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UNIVERSITY OF WISCONSIN SEA GRANT INSTITUTE UNIVERSITY OF WISCONSIN WATER RESOURCES INSTITUTE

INSIDE:

SEA GRANT RESEARCH

What's Eating Freshwater Ports?

RESEARCH LEADS TO ANSWER AND TO NATIONAL AWARD

It's a mystery to set a coastal engineer's heart aflame. Why are the steel piers, cofferdams, pilings and walls that form the bones of the largest port on the Great Lakes—the Duluth-Superior Port—corroding at an accelerated rate? The plot thickens when you consider that the corrosion levels were significantly higher than typically seen in fresh water and that other Great Lakes ports had not yet seen evidence of this in their own structures.

In fact, this mystery has set Gene Clark's ticker racing as he teamed with colleagues to get to the bottom of this premature, extensive and costly infrastructure failure mechanism. Pits and holes, some as large as a softball, dot the harbor structures. The first assessments identified 13 miles of corroded steel sheet piling and structures requiring replacement, estimated at $1,500 per lineal foot or $120 million in all.

The Duluth-Superior Port annually moves more tonnage than any other Great Lakes port. The projected value is $12.6 billion, supplying 73,719 jobs and representing $3.2 billion in personal income (figures from a 2011 study by Martin Associates). Something had to be done!

"I recall when I first learned about the problem, back in 2004," said Clark, Sea Grant's coastal engineer. "I was at a port meeting sitting next to Jeff Gunderson, then the assistant director at Minnesota Sea Grant. At the end of the engineer's

Corroding harbor structures at the Duluth-Superior Port posed an expensive mystery. Wisconsin Sea Grant's coastal engineer, Gene Clark, working with Minnesota Sea Grant and other partners, discovered both the cause and the solution.

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Aquatic Sciences Chronicle

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FEATURED **SOCIAL MEDIA + WEB**

Name That ROV

go.wisc.edu/31003l

A long and proud tradition in nautical history calls for naming the vessels that ply fresh and salty waters. The Aquatic Sciences Center would be remiss if it didn't also name its craft. Last year, the center's Information Systems Engineer James Grandt put his skills to use and built an underwater remotely operated vehicle (ROV) from an open-source kit.

Now, it's an open-call contest. This proud little craft needs a name. Send suggestions via email to linda@aqua.wisc.edu or through the U.S. Postal Service to the attention of Linda Campbell, Aquatic Sciences Center, 1975 Willow Drive, Madison, Wis. 53706. Suggestions must be received by Jan. 31, 2015. All suggestions will be entered in a random drawing to win an annual pass to Wisconsin's State Park System.

The ROV is a popular fixture at public events, including the annual Grandparents University at the University of Wisconsin-Madison, the Wisconsin State Fair and the Wisconsin Science Festival. ROVs can navigate to underwater places where human divers can't and help gather photos and/or water samples.

Watch a lively video at ASC's YouTube channel, **go.wisc.edu/31003l,** documenting the ROV's construction.

Terri Liebmann

The R.V. *Rover*? Name our ROV and enter to win an annual pass to Wisconsin's State Park System.

WATER RESOURCES RESEARCH

Matthew Weber

THE PLACE WHERE SURFACE AND GROUNDWATER MIX

LITTLE STREAM REVEALS SOMETHING BIG — AN UNRECOGNIZED HYDROLOGIC PROCESS

It was just supposed to be a routine groundwater monitoring exercise on a little stream in Barneveld, Wis. Instead, it opened up an unexpected research project on an unrecognized hydrologic process.

A couple of years ago, Steven Loheide, an associate professor of civil and environmental engineering with the University of Wisconsin-Madison, and his then-undergraduate student Matthew Weber went out to a stream in Barneveld to collect some general data on its flow.

They noticed something unusual almost immediately—the stream stage was unusually low compared to the remaining ice that was attached to the stream banks at a height more than double the current water level.

"It made us wonder—what's going on?" Loheide asked.

Several weeks of observation and data collection gave them the beginnings of an answer. The stream's dynamics were being heavily influenced by frequent ice formation and ice melt. It turned out that the formation cycle was occurring one out of every four days between December and February, and it was causing the stream depth to increase more than 100 percent as the ice cover slowed down the in-stream water velocity.

"We weren't out there to study this," said Loheide. "This is a process unrecognized in the literature. It's a big gap. We don't know the full importance, but we know it's definitely affecting in-stream hydraulics and potentially inducing hyporheic exchange."

Loheide is referring to the hyporheic zone, a mixed zone in a stream bed where surface and groundwater mix, creating critical chemical exchanges that have an effect on both the stream itself and the surrounding aquifer by filtering out contaminants and providing habitat for benthic organisms.

According to Weber, who's now a graduate student in California, it's possible these exchanges could be significantly altered by the frequent fluctuations in stream stage, and those changes could impact everything from sediment transport to benthic insect populations in spring.

"Because it's happening in winter, we wouldn't expect this to have a big impact on nutrient cycling," said Weber. "But if it's happening frequently—as it seems to be—the stage fluctuations will have an impact on streambed morphology and potentially affect benthic organisms like overwintering fish eggs and macroinvertebrates in the stream itself."

The dynamic could also have positive effects. One possibility is that increased winter ice regimes could be backing water up into the landscape, creating a reservoir and making more water available for ecosystems long after the ice is gone.

Loheide and Weber noticed the stream stage was much lower than the unmelted ice formation. That difference is what led them to discover a hyrdologic process that could profoundly affect groundwater exchange.

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Very (Lake) Superior Reading!

The mystique of Lake Superior is legendary. Many have described and photographed its towering cliffs, shipwreck sagas and stark wilderness. The Water Library has many titles about this majestic lake on all these topics and more. Send an email to **askwater@aqua.wisc.edu** and start exploring Lake Superior from the comfort of your favorite chair.

AROUND THE SHORES OF LAKE SUPERIOR: A GUIDE TO HISTORIC SITES

By Margaret Beattie Bogue. Madison, Wis.: University of Wisconsin Press, 2007.

Around the Shores of Lake Superior is an ideal trip planner and a unique guide to the region. As author Margaret Beattie Bogue follows the Lake Superior shoreline clockwise through Minnesota, Ontario, Michigan and Wisconsin, she evokes the richness of local history and highlights hundreds of landmarks and points of interest that surround the lake.

LAKE EFFECT: ALONG SUPERIOR'S SHORES

By Erika Alin. Minneapolis:: University of Minnesota Press, 2003.

The 2,900 miles of Lake Superior shoreline and its centuries of rich history are explored by Alin, who weaves together the social, cultural, ecological and geological events of this region in her essays.

SHIPWRECKS OF LAKE SUPERIOR

By James R. Marshall. Duluth, Minn.: Lake Superior Port Cities, 1987.

This collection of writings by and for divers and historians provides a look at Lake Superior's best-known wrecks. Intended as an overview, the book includes excellent underwater photos in color.

SUPERIOR PASSAGE

By Richard Thomas Coleman. Tucson, Ariz.: Wheatmark, 2006.

This is the gripping story of Shotty Murphy, who gives up a tedious desk job to pursue a life of adventure on a sailboat. While plying the cold waters of Lake Superior, a storm catches him off-guard and he must devise a rescue all on his own.

THIS SUPERIOR PLACE

By Dennis McCann. Madison, Wis.: Wisconsin Historical Society Press, 2013.

Picturesque little Bayfield on Lake Superior is Wisconsin's smallest city by population but one of its most popular visitor destinations. This book captures those unique qualities that keep tourists coming back year after year and offers a historically reliable look at the community as it is today and how it came to be.

If you wish to see more books on this topic, visit our recommended reading list at **go.wisc.edu/p8ow50**

Anyone in Wisconsin can check these books out. Please send an email to **askwater@aqua.wisc.edu**.

Narayan Mahon

Dirty Hands and Clean Water

Wisconsin Sends a Record Three Knauss Fellows

This year a record three Wisconsin graduate students were selected for the Dean John A. Knauss Fellowship—Caroline Mosely, Catherine Simons and Kristina Surfus. This competitive program matches highly qualified graduate students with "hosts" in the legislative and executive branches of government located in Washington, D.C., for a one-year paid fellowship. All three are graduates of UW-Milwaukee's School of Freshwater Sciences (SFS), and all three are tremendously bright and ambitious. They've come to the program from different directions, but each has extensive academic and field experience. To meet them, read on.

CAROLINE MOSLEY

Given that even her advisor has trouble keeping up with Caroline Mosley, Washington may want to think about preparing itself.

For the last two years, she's been helping Harvey Bootsma, an associate professor with SFS, with his research on the effects aquatic invasive species are having on Lake Michigan's ecosystem.

Well, that and maybe just a few things more.

"What impresses me about Caroline is her initiative and confidence," said Bootsma. "Over the two years we have worked together, Caroline has repeatedly surprised me by taking the lead on a number of high-profile outreach and service activities, including the organization of a Run4Water day, serving as president of the UWM Student Water Council, representing students on our school's Planning and Governance Committee and traveling to Guatemala to work with Engineers Without Borders on a water supply project."

"I can't keep up with all these initiatives," he added. "I usually learn about Caroline's involvement after the fact."

Did we mention that Mosley's also fluent in German and ran the Boston Marathon this year?

She was born in West Bend, Wis., and she dual-majored as an undergraduate at Creighton University in Nebraska. She began her educational career with designs on medical school, until sophomore year when a freshwater ecology course shifted her sights to environmental science.

"I've always been interested in applied science," Mosley said. "Fresh water is such an important resource. The pieces just fell into place," she said.

Her timing couldn't have been more opportune. She arrived at SFS just in time to watch the school invest millions in a new facility and several major water-based initiatives. Joe Fillingham, a former UW Sea Grant Knauss Fellow (2011) who's also working with Bootsma as a research assistant, encouraged Mosley to apply for the Knauss program.

"I'm happy there's a program like this for people like me," she said.

Mosley has always liked to work with her hands, which makes the scientific work she's been doing with Bootsma so perfect for her. She's spent the last two years examining the process of phosphorus recycling by profunda quagga mussels.

"Basically, I'm looking at mussel poop," she joked.

It's a flip assessment, given that the work she's doing is actually critical to understanding the massive changes the mussels are

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Wisconsin Sends a Record Three Knauss Fellows

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wreaking on Lake Michigan's food web. As the mussels drain the lake of nutrients at an almost alarming rate, Mosley and Bootsma's work could help us understand where those nutrients are going once the mussels have filtered them—potentially into the sediment, potentially converting to biomass.

It's a case where that hands-on approach she loves so much comes in, um, handy. On a recent collection trip, Mosley captured, cleaned and collected phosphorous samples from a whopping 500 mussels.

Working in an office, which is what she'll be doing as part of NOAA's executive team once her fellowship begins, won't give her nearly as much opportunity to get her hands wet and dirty, but she said she's prepared for the challenge. In particular, her experience with Engineers Without Borders in Guatemala has prepped her to work with people.

"I like expanding my horizons," she said. "So it'll be interesting to learn about the legal and policy side of things. I just keep finding more things to do."

From interning for a senator to completing two master's degrees (freshwater science and economics) and then to Sandra McLellan's lab at SFS, Kristina Surfus has the range of experience and education to make her an excellent candidate for a career in coastal research policy and management.

KRISTINA SURFUS

Kristina Surfus is drawn to water.

It's something she's always known about herself, but it was recently driven home as she searched for photographs of herself in response to a writer's request. Everything she could find included or was related to water: A picture of her kayaking on the tranquil Milwaukee River. A picture of her struggling through falling water in the Julian Alps in Slovenia. Even a professional photo of her taken in Milwaukee backdrops her against a window showing rain falling on the streets of the city, a subtle echo of her interests in sustainable urbanism and water management.

That love of water continues to drive her life, and it'll soon sweep her toward Washington, D.C. Surfus already has some Beltway experience under her belt—while she was an undergrad at Boston University, she served as an intern in the office of Oregon Senator Ron Wyden, where she got some first-hand experience with policy making.

"I'm excited to apply what I've learned in a legislative setting," she said of her return to the nation's capital. "I'm looking forward to getting more working experience in coastal resource management and a stronger sense of how it all comes together in the policymaking world."

When she began at Boston, she was a tentative biology major, unsure of her path. By the time she was done, she held degrees in international relations and environmental analysis and policy.

Surfus was born and raised in Milwaukee, but when it came to her post-graduate academic and professional development—a focus on urban planning and water resource management, please—she figured she'd have to search elsewhere, maybe toward the east coast again, to find just the right program.

But it turned out that it was in her front yard all along. SFS gave Surfus the opportunity to delve into freshwater economic policy. Most recently, Surfus has been working side-by-side with SFS Professor Sandra McLellan on a project examining the causes and economic impacts of degraded beaches in Milwaukee.

"Kristina's making great contributions to our Sea Grant project," said McLellan. "She does everything from dropping current meters into the lake to working on the economic analysis that will tell us what a healthy beach is worth. Her background and personality have allowed her to jump into all these activities and get results."

It's been a blast for Surfus as well.

"I've really appreciated the chance to work in a lab and do more of the research and lab work than I thought I would," she said. "It's been pretty remarkable how it's all worked out. I'm really excited to be exactly where I'm at."

Fresh on the heels of graduating from SFS with a master's degree in freshwater science, Surfus dove in to complete a second master's degree in economics, also at UW-Milwaukee, while continuing her research.

"Kristina exemplifies a truly interdisciplinary researcher who will be able to address some of our biggest challenges because she has well-rounded experience in both the natural and social sciences," said McLellan.

Surfus is aiming for a career that combines coastal research policy and management, and she'd love to return to the Great Lakes region to pursue it.

"I have a real passion and appreciation for the region," Surfus said.

CATHERINE SIMONS

Catherine Simons operates her life by a fairly simple and determined principle: If something looks like it's never going to work, make a way.

It's what she's used to navigate her winding and far-flung educational career, a road that's taken her from rural Boscobel, Wis., to Minnesota and Tanzania.

Immersing herself in the intricacies of the federal government's policy wing is something Simons has had her eye on for some time. She knew she had to bolster a social-science background with some hard science to reach her professional goals.

"It was an intentional leap to get my hands dirty with the science," she said. "I wanted to pursue something scientifically rigorous but [that] had policy implications."

That's what led her to SFS. Simons was listening to National Public Radio when she heard Jenny Kehl, director of SFS's Center for Water Policy, taking about international freshwater conflicts. She realized she'd found her ideal academic advisor.

Over the next few years, the two would team up on several projects related to international trans-boundary water-use issues, as well as Simons' master's thesis, which compared the water quality of tap and bottled water in ten major cities, including Milwaukee.

Simons also assisted UW Sea Grant social scientist Jane Harrison in surveying anglers about their reactions to massive cleanup efforts in the Sheboygan River Area of Concern.

"Catherine shows a strong commitment to environmental policy, practice, science and governance," said Kehl. "Her combined interests in science and policy are innovative, and she has high abilities in both, which is a rare combination."

Simons' interest in international economic and water issues actually began at a young age, inspired by a visit her family took to spend with her uncle, who was working at the time as an international development consultant in Malawi. Simons would return to Africa after graduating from high school in Manitoba, Canada, spending a year in Zambia working with street children infected with HIV.

While in Africa, she took several side trips, including a jaunt to Tanzania. It was like a bolt of lightning for Simons.

"I got off the train and was blown away," Simons recalled. "I thought, 'This is the most beautiful place I've ever seen.'"

Simons was especially drawn to the elegance of Swahili, Tanzania's national language. It's one of the reasons she chose to matriculate at the University of Minnesota, one of the handful of American universities that included it in the language program.

Minnesota also offered an unusual international student exchange program with the main university in Dar es Salaam, Tanzania's capital city. Simons filled out the appropriate forms ("it was probably more writing than I did for the Knauss program," she joked) and got accepted—only to discover that security issues in Tanzania caused the program to be cancelled.

So again, she found a way.

Under the guidance of sociologist Ron Aminzade, Simons developed her own undergraduate research project, eventually winning a $1,700 grant, combining it with her own savings and spending eight months researching the effects of invasive water hyacinth and decreased water levels on local communities living on the shores of Lake Jipe, a lake straddling the borders of Tanzania and Kenya.

"There were many complex issues beyond Lake Jipe's obvious environmental degradation, the most challenging being the divergent priorities of local stakeholders, the Tanzanian and Kenyan governments, regional industries and international NGOs," she said. "I learned that science and policy go hand in hand."

Since graduating from SFS with her master's degree in water policy in May, Simons has taken a trip to Turkey and Greece during which she attended an international economics conference, and she's eager to be back in Washington, D.C.—all the better to move toward one of her career goals: working for the United Nations.

"I'm anxious to get going on what my career path will be," said Simons. "If it involves international and water, I'd be set." —ARC

Tackling the Problem of Ghost Nets

Titus Seilheimer

Once they break free, they drift unrestrained, buoyed, submerged and battered by the wild waters and shifting ice sheets of Lake Superior. Yet they continue to entrap fish, waterfowl and marine debris, even though no fishermen will come to claim and clear them.

They're called ghost nets, and they're a problem in Lake Superior, where commercial and tribal fisheries depend on gill nets for their livelihood. In the Apostle Islands area alone, there are hundreds of commercial and tribal fish nets, spanning tens of miles. Sometimes, these nets come unmoored, creating hazards for wildlife and for recreational boaters and anglers.

Titus Seilheimer

Ghost nets can trap fish, wildlife and even humans. A new partnership is working together to produce workshops to educate commercial and tribal anglers on net-management practices and two educational videos for boaters to help them avoid nets and escape safely if they do become entangled.

To tackle the problem, Wisconsin Sea Grant has partnered with the Apostle Islands Sport Fisherman's Association (AISA) and the Great Lakes Indian Fish and Wildlife Commission (GLIFWC) Law Enforcement Team. Using a two-year, $25,000 investment from the National Oceanic and Atmospheric Administration's (NOAA) Marine Debris Program, the three groups will spend the next year organizing and holding a series of public workshops aimed at educating new commercial and tribal anglers on best net-management practices, as well as creating an educational video to detail the appropriate actions recreational boaters should take when they become entangled in a ghost net, or even a properly moored net.

Al House, a board member of AISA and member of Sea Grant's advisory board, estimates that although only one percent or less of commercial or tribal nets break free and become ghost nets, they still need to be addressed.

"These nets are depleting a resource that's finite," House said of the Lake Superior fish population, rich in valuable species like trout, cisco and whitefish. "The idea is to move quickly to protect it."

Currently, tribal fisheries have no requirement to report that their gill and trap nets have become unmoored. In some cases, several days may pass before a fisherman even notices that a net has broken free. Depending on what the ghost net encounters, it might float on the water's surface or sink to the bottom, trapping debris and fish life.

"The challenge is definitely finding them," said House. "They're worse than the proverbial needle in the haystack. The idea is also to find an accurate assessment of the scope of the ghost net problem—nobody knows how many or how few there are."

Eventually, the partners would like to develop and implement a GPS-based system for identifying, tracking and reporting ghost nets, as well as creating a second video on best-management practices fisheries can use to reduce gill net loss.

But the first step is education.

"This is really about raising awareness of how to be safe when you're fishing," said Titus Seilheimer, Sea Grant's fisheries outreach specialist and the project's principal investigator. "There's lots of sources of entanglement risk out there, and you may not know what you've become entangled in."

The safety video will include information for boaters on how to free themselves from any net, whether it is a ghost net or a properly moored one that a boater has blundered into.

The key is not to panic and to understand that the sooner you can extricate yourself, using the proper tools, the safer you will be and the less damage will be done.

House said the key to the project's eventual success is that it's designed as a partnership that involves the groups who most stand to benefit from raised awareness. That's why GLFWIC's support and involvement is so key.

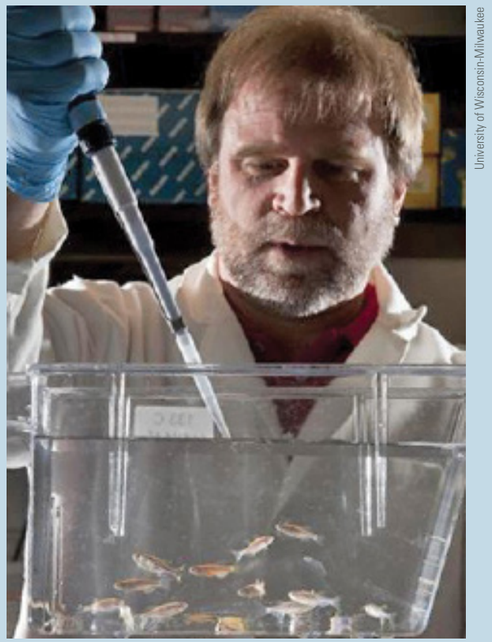
"We're not pointing fingers here," House said. "We're supportive of tribal and commercial fisheries, and their importance to the economy, and it's certainly not their fault that nets break free. We can cooperate and make the whole situation better."

Seilheimer agreed. "It's a win-win for both sides," he said. "Recreational anglers don't want to get entangled. For the commercial side, not losing your gear is a good thing."

Production on the first educational video is underway, and workshops are scheduled to begin early in 2015.—ARC

Dioxin Exposure—Dramatic Effect on Fish Sexual Development, Harm to Nose Tissues

Wisconsin Sea Grant-funded researcher Michael Carvan (right) and his research team fed both young rainbow trout and zebrafish food containing different levels of TCDD (tetrachlorodibenzo-p-dioxin) over a six-week period. Carvan, Shaw Associate Scientist at the University of Wisconsin-Milwaukee School of Freshwater Sciences, said their technique "more closely mimics actual environmental exposure to dioxin."



University of Wisconsin-Milwaukee

They found that 28 days of exposure to high doses of TCDD (100 parts per billion) caused lesions in the zebrafishes' noses, livers, kidneys, intestines and ovaries. The lesions in the fishes' nose tissue are concerning because fish use their noses to navigate through water and to find streams for spawning. While testing whether the fishes' sense of smell was impaired by dioxin exposure was not part of Carvan's research, he'd like to follow up to see if lesions lead to behavioral problems and impeded spawning success.

Another surprising finding was that dioxin acted as an endocrine disrupter.

"It had a dramatic effect on the development of the female zebrafish reproductive tract," said Carvan. "At higher dosage levels, we couldn't identify any female zebrafish. They all looked male."

Carvan said that rainbow trout are more sensitive to dioxin than zebrafish are. Because rainbow trout mature more slowly, researchers were not able to determine TCDD's impact on that species' reproductive tract, but Carvan suspects that their reproductive tracts would be affected by high levels of dioxin or dioxin-like chemicals.

Carvan said the amounts of dioxin they exposed the fish to were, "high for the average fish in Lake Michigan, but they're not necessarily that high for a fish found in a polluted environment."

For more information, see these articles:

- "Histopathic Alterations Associated with Global Gene Expression Due to Chronic Dietary TCDD Exposure in Juvenile Zebrafish," published on July 2 in *PLOS ONE* **go.wisc.edu/tdq963**
- "Gene Expression and Pathologic Alterations in Juvenile Rainbow Trout Due to Chronic Dietary TCDD Exposure," **go.wisc.edu/z73o9p** published in 2013 in *Aquatic Toxicology* — MEZ

Clean, Drain, Dry: On the Fishing Tournament Circuit With Jeremy Jones

Contributed photo

For the past two summers, Jeremy Jones has been on the front lines of Wisconsin Sea Grant's efforts to partner with fishing tournament organizers to raise awareness of the ways these events, and the anglers who participate in them, can prevent the spread of aquatic invasive species. In states like Minnesota, Michigan, Arkansas and, of course, Wisconsin, he's given AIS talks at tournament rules meetings, run boat washing stations and worked to recruit and train local support groups to run them. We caught up with him at the end of the summer, and here's a short excerpt of the conversation. For the full interview, see **go.wisc.edu/6983ks**.

So what have you seen change since you began this outreach project? I think what we've seen is an evolution in the thought pattern behind the tournament organizers, who are their own set of people. These are people who have to run a business—that's important to realize. They have a thin line to make any money and make sure it's a safe and fun tournament that also generates revenue for their anglers. These guys have evolved in their thinking—they view the AIS message very positively and they see it as something they want to embrace because they want to prevent any more regulation, and they also want to show they're good stewards of the resource. They also believe that AIS issues can affect the fishing itself, whether it's tarnishing the reputation of the tournament or through tarnishing the fishing itself.

I think that anglers are also continuing to embrace the message, continuing to get it. More and more, as we work longer with it, they're more willing to talk about it and more willing to talk with us, which is a huge stride. There's a pretty big gulf between the pro tournament anglers and the research that goes into AIS, and this outreach project has really bridged that gulf. So their patterns are evolving, and the hope is really in reaching the younger folks.

Where does the effort need to go from here? In terms of where we need to go from here, I think the essential message is out there. It is, at times, hard to find support groups, volunteers to take on the actual AIS prevention steps like running boat wash stations. Tournament organizers are our partners in this, and they're enthusiastic. The support group part is evolving—sometimes the support groups are there and sometimes they're not. As long as they get trained and they have some fun, learn a little bit about AIS and give some service, they tend to come back. If they're not there to begin with, they're tough to find. That's where the work is.—ARC

WATER RESOURCES RESEARCH

Surface and Groundwater

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On larger rivers, this type of ice-formation process creates troublesome ice dams and ice jams that can wreak havoc on docks and shoreline structures. In a small stream like the one in Barneveld, the effect isn't nearly as easy to see.

"The question we're pursuing is, how does it affect surface-groundwater connections?" Loheide asked. "We (scientists) haven't looked at how ice level affects that."

Having discovered the phenomenon in a single small stream, Loheide and a new graduate student will use funding from the UW Water Resources Institute to see if it occurs—and if so, how often and how it varies—in other geographic areas around the state.

"The new project looks at the bigger picture," said Weber. "What are the other conditions that allow for this to occur?"

More specifically, beginning in fall, the new student will pore over raw historical data collected by the U.S. Geological Survey using stage and ice regime changes to identify long-term trends. The second stage of the study, which won't begin until next winter, will involve measuring the ice regimes at five different sites in Wisconsin, looking specifically at the quantity of water exchanged between the stream and the adjacent aquifer. Finally, Loheide and his student will take what they've gathered back into the lab and model it. Given that the stream dynamics are tied to the length and severity of winters, which in turn are tied to the discussion on climate change, Loheide's work takes on an added significance.

"The exciting part of this project is that it's so new, Loheide said. "This is not like working out the third decimal point of a discovery that's already been documented. This is an entirely new process."—ARC

SEA GRANT RESEARCH

Award-Winning Port Research

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presentation, Jeff and I both looked at each other and asked, 'Did you know about this?' Neither one of us did but both knew our two Sea Grant programs could help with the science needed to solve the problem."

Fast forward to September, when the two Sea Grant programs celebrated national recognition for field and lab work that found solutions. The effort was named the winner of the 2014 National Sea Grant Association Research to Application Award in a competition open to 33 Sea Grant programs that attracted entries from nine states.

What were the antecedents to the award? Over several years, Wisconsin Sea Grant and the U.S. Army Corps of Engineers focused on repair, rehabilitation and corrosion-prevention techniques—coating small steel plates, known as coupons, with a variety of protective materials. Control coupons were left untreated. All coupons were placed in trays and submerged to assess harbor corrosion water-chemistry conditions, test the effect of ice abrasion and impact, and evaluate coatings to protect the steel. They also tested various wraps and jackets for piling protection.

Corroding harbor structures at the Duluth-Superior Port (left). Wisconsin Sea Grant's coastal engineer, Gene Clark (below), led the effort which solved the problem and protected the port for the future.

Success. Now, these wraps and jackets protect steel pilings while the coatings and outer steel plates protect the piers and walls. Coatings such as epoxies, paints and tars have been applied to more than 26,000 lineal feet of steel walls, saving an estimated $39 million. In 2014 alone, more than seven new projects or repairs of existing corroded walls were initiated using the technology and lessons learned.

Through the years and concurrent with field testing, Minnesota Sea Grant and U.S. Navy researchers searched for corrosion triggers. Bacteria and fungi were prime suspects. Results demonstrated that corroding steel structures were covered by complex microbial biofilms that contained bacteria responsible for steel corrosion in other environments.

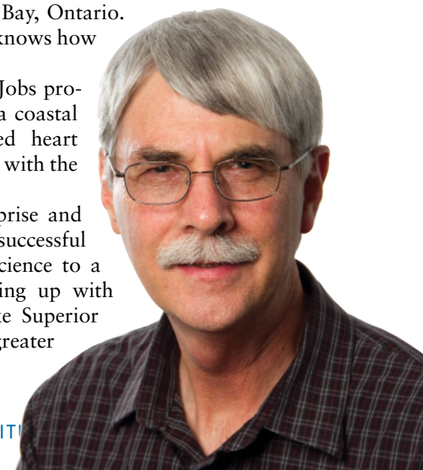
Through DNA analysis, researchers pinpointed the process by which specific iron-oxidizing bacteria attach to carbon steel, creating tubercles of biomass and corrosion products. Conditions beneath those tubercles cause copper dissolved in harbor water to precipitate and adhere to the iron. When ice chunks scrape against those pilings each winter, the tubercles break, exposing the copper-covered iron to oxygen. This causes the steel in those pitted areas to corrode at a faster rate.

Clark noted, "One of the nagging questions we had during the early stages of the studies was why is the steel corroding faster now than in the past? It turns out that the corrosion has accelerated since the 1970s, which is when we really started to clean up our harbor thanks to the Clean Water Act. The bacteria and the copper were always present, but perhaps we created the 'perfect storm' by providing for a cleaner environment in which the bacteria thrive."

Other Lake Superior freshwater ports have begun to see structural deterioration. Deeply pitted steel has been found in Two Harbors, Minn.; Ontonagon and Houghton, Mich.; Ashland and Bayfield, Wis.; and Thunder Bay, Ontario. Thanks to past work, Clark now knows how to advise those port managers.

Mystery solved. Money saved. Jobs protected. Award won. Plus, there's a coastal engineer with a now-normalized heart rate, unless you count his pleasure with the national accolades.

"The award is certainly a surprise and greatly appreciated. And this successful team effort of applying sound science to a very difficult problem and coming up with solutions that will save our Lake Superior ports millions of dollars is our greater reward," said Clark. —MH



ASC

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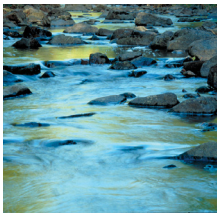

CALENDAR OF EVENTS

JAN. 21, 2015
The River Talks
Superior, Wis.
seagrant.wisc.edu

FEB. 22-27, 2015
Association for the Sciences of Limnology and Oceanography
Granada, Spain
sgmeet.com/aslo/granada2015/

FEB. 8, 2015
Lake Sturgeon Bowl
Milwaukee
glwi.uwm.edu/sturgeonbowl

FEB. 19 – 22, 2015
Aquaculture America 2015
New Orleans
bit.ly/1p95wt1

MARCH 5-6, 2015
American Water Resources Association – Wisconsin Section Meeting
Oconomowoc, Wis.
awra.org/state/Wisconsin

PUBLIC NOTICE:
Federal Review of the University of Wisconsin Sea Grant College Program

Wisconsin Sea Grant will undergo a program review by a site review team convened by the director of the National Oceanic and Atmospheric Administration-National Sea Grant College Program on April 21 and 22, 2015.

Members of the public are invited to email comments on the management aspect of the Wisconsin program or its engagement with stakeholders on or before March 21, 2015. Comments should be sent to **oar.sg.feedback@noaa.gov.**