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The Swale Tale

How an unusual Door County landscape is helping researchers learn how Great Lakes water levels affect groundwater and forests in coastal areas

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Aquatic Sciences Chronicle

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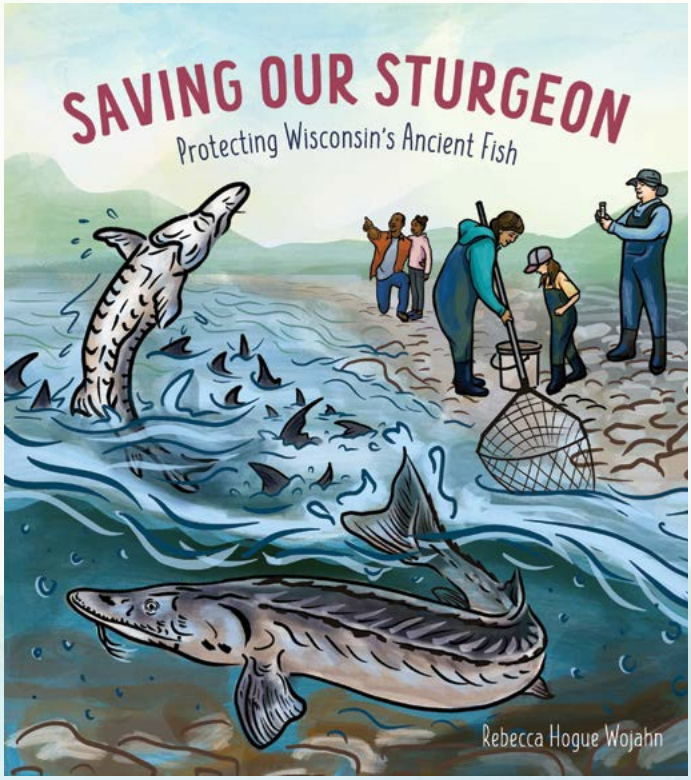
On the cover: The Ridges Sanctuary has 30 or so swales and crescent-shaped ridges that line the sanctuary from west to east.



Children's book celebrates sturgeon conservation in Wisconsin

By JENNA MERTZ

Call it a fish story, but author Rebecca Hogue Wojahn's latest book is absolutely true.

Released on August 19, "Saving our Sturgeon: Protecting Wisconsin's Ancient Fish," tells the story of how conservation efforts rescued lake sturgeon from extinction in Wisconsin. With kid-friendly illustrations, photos, and maps, the book explains how factors like overfishing and dam building threatened sturgeon survival and how people banded together to save – and continue to support – the iconic big fish.

Anne Moser, Wisconsin Sea Grant education coordinator and senior special librarian at the Wisconsin Water Library, served as a consultant on the book. She kickstarted the project by pitching the idea to the Wisconsin Historical Society Press in 2022.

"For many years, I've travelled to libraries and learning centers across the state teaching kids about Great Lakes fish and fishing, and their eyes always light up when I talk about lake sturgeon – how big they are, how they have barbels and scutes and how they can live to be 150 years old," said Moser. "The conservation story shows kids how they can make a difference, and Rebecca was the perfect writer to bring that story to life."

Wojahn, herself a public school librarian, has written several other science and animal-themed books for young readers. And while she didn't initially know much about sturgeon, she felt drawn to the topic.

"It was a really good fit for me because most of my life I've lived in Wisconsin, and I love the outdoors," she said. "It's history, it's science, it's everything I love."

Wojahn did extensive research to write the book, digging through archives and conducting interviews with biologists, members of the Menominee Indian Tribe of Wisconsin, and volunteers of the Sturgeon Guard who work to prevent poaching at spawning sites. She also made it a point to experience sturgeon in person and travelled across the state to visit hatcheries, observe spawning and spearing, and release baby sturgeon into Lake Michigan.

Wisconsin Sea Grant fisheries specialist Titus Seilheimer fact-checked the book, and of course, Moser was a big help. "Anne, as every librarian will, gave me tons of resources," said Wojahn.

One of those resources was "People of the Sturgeon: Wisconsin's Love Affair with an Ancient Fish," a book written by former Wisconsin Sea Grant staff members Kathy Kline and Fred Binkowski and retired sturgeon biologist Ron Bruch. The book, which was written for adults and published in 2009, served as a launching spot for Wojahn, who wrote "Saving our Sturgeon" to be appealing and accessible to readers aged 11 and up. Luckily, knowing what young people read is, quite literally, Wojahn's day job.

"I've always felt that being a school librarian has been a huge secret weapon for my writing because I am interacting with my audience," she said. "I can tell when their eyes glaze over and when they're like, ooh!"

Both Wojahn and Moser said the story of the sturgeon is a special one, in part because it's a rare conservation success story. Returning the lake sturgeon to Wisconsin's waters took decades of hard work from many dedicated people, and the book shows young people that they, too, can get involved and have an impact.

Wojahn also hopes readers feel a sense of wonder. "There are so many wild creatures that you may not even know about that need their space in our state, too."

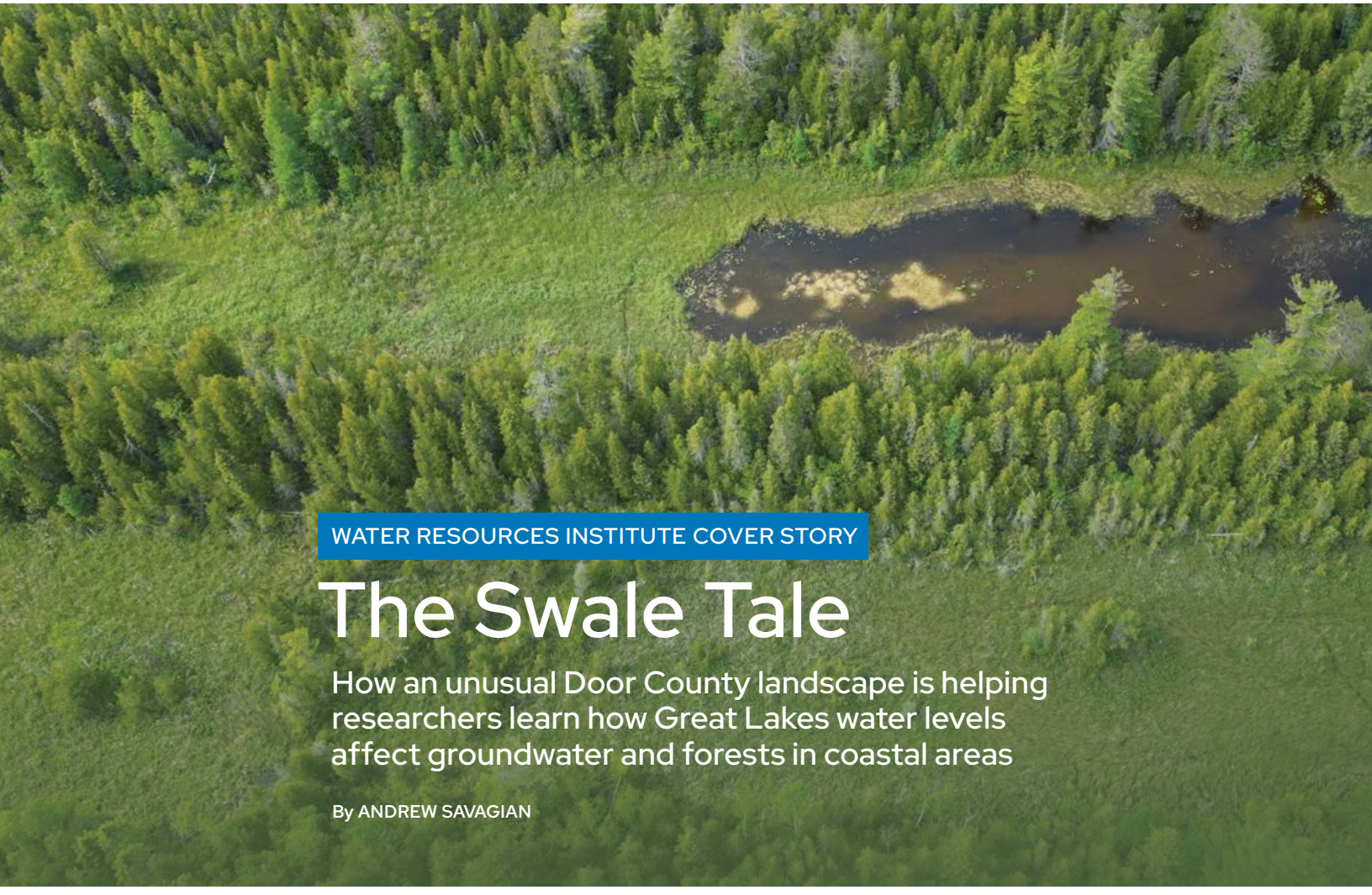
You can purchase the book at the Wisconsin Historical Society's online store or at your favorite bookstore. ■

Rebecca Hogue Wojahn, School librarian and author of "Saving our Sturgeon"

Left: In the spring, sturgeon move upriver to spawn. Hundreds of fish thrash through the water.

Right: Student volunteers slide the sturgeon down a tarp back into the Wolf River.

Illustrations by Camille Davis/Cricket Design Works



WATER RESOURCES INSTITUTE COVER STORY

The Swale Tale

How an unusual Door County landscape is helping researchers learn how Great Lakes water levels affect groundwater and forests in coastal areas

By ANDREW SAVAGIAN

Steven Loheide, Professor, UW–Madison

Above: The Ridges Sanctuary has 30 or so swales and crescent-shaped ridges that line the sanctuary from west to east.

Landscapes tell a story. That can be obvious to the casual observer traveling around the state, whether it's taking a scenic fall drive through the Driftless Area in southwest Wisconsin, exploring the potholes and drumlins of Kettle Moraine State Forest near Milwaukee, or kayaking among the water-etched sea caves off Lake Superior's Apostle Islands.

To the trained eye, these landscapes may also provide answers to important questions. University of Wisconsin–Madison Professor Steven Loheide, graduate student Eric Kastelic, Freshwater@UW summer students Lucie Carignan and Ella Flattum, and collaborators are focusing their collective scientific gaze on a particular section along Door County's southeast coast for clues to a decades-old question: How are wetlands and forests along the coast connected to the water levels of the Great Lakes?

The Ridges Sanctuary is a 1,700-acre nature preserve tucked along the bottom half of Door County as it pokes into Lake Michigan just above the community of Baileys Harbor. Initially established in 1937 as Wisconsin's first land trust, the sanctuary is a National Natural Landmark noted for a rich concentration of rare plants, including 25 species of orchids. What really sets this place apart from other preserves, however, is the 30 or so crescent-shaped ridges and marshy swales that line the sanctuary from west to east.

These are the areas where Loheide, Kastelic, and team have concentrated their efforts. The sandy formations represent former beaches that were left behind as Lake Michigan water levels dropped at different times in the past. Each is peppered with black and white spruce, balsam fir, and white pine. Between these ridges are swales, which are wet, lower areas, each containing their own collection of diverse marsh and bog flora.

> "What we're interested in is how the Great Lakes and the changing water levels within the Great Lakes affect the ridge and swale ecosystems," said Loheide. "There's a tight connection between the surface water, the Great Lakes, and then the groundwater, which is underneath the subsurface but is feeding the wetlands and forests."

Scientists have known for some time that water levels fluctuate in all five Great Lakes. Historically they change not just annually but over several decades, with the record high being more than 6 feet higher than the record low. What Loheide and his fellow researchers are most interested in are more recent water level changes.

"On short, seasonal scales, you might have a foot of variability from high water levels in one year to low

water levels in that same year," explained Loheide. "But when you look at it at a longer time frame, we see that there are cycles. For instance, in the early 2000s through about 2012-2013, we were in a low water state. That whole time, there were still ups and downs every year, but we were at low water levels, and then we went from near record lows then to record highs in 2017, 2018, and 2019. That really quick swing is something that we're interested in.

"There's always been a lot of variability, but we're seeing what seems to be sometimes faster changes from low water level conditions to high water conditions, so more extremes. And we're actually going through the same thing right now," said Loheide. "The high-water levels of 4-6 years ago are now dropping to below average water levels on Lake Michigan."

Those faster water level changes could have greater impact on coastal ecosystems, and that's where Loheide's team has zeroed in their research efforts.

"Even since last year, lake levels have gone down about 10 inches. What does that mean for the groundwater system? Are we draining water out of the groundwater system? How much change in storage is there in our groundwater resource, and how does that affect other hydrologic and ecological processes?"

Not just water and systems may be impacted, Loheide added. "We've been studying trees and groundwater in Wisconsin for over a decade now, and we've been surprised by some of the things we've learned, that groundwater is used by trees. Even in a wet climate like Wisconsin where we get a lot of rain, we're seeing that trees, particularly if they're in sandy soils that drain really quickly, do depend on shallow groundwater, and if they have access to shallow groundwater, they do better."

Given we know Great Lake levels fluctuate and those levels are connected to our coastal ecosystems, the team is looking at the Ridges and those funky swales lining the landscape to help them sketch out the rest of the story. "Our interest in the swales is knowing that we have lake levels that are driving changes in groundwater levels, how does that affect the ecosystem?" Loheide noted. "How does that affect tree growth? How does that affect whether the forest might be vulnerable to either drought conditions where there's limited water availability and the trees don't have access to shallow groundwater, versus what happens during really high lake stages, and you end up with the roots of the plants being saturated, having low oxygen availability that can be fatal to the trees?"

continued on page 14

Top center: Kastelic and Carignan measuring surface elevation with an RTK-GPS at the Ridges Sanctuary. This tool allows them to measure position in the landscape within 2 cm, including elevation.

Top right: Data are collected and viewed in real time via an app.

Bottom center: Kastelic holds a tree core sample from a red pine.

Bottom right: Kastelic and Carignan coring pine trees with an increment borer. This tool is designed to not harm trees in the coring process.

Summer Research Program Gives Students Hands-On Experience

Alison Mikulyuk, Research program coordinator, Freshwater@UW

Each summer, the Freshwater@UW Summer Research Opportunities Program brings together around 30 undergraduate students from across the 13 Universities of Wisconsin schools – and beyond – for an unforgettable summer of freshwater research. While they are here, they work with mentors across the state to conduct real research relevant to the environment and communities of Wisconsin. They participate in the program's professional development seminar and work together to build a lasting network of early-career colleagues. Staff at the ASC were excited to learn along with them as they explored Wisconsin's lakes, rivers, wetlands, and groundwater.

For many participants, the program is more than a summer job – it's a life-changing catalyst for the future. Alison Mikulyuk, the program's coordinator, is quick to point out the connections she's observed between early research experiences and later career success. She also sees the program as a celebration of collaboration across the Universities of Wisconsin.

"I was extremely impressed by the work these young researchers presented at the Freshwater@UW Summer Research Symposium," she said. "Not only were they able to realize some truly remarkable research findings in nine short weeks, their flash talks painted a beautiful picture of the variety and quality of freshwater research conducted in our state."

For a look into the experiences of three of these summer students, see the profiles on the following pages.

See the Freshwater@UW web page in November to learn more and apply for the 2026 summer research opportunities. **go.wisc.edu/ij9z9v**

Flattum and mentor Breunig use a Guelph permeameter to measure water conductivity.

Ella Flattum

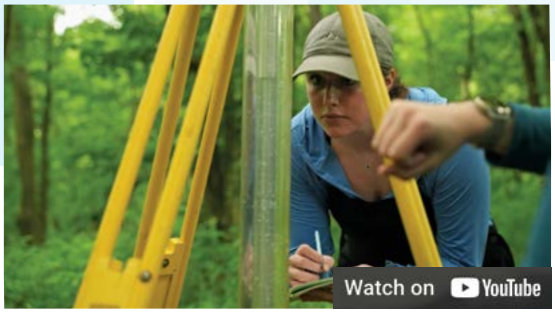
Environmental Science and Conservation/Ecological Biology
UW-Platteville

Ella Flattum worked with mentor Rachel Breunig (a graduate student in the Geoscience Department at UW–Madison) focusing on a soil called "loess" (wind blown silt) at Wyalusing State Park. Flattum is originally from Appleton, Wis., and has worked in the dendrochronology lab at UW–Platteville for the past three years. Flattum also contributed to the research described in the cover article (page 3).

During fieldwork Flattum set up a Guelph Permeameter, which lets water seep into the soil until it hits a steady state, allowing scientists to measure how fast the water is actually moving through the subsurface sediment. There's a lot of loess in the unglaciated region of southwestern Wisconsin – it's part of what makes the region so great for farming. Breunig and Flattum's exploration into how water moves through loess will help us better understand groundwater dynamics in general. Their work has many downstream applications, including understanding changes in lake and stream water levels, and how substances in the water, like nutrients and contaminants, move.

"The Freshwater@UW program has been one of my most impactful experiences in my undergraduate career," she said. "Beyond mentoring, the hands-on field experience has been incredible." ■

"I have been able to work with research tools and methodologies I had never encountered before, and it greatly expanded my scientific skillset."



WATCH THE VIDEO

Groundwater at Wyalusing State Park: Ella's Freshwater@UW research
go.wisc.edu/4t487z

Linda Hang

Information Science and Environmental Studies UW–Madison

Linda Hang worked with Wisconsin Sea Grant fisheries specialist Titus Seilheimer, learning how to monitor different aspects of a wide variety of habitats. She is from Milwaukee and plans to pursue a job at the Wisconsin Department of Natural Resources in the future, saying, "My big aspiration in life is working to be a bridge between technology and the environment."

Seilheimer has been gathering data in order to visualize and graph the changes that restoration may bring to an ecosystem, and Hang assisted with this work while conducting her independent project. Specifically, Hang wanted to know if the presence of wild rice was related to fish biodiversity. She compared three sites – one with low-density seeded rice, one with high-density seeded rice, and a third with high-density naturally occurring rice.

Did her research prove her hypothesis?

Hang says, "I was kind of like, if manoomin (wild rice) exists here, it is an indicator that the water quality is good and is a factor in fish diversity. Of course, it's way more complicated than that and I need more time than 10 weeks." ■

WATCH THE VIDEO

Wading in: Linda's Freshwater@UW research
go.wisc.edu/u8cdkf

> "My big aspiration in life is working to be a bridge between technology and the environment."

Top: UW–Green Bay's Amy Carrozzino-Lyon and Hang set a fyke net in Winegar Pond, near the mouth of the Peshtigo River. Middle: A thumbs-up from Hang while working in Valley Creek in Port Washington.

Lucie Carignan

Biological Systems Engineering
UW–Madison

Lucie Carignan researched tree productivity at the Ridges Sanctuary in Baileys Harbor, Wis, working in the UW–Madison Hydroecology Lab with graduate student mentor Eric Kastelic, collecting tree core and elevation data from white pine trees to investigate the impact of depth of groundwater on tree growth. Her work supported UW–Madison Professor Steven Loheide's larger project described in the cover article in this issue – "The Swale Tale" (page 3).

Carignan is from Milwaukee and transferred to Madison this past fall. As a biological systems engineering major, she said, "I am very interested in all natural sciences and the intersection of science and engineering, particularly involving the development of sustainable solutions that work alongside existing natural systems." ■

"One of my greatest professional aspirations is to contribute to a more sustainable world by adjusting the way we obtain natural resources, specifically involving either agriculture or forestry."

Top: Carignan collects a pressure transducer that measures surface water levels. Middle: Carignan cores a pine tree with an increment borer. This tool is designed to not harm trees in the coring process. Bottom: Carignan processes tree core samples by mounting them to prepare for sanding and ring measurement.

Anne Moser

Senior Special Librarian and Education Coordinator

In addition to consulting on the newly released "Saving Our Sturgeon" (see page 1), Anne Moser spent some of her summer working with fisheries specialist Titus Seilheimer at Grandparents University and teaching about shipwrecks, Great Lakes fish, and fishing during visits to libraries.

Grandparents University is an inter-generational learning experience for children and an adult older relative (not a parent). Moser and Seilheimer led a spirited session in the limnology major with 40 grandparents and their grandchildren. They taught participants all about the Great Lakes with activities such as "How Big Is a Crowd?" (about commercial fishing) and "Dichotomous Key" (identifying fish), and participants enjoyed working with remotely operated vehicles, wave action, the flume tank, and more.

Moser's library visits helped audiences learn what real marine archeologists do while virtually exploring the real shipwreck the Silver Lake, a scow schooner that went down in the waters near Sheboygan. A different library visit focused on the fish of Lake Michigan and Lake Superior and what makes them special, with special guest Stella Sturgeon. ■

Moser worked with participants at Grandparents University to identify Great Lakes fish.

From left to right, Hallie Schroeter, Jenna Mertz, Olivia Balde, Rosa Fabian, Titus Seilheimer, Linda Hang, Noah Kleinerman, and Digby Meister. Mertz and Fabian were visiting for the day.

Titus Seilheimer

Fisheries Specialist

A summer in the humid and smoky air might not have been what these students signed up for, but it is what they got! Working with fisheries specialist Titus Seilheimer of the Manitowoc field office, five students worked in wetlands and streams from Peshtigo to Port Washington. The students included Hallie Schroeter (Manitowoc Lincoln High School), Olivia Balde (UW–Stevens Point), Digby Meister (UW–Green Bay), Linda Hang (UW–Madison), and Noah Kleinerman (UW-Milwaukee).

The wetland work included wild rice monitoring, fish surveys in wild rice seeding areas, and other plant monitoring. This work was with UW–Green Bay restoration scientist Amy Carrozzino-Lyon. The stream work was primarily in Port Washington in Valley Creek, but there was also some mapping work in Manitowoc's Silver Creek and fish removal during restoration at Forget-Me-Not-Creek in Two Rivers. Valley Creek needs some improvements, so the work included documenting the habitat and species present in order to help to guide the restoration plans. ■

Hauser with Ethan Mondry, a high school student from the School District of Ashland.

From left to right, Emma Hauser, Erin Ross, Wyatt Slack, Rachel Virnig, Jack Patterson, Sharon Moen, Raatbek Baizakov, Nevin State Fish Hatchery staff member, Mike Aquino, Nevin State Fish Hatchery, Nevin State Fish Hatchery staff member

Emma Hauser

Aquaculture Outreach and Education Specialist

Summers at the University of Wisconsin -Stevens Point Northern Aquaculture Demonstration Facility (UWSP NADF) are always busy, and this summer was no exception. Emma Hauser, aquaculture outreach and education specialist, shared some highlights:

- Partnered with Wisconsin Sea Grant food fish outreach specialist Sharon Moen and aquaculture outreach specialist Dong-Fang Deng on a project to build awareness of fish farming and boost training opportunities for young people. The project, funded by the Freshwater Collaborative of Wisconsin, is a step towards developing an aquaculture workforce in the state.
- Partnering with Red Cliff Treaty Natural Resources and Lake Namakagon Lake Association to raise walleye for stocking into Lake Namakagon. Walleye eggs were harvested by Red Cliff Hatchery staff and raised by UWSP NADF throughout the summer in ponds and indoor systems.
- Teaching various audiences about raising salmon in water reuse systems as well as providing research on optimizing Atlantic salmon broodstock to spawn out of season.
- Investigated a process known as "cold banking" on various stages of walleye fingerlings. Cold banking involves exposing fingerling walleye to cooler water temperatures to slow growth rates, potentially allowing producers to bring walleye to market size throughout the year.
- Testing the hypothesis that sea lamprey parasites induce quantifiable changes to hemostatic regulation (blood flow) in lake trout, laying the foundation for establishing blood biomarkers that allow for field assessments of lamprey-induced damage to fish stocks. Ultimately, this will help management improve estimates of damage from sea lampreys. ■

WATCH THE VIDEO SERIES

Atlantic Salmon and Recirculating Aquaculture Systems
go.wisc.edu/38nx32


LAKE GUARDIAN
LAKE GUARDIAN

Teachers Set Sail

By ANDREW SAVAGIAN

Three Wisconsin educators were chosen to join Sea Grant aboard EPA's research vessel on Lake Michigan in July

Alina Prahl, Jamie Lauer, and Robert Fish joined Center for Great Lakes Literacy (CGLL) staff, Great Lakes scientists, and other participating teachers to work aboard the EPA research vessel Lake Guardian and bring Great Lakes knowledge and information back to their classrooms. These educators spent a week on the Guardian, rotating between collecting samples on the deck and working together in the lab with the research team. Upon their return they shared some thoughts about the experience and how they plan to incorporate it into their teaching.

Alina Prahl is the program manager at Riveredge Nature Center in Saukville. She oversees all family and community educational programming at the center as well as teaches environmental education for school, summer, evening, and weekend groups.

"I, for one, am immediately excited to incorporate some of the cultural knowledge and archaeology of the Alpena-Amberly Ridge in Lake Huron and the potential of the Mid Lake Plateau as examples of how the glaciers shaped much of Wisconsin's landscape and how Indigenous people navigated those glacial changes for our Wisconsin Glacial Landscapes program. I really enjoyed the sonar modeling activity and could see that as a great activity for our middle school and high school homeschool classes. I hope my learners develop a deep curiosity about both the human and natural history of the Great Lakes region and an understanding of the forces that shaped the landscape."

Jamie Lauer is a chemistry teacher at Hartford Union High School, where she teaches introductory and AP chemistry.

"I hope that my learners see that the practice of science in the world involves all disciplines. The Sweetness and Light activity [an interactive lab analyzing how color is absorbed through water] has ties to biology with photic zones, physics with light reflection, and chemistry with light absorptions. It will be exciting to show them that gathering and collecting data is often done in a unique setting with many variables to think about."

Robert Fish is a tribal engagement coordinator at the UW-Green Bay National Estuarine Research Reserve. He works with tribal schools to develop, promote, and integrate education programs around wetlands, estuaries, and coastlines, connecting those water science programs with Wisconsin First Nation history, culture, and sovereignty.

"I will definitely be using this experience to illustrate what life on a research vessel can be like as a career option. For those students who are keen to earn a living by traveling, researching, teaching, or otherwise, life on a ship like this might be just what they are looking for. I hope that they can see in themselves the potential to become freshwater scientists and technicians. I hope that by sharing my experiences ... I can inspire our youth to pursue lives less ordinary, more extraordinary, like the folks who call the Lake Guardian home."

Educators were able to enjoy the experience thanks to a partnership with the EPA Great Lakes National Program Office and NOAA, and with funding from the Great Lakes Restoration Initiative. Hosts for the expedition were CGLL partners Illinois-Indiana Sea Grant and Wisconsin Sea Grant. The Shipboard Science Immersions are designed to promote Great Lakes sciences while forging lasting relationships between researchers and educators. CGLL is a collaborative effort led by Sea Grant educators throughout the U.S. Great Lakes watershed. ■

For more information visit the Center for Great Lakes Literacy website.
go.wisc.edu/u4h28u

Protecting a Summer Day at the Beach

Developing a faster way to detect *E. coli* and identify its source at public beaches

By JENNA MERTZ

Ryan Newton, Professor, UW–Milwaukee School of Freshwater Sciences

Nothing ruins a day at the lake like *E. coli*. At elevated levels, the bacteria — which is prevalent in the guts and feces of both humans and animals — can make people sick, forcing beach managers to post advisories or close beaches entirely. And while current testing methods provide an accurate snapshot of *E. coli* levels in beach water, the results aren't always timely."

There's a 24-hour lag before you get those results," said Ryan Newton, a professor at the University of Wisconsin-Milwaukee School of Freshwater Sciences who studies microbes in aquatic environments. "It's not ideal because you have to wait 24 hours to close a beach or take some sort of action. And at that point, the conditions may not be the same as what they were when you took the sample."

That delay in getting results can mean people are swimming in unsafe waters or, alternatively, a beach is needlessly closed, which can have negative economic consequences.

That's where Newton's research comes in. With funding from Wisconsin Sea Grant, he and his team are developing a faster way to test for *E. coli* and identify its source so beach managers can make quick, informed decisions about the safety of their beaches and identify ways to prevent future pollution.

The new process Newton is developing will be able to skip the incubation period that slows down the current process. Currently Newton's team is fine-tuning the method in the lab before trying it out on lake water, which will present its own set of challenges.

"Things in nature don't always play as nicely as clean water in the lab," he said.

But whose poop is it?

In addition to developing a faster way to detect *E. coli* in lake water, Newton's team is also working on a method to identify its source. Such information will help public health officials assess the threat — human feces are generally considered riskier to human health than those of cows or dogs — but also help beach managers prevent future pollution.

"Right now, we're envisioning [the test] as a way to do a quick survey of your beach and understand which pollution sources are most likely," said Newton. "If you know it's coming from sewage, then you just have to identify where that sewage might be coming from, whether it's a leaky pipe or infrastructure or misconnection."

While tests to identify individual sources exist, Newton is developing a method to identify multiple sources in one water sample. He'll use a handheld, portable DNA sequencer to identify the types of microorganisms present, which can then reveal whether the fecal contamination is coming from humans, cows, dogs, or gulls.

It's useful information for municipalities looking to address longstanding *E. coli* issues at beaches. Newton pointed to the work of colleague and Sea Grant-funded researcher Sandra McLellan, who identified seagulls and stormwater runoff as the primary sources of *E. coli* at Milwaukee's popular Bradford Beach a little over 15 years ago. As a result of the study, the city implemented strategies to prevent stormwater from running across the beach during heavy rains and used dogs to scare birds off the beach.

The changes made a difference.

"Bradford became much, much cleaner after those processes were implemented," said Newton. ■

Bottom right: Two undergraduate students collect water samples from Lake Michigan for *E. coli* and other microbial DNA testing. Image by Ryan Newton

continued from page 4

Kastelic collects a pressure transducer that regularly measures groundwater levels under forested ridges.

The team has developed an ecohydrological observatory at the Ridges, which besides the cool name is also a great way to continuously monitor groundwater levels and changes that occur daily as the trees start to use water, from when the sun rises higher in the sky and exerts its considerable influence on the flora to when things start to shut down in the evening.

Loheide's team, however, is looking beyond daily data. "We're really hoping to leverage long-term data sets, and that's coming from the trees themselves. If we core the trees, we can see variability in the annual growth. When conditions are good, when you're getting the right amount of rain, when groundwater's at the right level, we see larger growth rings. But we see narrow growth rings during dry years or years where groundwater is not available, or even when groundwater's too shallow," said Loheide. "So that gives us an opportunity to not just have the data we collect during this two-year project, but to have a record that extends over a hundred years with some of these older trees."

The two-year project window Loheide references comes from funding through the Aquatic Science Center's Water Resources Institute. (wri.wisc.edu) Additional work was done by Joe Binzley (Hilldale Undergraduate Researcher 2025, UW–Madison) and collaborators from the Ridges Sanctuary, UW-Platteville TREES Lab, and the Wisconsin Department of Natural Resources.

Loheide said that the findings his team develops could be used to better understand how extreme changes in water levels impact groundwater and flora not only at the Ridges but also for other areas throughout the Great Lakes.

"We're hopeful that we can use remote sensing tools to try to compare other sites, and if satellite data can show us how transpiration or water use might be changing," Loheide said. "There are new satellites out there that are at fine scale that we might actually be able to see and map out the spatial variability within ridge and swale wetlands, and then also compare among them what the response is.

"We're excited about what the future holds." ■

Learning for Teachers

The Wisconsin Water Library collects books that support teaching Great Lakes literacy in schools and beyond. These titles and more are available for anyone who educates the next generation of Great Lakes stewards.

Cultivating Genius: An Equity Framework for Culturally and Historically Responsive Literacy by Gholdy Muhammad. New York, NY: Scholastic, 2020.

Eco Literate: How Educators Are Cultivating Emotional, Social, and Ecological Intelligence by Daniel Goleman. San Francisco, CA: Jossey-Bass, 2012.

Educating Young Children through Natural Water: How to Use Coastlines, Rivers and Lakes to Promote Learning and Development by Judit Horvath. Abingdon, Oxon ; New York, NY: Routledge, is an imprint of the Taylor & Francis Group, an Informa business, 2016.

Exploring Science through Young Adult Literature edited by Paula Greathouse, Melanie Hundley, and Stephanie Wendt. Lanham, Maryland: Rowman & Littlefield, 2023.

Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder by Richard Louv. Chapel Hill, NC: Algonquin Books of Chapel Hill, 2005.

Protecting the Promise: Indigenous Education between Mothers and Their Children by Timothy San Pedro. New York, NY: Teachers College Press, 2021.

Science and Engineering in Preschool through Elementary Grades: the Brilliance of Children and the Strengths of Engineering by the Committee on Enhancing Science and Engineering in Prekindergarten Through Fifth Grades; Board on Science Education; Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press, 2022.

Teaching Climate Change in Primary Schools: an Interdisciplinary Process edited by Anne M. Dolan. New York, NY: Routledge, Taylor & Francis Group, 2022.

Anyone in Wisconsin can borrow these books and more.
Email askwater@aqua.wisc.edu

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