2016 volume 3

ASC
Aquatic Sciences Chronicle

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

INSIDE:

David Nevala

WRI-FUNDED RESEARCHERS PLUMB DEEPLY TO PINPOINT THE SOURCE OF ONE OF WISCONSIN'S NEXT BIG WATER-QUALITY ISSUES.

UNRAVELING THE RADIUM RIDDLE

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Aquatic Sciences Chronicle
aqua.wisc.edu/chronicle

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The Aquatic Sciences Center is the administrative home of the **University of Wisconsin Sea Grant Institute** & the **University of Wisconsin Water Resources Institute.**

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University of Wisconsin Sea Grant Institute is part of a national network of 33 university-based programs funded through the National Sea Grant College Program, National Oceanic & Atmospheric Administration, U.S. Department of Commerce, and through matching contributions from participating states and the private sector. *seagrant.wisc.edu*

University of Wisconsin Water Resources Institute is one of 54 Water Resources Research Institutes nationwide authorized by the federal Water Resources Research Act and administered through the U.S. Geological Survey. *wri.wisc.edu*

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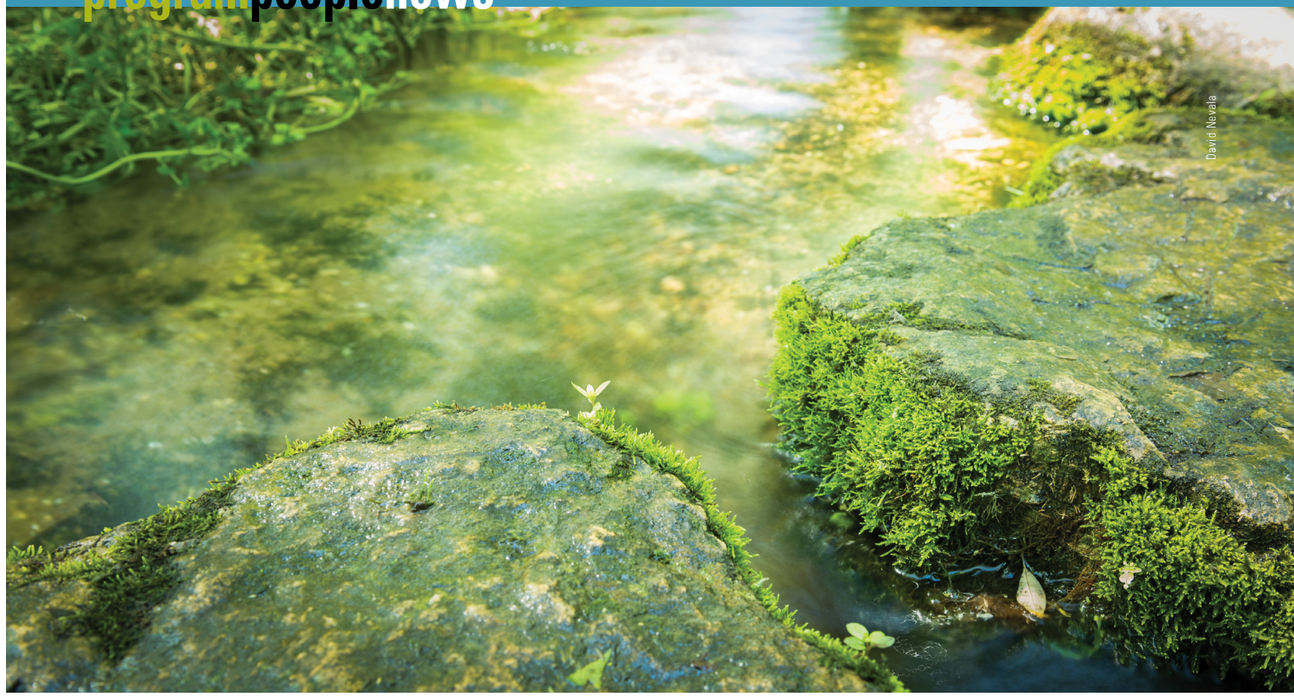
FEATURED **SOCIAL MEDIA + WEB**

Connect With the New Water Library Website

aqua.wisc.edu/waterlibrary

The Water Library has a modern new website with a wealth of water science. New content has been added especially for parents and educators. Among the additions are lesson plans for teaching water and Great Lakes science to kids from ages three to nine, full descriptions of new STEM kits and how to borrow them, and a map of where librarians have given programs. The old favorites are here too — reading lists by topic, upcoming library events, book request forms and the "ask water" feature. The site is also an easy way to connect to popular social media resources — Facebook, Instagram, Twitter and the Aqualog blog.

Chris Hynes Photography



David Nevala

New Studies Aim to Protect and Better Manage Wisconsin's Water Wealth

Three new groundwater research projects funded by the University of Wisconsin Water Resources Institute started in July.

- Throughout the north-central United States, including 95 public water systems in Wisconsin, people rely on the Midwestern Cambrian-Ordovician aquifer system for drinking water. It is a system that is contaminated, to various degrees, by the carcinogen radium. The source of radium in any given location is unknown, so avoiding it is difficult. Researchers are working to develop a relationship between sediment and aquifer geochemistry and the concentration of radium in groundwater.
- The bacterial community within a water system typically fulfills many functions, including naturally remediating contaminants and mobilizing heavy metals. Researchers will use a well field near the upper Fox River in Waukesha, Wis., to assess the effect, if any, of added nutrients on a water system's bacterial community. The study will offer insight not only on the physical dynamics of a water system but also the changing dynamics around septic systems, heavily fertilized farm fields, confined animal feeding operations and naturally remediated cleanup sites. This will also shed light on the fate and transport of pharmaceuticals.
- Additions of nitrates-nitrogen through septic or fertilizer inputs could enhance the concentrations of uranium in the groundwater of some central and northeastern Wisconsin communities. Researchers will sample wells in Portage, Marathon and Shawano counties to track changes in uranium levels when nitrates-nitrogen are added. Uranium is a naturally occurring element that is also a carcinogen, affecting mainly the kidneys.

wisconsinwaterlibrary

Getting a Read on a Slippery Issue

Did you know that overall domestic crude oil production has increased 38 percent since 2009? Production is outpacing pipeline capacity, putting increasing pressure on other forms of transportation, such as rail, truck and barge. These publications offer information about oil transport and spills for both children and adults.

ISSUES AND TRENDS SURROUNDING THE MOVEMENT OF CRUDE OIL IN THE GREAT LAKES-ST. LAWRENCE RIVER REGION

By the Great Lakes Commission. Ann Arbor, Mich.: The Commission, 2015.

This online report describes the dramatic growth in North American oil production and the associated increase in oil transportation to and through the Great Lakes and St. Lawrence River region. It covers a wide range of topics from the economic significance of oil to the region, the dangers of oil transportation and the policies and regulations governing the movement of crude oil.

glc.org/projects/water-quality/oil-transport/

OIL SPILL!

By Melvin Burger; illustrated by Paul Mirocha. New York: HarperCollins, 1994.

Beginning with the *Exxon Valdez* disaster, Berger introduces children to the causes of oil spills, the ecological damage they cause, and the ideas and technologies developed to deal with them.

OIL SPILL IMPACTS: TAXONOMIC AND ONTOLOGICAL APPROACHES

Edited by Yejun Wu. Boca Raton, Fla.: CRC Press, 2016.

Starting with the 2010 Gulf of Mexico Deepwater Horizon oil spill, this book focuses on the impact of oil spills and provides an understanding of these incidents using a number of approaches. It includes an interdisciplinary oil spill taxonomy and an oil spill topic map, and provides information-organization tools, such as indexes, taxonomies and topic maps.

OIL SPILL!: DISASTER IN THE GULF OF MEXICO

By Elaine Landau. Minneapolis: Millbrook Press, 2011.

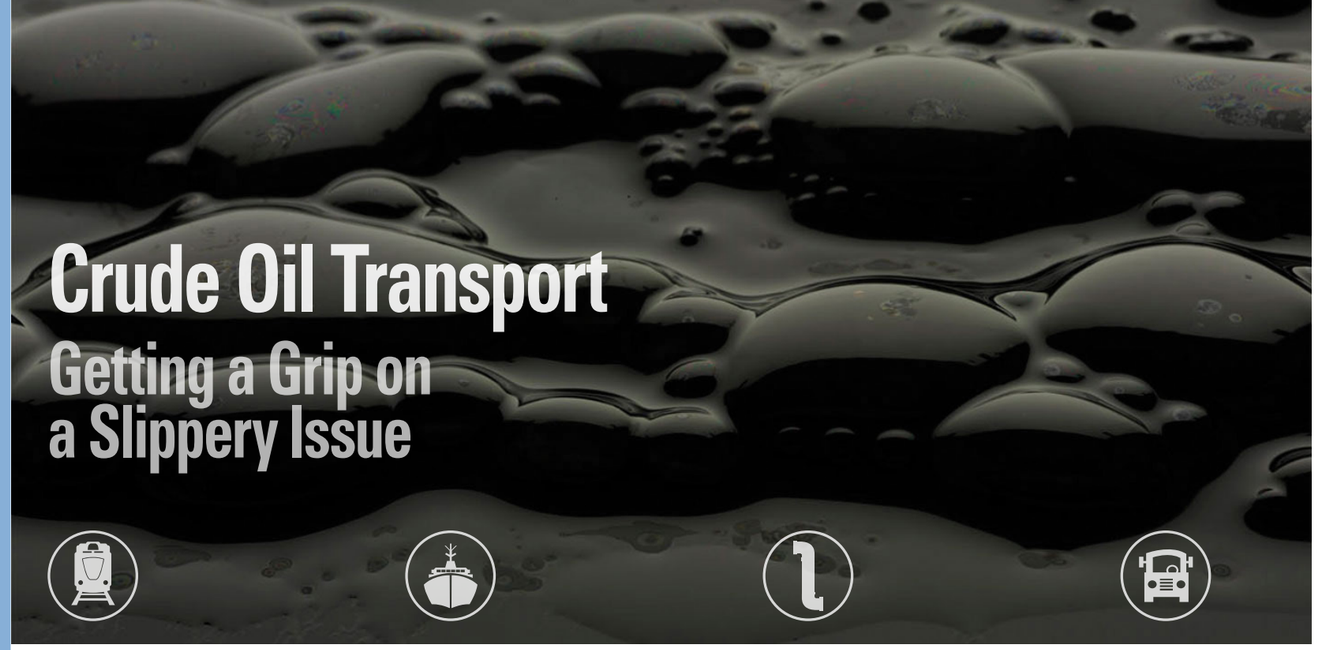
This children's book explores the BP oil spill in the Gulf of Mexico. With vivid images and diagrams, it illustrates how the spill happened, how it affected the Gulf and how it compares to past spills.

OIL, WATER AND CLIMATE

By Catherine Gautier. New York: Cambridge University Press, 2008.

Population and development pressures are at an all-time high, as are energy and water consumption. Anxieties over global and national energy, water and climate security are growing. This book provides the information readers need to understand and address these problems.

Anyone in Wisconsin can borrow these books. Just email **askwater@aqua.wisc.edu**.



Crude Oil Transport

Getting a Grip on a Slippery Issue

Greg Aylsworth / Ohio Sea Grant

"Technology and safety regulations of our transportation systems have not kept up with the amount and demand for oil."

What if the Great Lakes region required a substance that's explosive, flammable, toxic and capable of destroying entire ecosystems — even cities — in order to sustain its economy and way of life?

It does, and that substance is crude oil. It is traveling through the Great Lakes Basin in ever-increasing quantities, and its usage is so entrenched for agriculture, transportation and the plastics that surround us, there is no question it will continue to flow.

The Great Lakes Sea Grant Network (GLSGN), which includes Wisconsin Sea Grant, has developed a bi-national, collaborative body of experts from government agencies, industry, transportation, nonprofit organizations and academia to examine the potential consequences associated with different modes of transporting crude oil within the Great Lakes Basin. This group, called the GLSGN Crude Oil Working Group (COWG), is developing a research agenda and creating collaborative resources for outreach/dissemination and policy evaluation.

"Sea Grant recognized that crude oil transport is a really complex problem that has multiple different stakeholders," said Julia Noordyk, Wisconsin Sea Grant's water quality specialist. "There's a lot of opportunities and risks, and there are trade-offs between transportation modes. So what are those trade-offs and how as a region do we make those decisions and policies that are the best moving forward?"

The COWG developed a webinar series called Crude Move: Crude Oil Transport in the Great Lakes Basin to bring together all of the issues. The presentations are available online at **Go.osu.edu/crudemove**.

The risks of transporting crude oil are obvious. In July 2010, a pipeline carrying crude oil burst and spewed as much as 1.1 million gallons of heavy crude oil over the course of 18 hours into the Kalamazoo River in Michigan — the largest inland oil spill in U.S. history. It created a 35-mile oil slick that required neighborhood evacuations and took more than four years to clean up.

Environmental groups in Michigan are protesting a pipeline in another location — the 63-year-old Line 5 at the bottom of the Straits of Mackinac, where complex currents could allow any spills to spread throughout lakes Michigan and Huron with great speed. The 645-mile, 30-inch diameter pipeline originates in Superior, Wis.

Pipelines don't tend to be popular, especially among local residents.

"With most of the new-build pipelines, there are lots of protests out there," said Bradley Hull, professor at John Carroll University and speaker in the first webinar of the series.

However, in comparison to other methods of transportation, such as railway and trucks, pipelines have some clear benefits.

"Pipelines are definitely the most environmentally friendly way to move oil," said Noordyk. "They're the least carbon-intensive way, and while they can cause some really major ecological damage, they are not typically related to explosions and human catastrophes. Technology and safety regulations of our transportation systems have not kept up with the amount and demand for oil, and when you have a lot of these trains and trucks going through high-population areas safety really becomes a big concern. They can basically become a bomb if something derails or crashes."

That situation has already occurred. In 2013, a train carrying crude oil derailed in Lac-Mégantic, Quebec, Canada, and the ensuing explosion destroyed about half of the downtown, contaminated the rest and killed 47 people. Flaming oil ran into storm sewers, contaminating the water treatment plant and causing explosions inside the storm drains.

The COWG hopes to enable stakeholders and policymakers to cooperatively make the difficult decisions by providing the information they need. This could be in the form of a computer model that would encompass all the possible transport options and their benefits and drawbacks.

"We would use that model to come up with the best possible routes so that things don't just happen on their own," said Hull. "Decision-makers would have a little more guidance toward economic, social and environmental goals."

Given that the movement of crude oil in the Great Lakes Basin isn't likely to decline and is even projected to increase, a proactive approach becomes even more important.

"The fact is that crude oil is moving in more and more quantities and it's not going to stop," said Noordyk. "We have choices as a region as to how we want it to develop."—EAW

OUTREACH

Sunlight breaks down the molecules of chemical contaminants in water. The question is, how long will it take?

A Ray of Light

Sunlight streams down onto the waters of the St. Louis River Estuary, glistening and reflecting off the surface.

It's beautiful, yes, but there's something else going on here, too: The sunlight's breaking down the molecules of chemical contaminants that have seeped into the estuary through runoff and wastewater effluent.

The natural process is known as photolysis, and it could be an important key to the health and recovery of waters not just in Duluth/Superior, but all across Wisconsin.

Backed by funding from Wisconsin Sea Grant, Christy Remucal, an assistant professor of civil and environmental engineering at the University of Wisconsin-Madison, is part of a team that's measuring and mapping the ways light is breaking down five pharmaceuticals and personal-care products — the insect repellent DEET; carbamazepine, a common anti-epileptic drug; sulfamethoxazole, an oral antibiotic; the antidepressant drug fluoxetine; and atorvastatin, which is used to treat high cholesterol. Four of the five have chemical compounds Remucal said will be easy to work with and study; the fifth, carbamazepine, a compound Remucal characterized as a "bad actor" is both prevalent and extremely difficult to break down, making it an attractive research target. The list of contaminants could evolve further as the project progresses.

Photolysis can occur in two different ways. It can occur directly, as the rays of light hit the contaminant molecules near the surface of the water and begin the breakdown process. It can also occur indirectly, a process through which different types of dissolved organic matter (plant, bacteria, etc.) in the water absorb light to create radical species that attack and break down the contaminant molecules.

Each process takes a different amount of time to occupy.

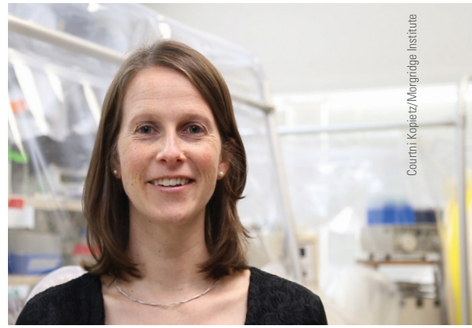
"What we're after is the answer to the question, if pharmaceutical X ends up in your water, how long will it stay there?" Remucal asked. "As you can imagine, a lot of different variables go into that answer."

The first is the sunlight itself, since levels of sun in Wisconsin vary wildly, depending on whether you're talking about July or January. The bigger and more important one is the amount and chemical composition of dissolved organic matter that's present in the water. That's one of the reasons Remucal is excited to study the St. Louis River Estuary system — the dissolved organic matter chemistry changes dramatically throughout the system.

"We're trying to relate the chemistry of the dissolved organic matter throughout the whole system with ultimately being able to predict how fast pharmaceuticals and other contaminants will dissolve."

In the upper part of the estuary, the organic matter is largely plant-based. Closer in to Duluth and the harbor, wastewater effluent is one of multiple contributors. That diversity is likely to yield results that could transfer easily to other bodies of water in Wisconsin and even other states. It's also a project that could be replicated to predict what might happen with a growing list of pharmaceutical contaminants.

"There is no shortage of things to work on," Remucal explained.



Courtni Kopietz/Morgridge Institute

Christy Remucal is part of a team that's measuring and mapping the ways light is breaking down five pharmaceuticals and personal-care products.

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WATER RESOURCES RESEARCH

Unraveling the Radium Riddle

Continued from page 1

Over the last several years, the city of Waukesha, Wis., has become the poster child for requests to divert water from Lake Michigan under the Great Lakes Compact, in part because it's also the poster child for something else: Communities built on sandstone-based groundwater aquifers with higher than normal concentrations of radium, a radioactive contaminant that can increase the incidence of bone cancer.

But Waukesha's hardly the only Wisconsin community struggling with radium issues. There are areas of eastern Wisconsin, stretching up as far as Green Bay, in a similar situation. Even in Madison, where water quality is considered generally high, water utility officials recently investigated a municipal well because standard testing revealed that it exceeded — barely — the limit of 5 picorcuries of radium per liter the federal government established in 2000.

> "…maybe, if we get smarter about where we case the wells and where we pump the well water from, maybe we can avoid some of the problems."

"Radium has become a significant issue for municipalities," said Madeline Gotkowitz, a hydrogeologist with Wisconsin's Geological and Natural History Survey. "Every utility wants to provide drinking water that supports human health."

In August, Gotkowitz and Matt Ginder-Vogel, an assistant professor of civil and environmental engineering with the University of Wisconsin-Madison, began using a two-year grant from the University of Wisconsin Water Resources Institute to examine water samples taken from 22 monitoring wells in and around Dane County to try to determine the geological strata that contribute to elevated radium levels in groundwater.

"Like iron and calcium and manganese, the radium that's present is all natural," said Ginder-Vogel. "Figuring out where it's coming from is the big issue."

Gotkowitz and Ginder-Vogel enter the project with a couple working hypotheses. The radium could be a matter of simple geography: Uranium and thorium are the elemental parents of radium, and both are prevalent in the carbonate-cemented sandstone aquifers that underpin much of eastern and south-central Wisconsin. Interbedded shale deposits scattered throughout the aquifer could also be a key factor in the equation.

But natural geology may be only one of the possible sources. Gotkowitz and Ginder-Vogel will also be looking at deep brines near the base of the sandstone aquifer. These possible radium sources are tougher to detect because they're so far below the surface.

"Is it coming from the carbonate-cemented sandstone, in which case it's everywhere, and we're out of luck?" asked Ginder-Vogel. "Or is it these interbedded shale layers, and maybe, if we get smarter about where we case the wells and where we pump the well water from, maybe we can avoid some of the problems."

For instance, if shale's the eventual culprit, Ginder-Vogel suggested that communities could case their wells to prevent radium seepage. If the source is a combination of deep brine and geologic features, reducing well depth could offer a practical solution.

"If utilities only need to abandon the bottom 100 feet of a municipal well, the well may still provide enough volume of water to meet their needs," said Gotkowitz.

David Nevala

Even though radium's been present in Wisconsin groundwater for decades, research on the topic has been scarce. Determining the radium concentration in water samples is typically an expensive and time-consuming proposition, requiring large volumes of water, making lab studies of natural materials difficult, said Ginder-Vogel.

To deal with their radium problems, many communities, including the aforementioned Waukesha, have relied on blending strategies — taking water from a contaminated well and blending it with water from a non-contaminated reservoir, dissipating the radium to safer levels. That's not a viable strategy for cities like Madison, where transporting water from one side of town to the other is inefficient.

"Municipal wells are so big that it's hard to pull something like that off," Ginder-Vogel said.

In the second year of the WRI-funded study, Gotkowitz and Ginder-Vogel will compare the groundwater quality data they've collected to the chemistry of geologic samples held at Wisconsin's rock core library in Mount Horeb, to further characterize the areas of the state where radium levels are most likely to be problematic.

"It all comes down to, what's the most cost-effective way to provide safe water to the community?" stated Ginder-Vogel. "We've gotten pretty good at removing radium from water. But if, instead, you can construct your well a little differently up front, the price differential in a well might be a few percentage points higher, but that's better than having to spend millions of dollars in treatment costs on the back end." —ARC

SEA GRANT RESEARCH

A Ray of Light

Continued from page 7

Remucal is working with Kristine Wammer, an associate professor of chemistry at the University of St. Thomas in St. Paul, Minn. The project doesn't officially begin until next February, although Stephanie Berg, a recent University of St. Thomas graduate, began collecting water samples in the estuary in

August. Remucal's lab will characterize the size and distribution of the dissolved organic matter in the samples, including using high-resolution mass spectrometry to determine how it absorbs light. Wammer's lab will perform the water chemistry experiments that link the information together. The team plans to collect samples at different times throughout the year to account for changes in sunlight levels and organic matter composition.

The study's results could end up creating a tool resource managers, both in the estuary and beyond, could use to direct and prioritize their remediation efforts.

"What we're likely to find is that photodegradation is going to happen really fast, and that could mean we don't need to worry about the contaminant, or, because of the chemistry of the water or the location of the contaminant, photodegradation is going to take a really long time. If that's the case, maybe we need a better treatment process."—ARC

OUTREACH

St. Louis River Speaker Series Concludes Third Year

A special bonus River Talk featured different rivers than usual. Adventurer Natalie Warren recounted her 2,250-mile canoe journey from Minneapolis to Hudson Bay.

Almost 190 people participated in informal discussions about the St. Louis River along the Wisconsin-Minnesota border this past year. Topics ranged from the animals found in the estuary, to ongoing restoration projects, to how to put a dollar value on the services and natural areas the river watershed provides.

The talks were held at the Vikre Distillery in Duluth, Minn., and Barker's Waterfront Grille in Superior, Wis. This year, Minnesota Sea Grant joined partners Wisconsin Sea Grant and the Lake Superior National Estuarine Research Reserve in the project. The organizations are working on plans for next season's series.

Habitattitude
PROTECT OUR ENVIRONMENT
DO NOT RELEASE FISH AND AQUATIC PLANTS
TM

No Release — Habitattitude Continues to Prevent AIS

That sweet feeling of Habitattitude will last, thanks to a continuation of a grant from the Great Lakes Restoration Initiative.

For the past several years, Tim Campbell, Wisconsin Sea Grant's aquatic invasive species specialist, has been involved in the national public education campaign to warn the public about the dangers of releasing exotic species — from koi to classroom crayfish to invasive plants — into the environment. The original outreach message was broad and effective, but now it's time to focus.

"We'll be targeting groups like teachers, retailers and pet store employees," explained Campbell. "We want everyone who might get a request from someone looking to surrender a pet to know exactly what to do so that a pet never gets released."

Over the next year, Campbell and the other members of the Habitattitude Surrender Collaborative, including existing partners like Jamie Kozloski of Kingdom Animalia Exotic Pet Rescue and new ones like the Green Bay Aquarium Society, will work on developing classroom curriculum/lesson plans to train teachers who use exotic and aquatic invasive species in their classrooms. They'll also conduct workshops and online trainings, and visit pet shows and pet stores to gauge how much people already know about Habitattitude. Finally, the grant will also allow Wisconsin Sea Grant to host a second Great Lakes Briefs on Invasive Organisms Traded in Commerce Symposium in Milwaukee in 2017. The symposium will convene invasive species experts from across the country to share information on how to best manage invasive organisms in trade and how to implement Habitattitude.

EDUCATION

Wisconsin Teachers Trade Whiteboards for Whitecaps

Five Wisconsin teachers spent six days on Lake Superior this summer in the name of Great Lakes science literacy. The teachers joined 10 others as part of a Shipboard Science Workshop aboard the R/V Lake Guardian that departed from Duluth, Minn., in July.

The workshop, hosted by the Center for Great Lakes Literacy, was for fourth- through tenth-grade teachers and nonformal educators from the Great Lakes region. The teachers worked with research scientists on projects; explored lake ecology, geology, geography, weather and water quality; and learned about resources they can use in their classrooms.

The teachers were Quan Banh, a high school teacher from Prentice, Wis.; Kathy Biernat, a middle school teacher from Elm Grove, Wis.; Lori Danz, a high school teacher from Superior, Wis.; Deanna Erickson, education coordinator for the Lake Superior National Estuarine Research Reserve in Superior; and Jacob Peterson, an elementary school teacher from Boyceville, Wis.

The teachers have brought their new knowledge back to their classrooms and school districts this fall. Here are two testimonials from some of the workshop applications:

"I grew up near the Atlantic Ocean and had little to no experience with lakes as a child," said Biernat. "But I married a man from the Milwaukee area, spent my honeymoon on a lake in northern Wisconsin, and became a lake-lover. As a general science teacher for fifth- through eighth-grade students who live half an hour away from Lake Michigan, it is crucial for me to help students appreciate the Great Lakes."

Biernat also plans to help other teachers through presentations at professional conferences.

Danz was looking forward to learning more about her "backyard."

"Living on the shores of Lake Superior, I like to think I have a strong knowledge of our Great Lakes, especially Lake Superior. But every time I attend a professional development class related to the lakes, I discover there is much I do not know."

She is applying what she learns to the School District of Superior's outdoor education curriculum to share her knowledge with other teachers.

The Shipboard Science Workshop is coordinated by the Great Lakes Sea Grant Network and the U.S. Environmental Protection Agency's Great Lakes National Program Office. Funding comes from the Great Lakes Restoration Initiative. For more information, visit: **cgll.org/opportunities**.—MEZ

Kristin TePas / Illinois-Indiana Sea Grant

Tracy Leavenworth, an informal educator with the Ramsey-Washington Metro Watershed District in Little Canada, Minn., enjoys a hands-on project during the workshop.

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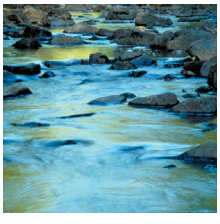
a joint newsletter from UW Sea Grant and UW Water Resources



CALENDAR OF EVENTS

OCT. 16-19, 2016
Upper Midwest Invasive Species Conference
La Crosse, Wis.
umisc.net

OCT. 18-22, 2016
North American Association for Environmental Education
Madison, Wis.
naaee.org/conference

NOV. 9-11, 2016
Wisconsin Association for Floodplain, Stormwater and Coastal Management Conference
La Crosse, Wis.
wafscm.org/annual-conference

NOV. 13 – 17, 2016
AWRA Annual Water Resources Conference
Orlando, Fla.
awra.org/meetings/Orlando2016/

DEC. 10-15, 2016
8th National Summit on Coastal Restoration and Management
New Orleans
go.wisc.edu/xw7542

START SAVORING WISCONSIN FISH

Eatwisconsinfish.org recently relaunched with new navigation, bright images and plenty of recipes. Arctic char with lemon-almond sauce, smoked fish spread or root vegetable hash with lake herring? There are also tips on preserving fish.

Those prep ideas are just one of the six areas of the website, which also includes information on why eating local fish is a healthy and delicious choice that also keeps dollars in local economies, and a detailed list of Wisconsin's fish; producers, which introduces Wisconsin's fishermen and fish farmers; resources, which offers a seasonal buying guide and a state map indicating where to get fresh fish; events; and about the Eat Wisconsin Fish initiative.