lead to a lower saturation of calcium carbonate, which coral use to build the reef. Price said that means trouble for the Kiribati inhabitants too, because they rely on the reefs to feed and protect them.

Ocean pH is not the only thing harming the coral. Pollution runoff and heavy fishing near inhabited Christmas, Fanning and Washington islands can foster harmful seaweed growth over coral reefs compared with pristine examples near uninhabited islands.

Despite somewhat bleak findings, Price said studying rare pristine reefs will help scientists find solutions to coral's man-made ailments.

Price and some of her fellow researchers will be part of an American Museum and Natural History Center for Biodiversity and Conservation symposium on managing land resources to maintain island ecosystem health.

So far researchers have not been able to confirm whether or not their small-scale observations can be expanded to a larger scale. The Scripps research team will travel to the southern Line Islands next fall to expand the study and continue learning about the Islands' coral populations. AV

A closer look at the Scripps sensor package

Todd Martz, an assistant professor of marine chemistry at the Scripps Institution of Oceanography, wanted the most stable sensors on the market that could hold their calibrations and handle long term deployment in seawater.

But no commercial sensor package included all of his ideal parts. So, he and his colleagues built their own, compiling sensors from three competing manufacturers that would likely never collaborate.

"It was basically something that no one else was going to commercialize," Martz said. "Since we could not purchase this combination of sensors, we built it ourselves."

Martz wanted to reliably measure seawater pH. But common glass bulb sensors tend to drift away from calibration, especially in the ocean.

Martz settled on an ion selective field effect transistor: the Honeywell DuraFET III. The DuraFET's small computer chip senses hydrogen ions when submersed. It has a much faster response time than glass electrode bulbs and minimal drift.

The DuraFET does have limitations. It can only go to a depth of 80 meters, making it impossible to profile the full 5000 meter water column.

"The pressure tolerance issue is being addressed now as part of a grant from the National Ocean Partnership Program," Martz said.

Martz and Ken Johnson, a senior scientist at the Monterey Bay Aquarium Research Institute, installed the DuraFET sensor in a waterproof housing with a data logger, creating what they called the SeaFET package. The unit measures pH and temperature and can last around six months in seawater without calibration.

Martz later added an Aanderaa Optode 3835 dissolved oxygen sensor and a Sea-Bird SBE-37 conductivity sensor to the package, dubbing it the SeapHOx. Martz said usually the batteries die or biofouling occurs before the sensors drift out of range.

SeaFET is commercially available but the SeapHOx can't be bought from any manufacturer. Martz's group at Scripps has constructed about 50 SeapHOx units for their collaborators.

Air Quality Road Trip

Car-mounted sensors help satellites get a better picture of ground-level air pollution

BY JEFF GILLIES

Kang Sun and fellow researchers from Princeton University drove 2,700 miles across California this winter, but it was no ordinary road trip. Strapped to the roof of their car was a suite of environmental sensors that might look more at home on the Mars rover than their rented Chevy Impala.

"It is definitely unique," said Sun, a doctoral student in Princeton's Department of Civil and Environmental Engineering.

Sun traveled with David J. Miller, graduate student, and Lei Tao, post-doctoral research associate. They covered territory in California's Central Valley, from L.A. to the San Francisco Bay area while collecting data from an array of air quality sensors hooked to their luggage rack. The six gasses they were tracking include carbon dioxide, ammonia and nitrous oxide.

"Some of them are greenhouse gases," Kang said. "Some of them are precursors to particulate matter. Some are just general air pollutants."

The data they collected will be contributed to a NASA air quality research mission called DISCOVER-AQ. The mission's goal is to help scientists make better air quality forecasts using Earth-observing satellites. Such forecasts are a challenge because it can be difficult for satellite instruments to distinguish between air pollution near the surface -- where people live and breath -- and the upper atmosphere.

The heart of the DISCOVER-AQ campaign is a fleet of sensor-equipped aircraft. The planes were also traveling around California while Sun's group collected data at the surface.

The car sensor suite includes two custom, laser-based sensors developed by Princeton's Atmospheric Chemistry Group. The group is led by Mark Zondlo, an assistant professor of civil and environmental engineering. One of the group's sensors measures ammonia, and the other simultaneously measures nitrous oxide and carbon monoxide.

The car also carries two off-the-shelf sensors from LI-COR. One measures methane and the other carbon dioxide and water vapor.

The suite also includes a Vaisala weather station that measures air temperature, atmospheric pressure and wind speed. The temperature and pressure measurements are particularly important for calibrating the data from the gas sensors.

"These two are very important to us," Sun said. "If we really want to have data with very good quality, we need to have a very good temperature sensor and pressure sensor."

The Vaisala weather station is particularly well suited for their needs because it's built for field use. That means it can withstand dusty, windy and bug-splattering conditions that come with cruising down country roads and freeways. JG

Photo: Mark A. Zondlo

Mapping the Invasion

An online tool based on satellite data could help fight invasive Phragmites in the Great Lakes

BY DANIEL KELLY

Plots of invasive reeds near Lake Erie grow so thick that not even mosquitoes venture in. Biologists say you're lucky if you can find a slug.

The culprit, Phragmites australis, is no ordinary plant. It has proliferated in the Great Lakes region to the point that it can even be found along highways.

"Phragmites was not always an invasive species," said Laura Bourgeau-Chavez, research scientist at Michigan Technological University. "But in the last 20 to 25 years, it has really taken off. Some was actually planted in the past by boy scouts to stop erosion."

Through seeds and underground stems, Phragmites establishes itself like few other plants, settling in, digging deep and continuing to spread.

"It takes over a wetland over time, changes the ecosystem and cools the water. It dries it out," said Bourgeau-Chavez. "That affects water fowl – it scares them away."

Bourgeau-Chavez, along with scientists from the U.S. Geological Survey and the U.S. Fish and Wildlife Service, mapped the U.S. coastline of the Great Lakes, looking specifically at the reach of phragmites.

"When we discovered we could identify it, we developed methods of using remote sensing," said Bourgeau-Chavez. "We started doing mapping with radar and could pick up the stands."

The researchers used a Japanese satellite equipped with synthetic aperture radar, meaning its antenna could be artificially lengthened. That capability increased the satellite's reach, helping to penetrate the canopy of vegetation and detect phragmites' high biomass along the Great Lakes' coastline. Field tests were then used to confirm the radar's findings.

"We took GPS units to get a position of the plots and sampled using a computer," said Bourgeau-Chavez. "We mapped areas about 40 by 50 meters, described the dominant plants, their density, and took photos."

Data from the field and images are available on the Phragmites Decision Support Tool Mapper, a website set up by the Great Lakes Restoration Initiative, USGS, and research partners.

"The decision support tool is a place you can change parameters and do different things like see the proximity to agriculture or roads, detect or target phragmites," said Bourgeau-Chavez.

Rows of agriculture were a concern in mapping phragmites, as they appear similar to the reed on radar. Ancillary data was used to remove farmland from consideration.

Lake Erie's coastline had the most phragmites. Lake Huron came next, followed by Lake Michigan. Only a few stands were found in Lake Ontario and almost none in Lake Superior.

"Erie is shallow. There is a lot of agriculture around it," said Bourgeau-Chavez. "The water level doesn't fluctuate as much in Ontario and it's not as windy."

Fighting invasive species in the Great Lakes is not easy, and phragmites is no exception.

"It's not a losing battle. If we can understand the mechanism of invasion, we can control it, " said Bourgeau-Chavez. "Look at other invasives, like purple loosestrife. Ladybugs were used to stop the spread of it."

In the future, Bourgeau-Chavez would like to expand the mapping to the Canadian coastline and other areas that couldn't be covered due to funding considerations.

"My concern is that we weren't able to map every half acre. We don't have areas along roads and ditches," said Bourgeau-Chavez. "But at least managers can see patterns and get ideas of where it's moving next." DK

All Photos: Liz Banda

Naomi Hamermesh, an assistant research scientist at Michigan Tech, stands at five feet tall.

Remote Controlled Sensing

Michigan Tech's toy-sized boat collects bathymetric data where bigger boats can't go

BY JEFF GILLIES

When University of Michigan football coach Fritz Crisler pioneered the winged helmet design worn famously by the Wolverines since the 1930s, it's unlikely he knew his influence would reach as far as bathymetric surveys of remote lakes in Alaska.

In 2006, a collaboration between the University of Michigan and the Michigan Tech Research Institute took Guy Meadows, Robert Shuchman and Liza Jenkins to the shores of some of the thousands of lakes that dot the Alaska North Slope. The lakes there are the source of water for ice roads that facilitate oil development in the region.

Regulations protect the lakes' water quantity and quality. But with so many lakes and so little data, the rules can be difficult to follow and enforce. The lakes are accessible only by helicopter. The standard survey method of flying some scientists, equipment and an inflatable boat to a lake was slow going and expensive.

"The trouble is there are 156,000 lakes up on the North Slope," said Shuchman, co-director of the Michigan Tech Research Institute. "Taking a Zodiac up there was one lake a day."

"Only in the ice-free summer," added Jenkins, a research scientist at the institute. "And the summer is only two months long."

The U.S. Bureau of Land Management began working with the institute and the University of Michigan to speed up lake assessments and get a better handle on the volume of water in the lakes. Part of the solution was a highly portable remote controlled, electric boat equipped with a depth sounder and GPS. They called the craft Bathy Boat, short for the bathymetric data the boat collects on the contours of underwater surfaces.

Bathy Boat began as a joint project between the University of Michigan and Michigan Technological University. It has since transferred fully over to the latter's new Great Lakes Research Center, where Guy Meadows is the director, and the Michigan Tech Research Institute.

Despite the transfer, the 25-pound, 3-foot boat is still topped with a replica of the winged helmet worn by the Michigan Wolverines football team. Just like the design helped coach Crisler's quarterbacks keep track of their receivers and which way they were facing, it helped Bathy Boat's pilots keep track of the craft at very long distances during a technology demonstration on the North Slope lakes.

"It turns out that the design actually helped us when we were way out at the fringe of the radio control of Bathy Boat," Shuchman said. "Liza and I would look with the binoculars, and having that silly helmet would help us. 'Oh, the boat's going that way.'"

With its depth sensor collecting a measurement every second, the boat could collect data for a lake's depth profile in the time it took for pilot to snake the boat back and forth across enough times to ensure sufficient coverage.

Combined with satellite monitoring technology developed at the research institute, they turned what was once an all day affair into a relatively quick job that let the survey crew hit several lakes in a day.

Since returning from Alaska, Bathy Boat has proven useful anywhere that depth data is important but hard to come by. The Michigan Department of Environmental Quality recruited the tool to map shallow nearshore areas along Great Lakes beaches. That work is part of an effort to forecast rip currents and prevent drowning deaths this summer. A deployment along the Sleeping Bear Dunes National Lakeshore will help the National Parks Service track sand transport in shallow, boulder-strewn areas. As the Great Lakes hover around record lows, coastal marina operators are increasingly interested in depth data around their docks.

"It's a very small portable device that can easily maneuver between pilings where larger survey vessels aren't able to get," Jenkins said.

Under the helmet, Bathy Boat carries off-the-shelf sensors for depth, temperature and conductivity. A GPS receiver and compass help with navigation and mapping the data. A Linux computer around the size of a cigarette pack conditions the data and facilitates its storage in flash memory. The motor and servos are high-end hobbyist models.

"I'll use a technical term," Shuchman said. "It's cobbled together." JG

Bathy Boat's first mission was on Alaska's North Slope where researchers don protective clothing against thick mosquitoes.

All Photos: Michigan Tech Research Institute

Q&A Matt COHEN

on sensors and Redfield's ratio

Matt Cohen, an associate professor with the University of Florida's school of forest resources and conservation, works with sensor systems to uncover the nutrient and chemical dynamics of Florida's spring-fed rivers. The Environmental Monitor recently spoke with Cohen about his National Science Foundation-funded work on using Redfield's ratio and high-resolution data from water quality sensors to understand how elements cycle through ecosystems.

Environmental Monitor: What is Redfield's ratio and why is it an important thing to study?

Matt Cohen: Redfield's ratio is basically a statement about how different elements are assembled inside organisms. It's reported as a ratio of carbon to nitrogen to phosphorous. We can measure it in organisms, but we've never really been able to measure that ratio in ecosystems to see how organisms essentially affect the way that elements move and are transported through ecosystems. That is what sensors now are allowing us to do.

Understanding how elements are coupled to one another at different scales, at the scale of the individual organism all the way up to the scale of the biosphere, is a really pressing question. Understanding global carbon cycles, for example, is obviously important for mitigating and predicting climate change. But you can't really understand the global carbon cycle all that well until you start understanding the global nitrogen cycle, because they're really intimately coupled with one another. The same is true for phosphorous, and arguably for all of the elements that organisms require, and also therefore affect environmental concentrations.

But it's also really important to understand things like the effects of nutrient pollution. We want to be able to say at what point is there too much phosphorous or nitrogen in a river or lake or an estuary. And our argument is that by understanding how those nutrients affect the ecosystem behavior, how they affect the metabolism, we can say that with much more scientific rigor.

EM: How are sensors helping?

MC: Dissolved oxygen sensors really help us understand carbon dynamics. Similarly, nitrogen sensors let us understand nitrogen dynamics and phosphate sensors let us understand phosphate dynamics. And now, by putting all three of them together, we can really start to delve into how they work--how they are coupled. That's sort of a basic science application.

The sensors, in my mind, are opening up doors to understanding the fundamentals of ecosystems, but also making predictions about how they work, which is really what ecosystem management and restoration is all about.

EM: Why do you work in rivers, and how do you go about collecting data there?

MC: Everything that happens in the river ecosystem, the signal of it is sort of written into the water as it flows by. And if we measure the water downstream, we can really start to understand those ecosystems and how those elements are coupled.

We work in North Florida's springs. This is actually the world's highest density of artesian springs. It's an extraordinary resource. These rivers that we study, they come out of the ground, basically, constant. We put our sensors just downstream, four or five miles. And we know, because the water comes out of the ground constant and we're measuring variation downstream, that we can attribute all of those changes to that little stretch of river.

For the most part, we track what happens to the water chemistry over a 24-hour cycle. We put out sensors to measure dissolved oxygen and temperature, conductivity, pH, nitrates and phosphates.

EM: Are you to the point where you can connect your data back to Redfield's ratio?

MC: We are. Our rivers have many different types of plants. There is algae that grows in the water. There are plants that are rooted to the river bottom. Using our technique, in theory, it's possible to divide the amount of primary production between those two. That's never been possible before, but you can use Redfield's ratio because plants and algae have systematically different ratios. We can use what happens at the ecosystem to say, 'Well, algae are doing most of the production,' or, 'Plants are doing most of the production.' That's an important step.

It also allows us to understand whether a river is saturated with respect to its nutrient supply. We are honing in on that question too, which is obviously really important from a water quality perspective, because we want to make sure that if systems are nutrient limited that we keep them that way.

NEW TECHNOLOGY

IBuoy

The suitcase-like box lying on the ice of the frozen Arctic Ocean last spring wasn't a bad case of lost luggage. The black box was there as part of a test of the IBuoy, an instrument platform developed as an affordable option for researchers to track ocean currents, ice movement and other marine variables.

Scientists have long measured ocean currents and ice movement. The technology for doing so was well established before scientists at the Johns Hopkins University Applied Physics Laboratory undertook the IBouy project.

Tracking ice movements through polar marine environments often involves GPS-equipped buoys that can cost on the order of tens of thousands of dollars, according to Daniel Greenspan, senior staff at the laboratory. The buoys are left on the ice for a season, broadcasting their location as the ice drifts across the Arctic. Because the buoys are so expensive, they're usually designed to float once the ice melts so a research vessel can retrieve them.

"That's all very fine and good," Greenspan said, "but if your budget only allows you to buy one or a handful of these expensive buoys, then you can't do as much ice tracking as you can if you have a less expensive device that you could just abandon."

That's what drove the development of the IBuoy, a small assemblage of off-the-shelf components with satellite data telemetry that can be tailored to suit an assortment of monitoring jobs. In some applications, the cost of the buoy is low enough that researchers can desert the device at sea, saving themselves the expense of a recovery trip.

The first version of the buoy was designed to measure waves and the paths of ocean currents. The wave model of the IBuoy is packaged in a cylinder around the size of a roll of paper towels tucked into a disc-shaped float with the circumference of a large dinner plate. It was successfully tested in Chesapeake Bay in 2011, functioning as well as a commercial buoy at a cost four to 10 times less.

A test deployment of the polar IBuoy tracked ice movement in the Arctic Ocean.

"And so we thought, this will be great," Greenspan said. "We can takes fleets of these things on our research field trips, and just drop them off the boat, and we'd be able to measure vast swaths of currents."

The IBuoy measured wave height in Chesapeake Bay.

After developing the polar ice-tracking model, Greenspan caught a ride on the Arctic Switchyard Project, an annual research expedition to an area of the Arctic Ocean where several major oceans and fresh water from melting ice sheets meet and mix.

"It's very interesting to study scientifically," Greenspan said. "It's is one of the places where you can keep an eye on how ocean conditions are changing and how they're related to global climate change."

The nine installations of the polar IBuoy on the Switchyard mission included a version that integrates an acoustic depth sounder. The instrument profiled the ocean floor along the buoy's drift.

The Switchyard trip was a successful proof-of-concept demonstration for the polar IBuoy, and Greenspan will return next year for an operational deployment. As for future applications, Greenspan said he and his collaborators are on the lookout for new instrument configurations and environments to explore. JG

Photos: (top) Daniel Greenspan, (bottom) Dave Porter

CitiSense

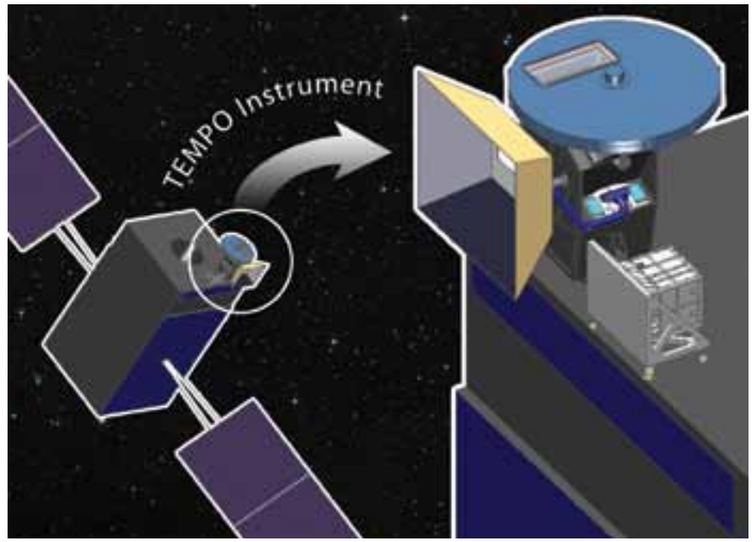
Scientists at the University of California San Diego have developed personal pollution sensors allowing users to monitor the air around them using smart phones, according to a release from the school. The sensors are not attached directly to the phones, but interface with them wirelessly.

Each unit, called a CitiSense system, can read levels of ozone, nitrogen dioxide and carbon monoxide, which are some of the most common pollutants emitted by cars and trucks. By tracking air quality in real time, users can modify their routines and avoid polluted air. Cyclists or bike commuters appeared to be particularly prone to experiencing elevated pollution levels while riding near roadways.

By using anonymous data from multiple CitiSense systems, the UC San Diego team could get a clearer view of a region's air quality. The sensors' size and multi-user potential could provide more data than standard air monitoring deployments.

The cost for making each sensor is around $1,000 and the researchers have brainstormed plans for cheaper mass production. The CitiSense program is being funded by a $1.5 million grant from the National Science Foundation. DK

Photo: (left) UC San Diego Jacobs School of Engineering, (right) NASA



TEMPO: Air Pollution Satellite

NASA officials recently approved a project to build a space-based instrument that will pinpoint emissions with higher resolution than ever used in air pollution monitoring.

New technology will enable the instrument to scan North America hourly, detecting emissions in areas as small as nine square miles. It will communicate on an hourly basis where most monitoring satellites communicate once a day.

Scientists at the Smithsonian Astrophysical Observatory will lead the development of the instrument known as the Tropospheric Emissions: Monitoring of Pollution project.

A spectrometer on TEMPO will have at least 30 times the resolution of other instruments air monitoring instruments deployed into space. Detectable pollutants will include ozone, nitrogen dioxide, sulfur dioxide, formaldehyde and aerosols.

TEMPO's high resolution means any source of significant air pollution will be easily seen and identified within a manageable area, making polluters easier to spot. "The observations will help agencies to develop effective emissions control," said Kelly Chance, TEMPO principal investigator and Smithsonian scientist.

Scientists from the SAO, NASA Langley, Harvard, University of California Berkley, St. Louis University, University of Nebraska, and several other organizations will help design and create the instrument. Ball Aerospace and Technologies Corp. will build the instrument.

The scientists will put their design elements together to create an instrument that will work with a satellite. "The biggest challenge is in learning how to combine our scientific instruments with a host satellite, implying constraints on vibration, instrument placement, available telemetry bandwidth and launch schedule," Chance said.

If all goes to plan, TEMPO will be part of a constellation of air monitoring instruments covering the North America, Asia and Europe. AV

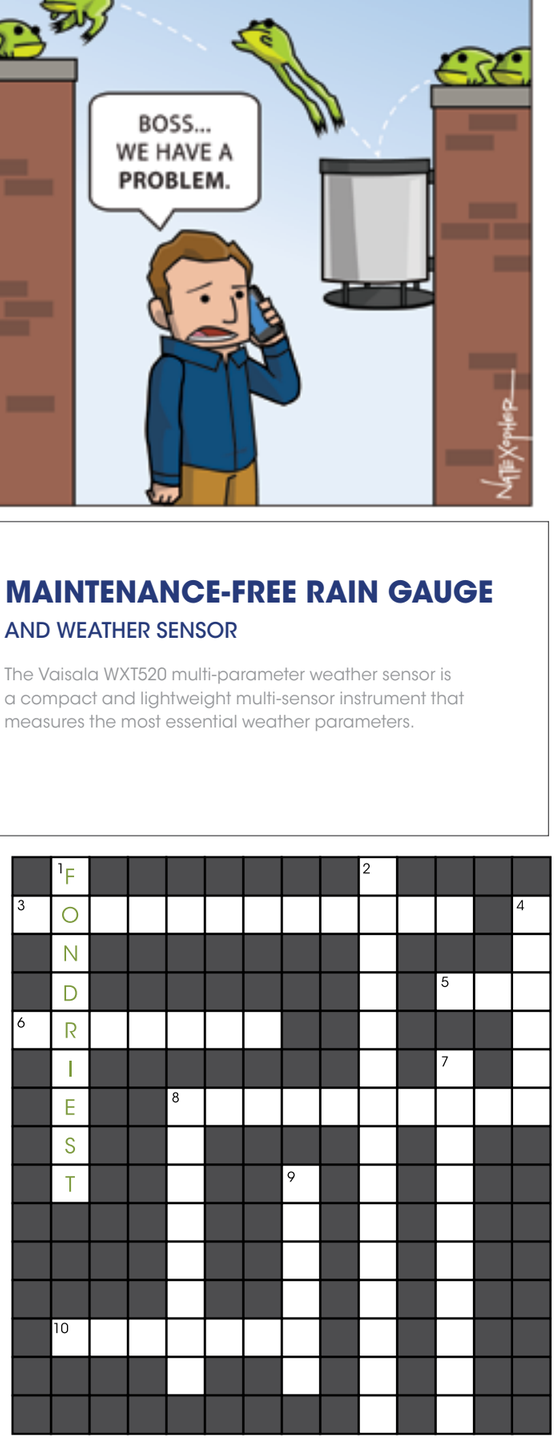
Freshwater Fish

Across

3. Predator known to feed on ducklings
5. Long, alligator-like mouths
6. Nicknames include "papermouths" and "specks"
8. In the Charr genus, despite common name
10. Light-reflecting eyes

Down

1. Where to buy a lake monitoring buoy
2. Largest member of the sucker family
4. Nicknames include "eelpout" and "poor mans lobster"
7. Highly invasive; most common aquaculture fish
8. Also known as "sunnies" or "bream"
9. Often confused with the walleye



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