Two Hubs, One Mission: Protecting the Great Lakes

Across Michigan's university landscape, two powerhouse hubs are shaping the future of the Great Lakes. In Houghton, Michigan Technological University's **Great Lakes Research Center** serves as a hands-on freshwater innovation lab, where scientists and engineers study everything from winter limnology to under-ice robotics. At the University of Michigan and Michigan State, **Michigan Sea Grant** translates cutting-edge research into community action—supporting coastal resilience, fisheries, harbors, and policy. Together, these Michigan university centers demonstrate how academic research, engineering, and community partnerships are building a more resilient future for the world's largest freshwater system.

Great Lakes Research Center
Michigan Technological University

Sea Grant
MICHIGAN

Inside Michigan Tech's Great Lakes Research Center

BY SUSAN THWING

On the edge of Michigan Technological University's campus in Houghton, the Great Lakes Research Center (GLRC) feels less like a traditional academic building and more like a launch pad. Research vessels tie up just outside on the Keweenaw Waterway, under-ice robots and autonomous subsurface vehicles are prepped for deployment, and teams of biologists, engineers, chemists, and computer scientists move between wet labs, control rooms, and classrooms.

The mission: to understand, protect, and engineer the future of the Great Lakes at a moment when the stakes have never been higher.


Amy Marcarelli

"We are blessed by having an abundance of water, and that's going to make us an attractive place as water availability changes across the landscape," says Amy Marcarelli, professor of biological sciences and director of GLRC's Ecosystem Science Center. "Being poised to think about the opportunities and challenges that arise from that is something that is really pressing in Michigan."

At GLRC, that preparation happens on multiple fronts: from climate and coastal resilience to winter limnology, emerging contaminants, and the engineering tools needed to monitor a system that is both vast and vulnerable.

A DYNAMIC SYSTEM UNDER MULTIPLE STRESSORS

Marcarelli is quick to dispel the notion that there is a single "biggest threat" to the Great Lakes.

"If it were one threat, it would be easy to address," she said. "In most cases, and the Great Lakes are no exception, there are many different interacting stresses happening at the same time. These include invasive species, nutrient loading, harmful algal blooms, increasing storm frequency, and shoreline erosion. The real challenges come when those things interact and amplify each other."

Understanding those interactions across scales—physical, chemical, biological, social—is a central challenge



The Great Lakes Research Center in Houghton.

for GLRC researchers. Climate change is reshaping everything from water temperatures and ice cover to disease dynamics and infrastructure performance. At the same time, population growth and development patterns are shifting toward water-rich regions like the Great Lakes.

"We're in a dynamic time," Marcarelli said. "We need continuity of information so we can make the big decisions that need to be made."

That continuity depends on monitoring systems, modeling tools, and collaborative teams that can keep pace with a changing lake system, and that's where GLRC's engineering strength comes in.

THE LAKES AS BUFFER—AND WARNING SYSTEM

For Hayden Henderson, Senior Research Engineer, Assistant Director of the Center for Environmental Engineering, Sensing, and Integrated Modeling, one of the most important realities of the Great Lakes is also one of the least understood outside scientific circles.



Hayden Henderson

"One of the eye-opening stats about the Great Lakes is that we have more miles of shoreline than the contiguous 48 Atlantic and Pacific coasts combined," Henderson said. "Where do people interact with water? At the shoreline. So we almost have this concentration in proximity to water that the oceans can't even compete with."

That shoreline, he stresses, is where the impacts of climate change will be felt most acutely, through flooding, erosion, infrastructure strain, and shifting ecosystems.

Henderson also describes the Great Lakes as a kind of regional climate "buffer," but he's careful to unpack what that really means.

"The heat capacity of water is massive," he said. "As climate change is occurring, the Great Lakes are going to absorb a lot of that thermal regime. We don't experience changes in air temperature as abruptly as somewhere like Nebraska because of our proximity to the lakes. That sounds nice when you say it, but buffer means they're being impacted. They're suffering for our benefit, whether that's temperature or other things."

Meanwhile, water quality issues are evolving faster than many systems can react. "We're still figuring out how to treat PFAS—that's been decades in the making," Henderson noted. "We haven't even begun to fully turn our attention to pharmaceuticals and other emerging contaminants in our water supply."

HIGH-TECH EYES ON A CHANGING FRESHWATER WORLD

To anticipate and adapt to these changes, GLRC is investing in advanced observing systems and modeling tools. Henderson leads several multi-year projects funded through NOAA's Great Lakes programs, including one that is measuring CO_2 flux at the water surface at high resolution—effectively, 'acidification research' for the Great Lakes.

"You hear a lot about the oceans acidifying," he said. "We really don't know what that looks like for the Great Lakes, and the reality is that it means different things at different times of year for different lakes."

Part of the challenge is that we often talk about "the Great Lakes" as if they were a single entity. Henderson argues for a more nuanced view.

"Lake Superior could not be more different than Lake Erie, from a biological perspective, a physical perspective, everything," he said. "I'd argue we should talk about Upper Great Lakes and Lower Great Lakes. Population density, stressors, even the kinds of infrastructure issues you see are vastly different."

Another of Henderson's projects focuses on real-time coastal water level data and erosion concerns, in which they are developing high-frequency, high-resolution coastal water level monitoring systems that give communities and engineers better tools to design resilient shorelines and plan for extreme events such as seiches and storm surges.

These engineering efforts are supported by GLRC's fleet: surface vessels such as the RV *Agassiz* and RV *Soliton*, monitoring buoys, and a subsurface fleet that includes remotely operated vehicles (ROVs) and autonomous underwater vehicles (AUVs). Together, they enable researchers to capture sonar images, deploy sensors, and sample under ice across seasons and at scales that match the complexity of the lakes themselves.

WINTER AS A LIVING LABORATORY

While many people think of Great Lakes research as a summer endeavor, GLRC treats winter as a critical window and a time historically underserved by scientific data but increasingly important as the climate warms and ice regimes shift.



A Great Lake Research Center crew on one of their vessels.

"One of the areas where I think we've been really at the forefront in the GLRC community is trying to understand winter conditions," Marcarelli said. She points to work led by colleagues such as Trista Vick-Majors and others in the biological sciences. "They've been characterizing winter ecological and chemical dynamics across the Great Lakes, and there have been increased coordinated sampling efforts."

Michigan Tech's location—with consistent snowpack and ice cover right outside the center's doors—makes it an ideal testbed. Researchers deploy instruments under ice, develop technology for cold-region operations, and even extend their findings to Arctic applications.

"The same group doing winter sampling also has a DoD-funded project to understand how ice-dwelling bacteria might help the U.S. military operate in cold conditions," Marcarelli explained. "We do a lot at this interface of biotechnology and environmental research."

POWER FROM BROWN WATER AND OTHER CROSS-DISCIPLINARY SOLUTIONS

Marcarelli's own work highlights GLRC's deeply interdisciplinary approach. One of her major projects asks a deceptively simple question: Can the organic matter that turns rivers and lakes "brown" be used as a power source?

"We're trying to understand how organic matter in the water column, the stuff that makes water look brown, can fuel microbial fuel cells to generate power in nearshore environments," she said. The project brings together teams from GLRC, mechanical engineering, environmental engineering, and biological sciences.

This kind of cross-cutting collaboration is the norm rather than the exception at GLRC. Another major initiative, led by faculty member Pengfei Xue and others, is the DOE-funded Center for Climate-Driven Hazard Adaptation, Resilience, and Mitigation (C-CHARM).

"That group includes PIs from engineering, social sciences, economics, and more," Marcarelli said. "The goal is to provide solutions to climate-driven challenges facing rural communities in the Great Lakes, things like extreme storms, flooding, sinkholes, and to translate applied science into actionable strategies that help communities prepare for climate change."

ADAPTING, NOT JUST REACTING

When it comes to climate change, both Henderson and Marcarelli emphasize a dual mission: understanding what's coming and helping communities adapt.

"I think it's all of the above," Henderson said. "You need interdisciplinary teams to make sure the right conversations happen at the right time. Core science can get hyper-focused, and that's valuable, but bigger teams can point out what you might be overlooking in your excitement about a given topic."

On the ecology side, Marcarelli sees GLRC's role less as "stopping" climate change than enabling intelligent adaptation.

"Most of the folks I work with are thinking about how you adapt to it," she explained. "That could mean assisted migration of tree species, changing forest management strategies for water availability and temperature, or using forest management to influence how much water reaches streams and nearshore zones."

GLRC researchers also participate in the Northern Institute of Applied Climate Science (NIACS), a multi-university consortium that works directly with landowners, foresters, and communities to translate climate science into practical decisions—whether it's managing forests, mitigating coastal erosion, or planning local infrastructure.

At its core, the Great Lakes Research Center is as much about people and place as it is about instruments and models.

"One of the things that's really unique about Michigan Tech is that it's a STEM school with core strength in engineering, but we also have an amazingly rich community of people across disciplines who care deeply about the environment and about this place," Marcarelli said.

Michigan Sea Grant Bridges Science, Community, and the Great Lakes

BY SUSAN THWING



MICHIGAN SEA GRANT PHOTO

A fish fry at the Michigan capitol 2025

Michigan sits at the heart of the world's most remarkable freshwater system—20 percent of the planet's usable surface freshwater, more than 3,500 species of plants and animals, and a network of coastal communities whose economies, cultures, and daily lives revolve around the Great Lakes. Stewarding this resource is both a privilege and a profound responsibility, one that Michigan Sea Grant (MISG) has embraced for more than half a century through research, education, community engagement, and multi-sector partnerships that stretch from small harbors to international agencies.

For Silvia Santa Maria Newell, Director of Michigan Sea Grant and Professor in the University of Michigan School for Environment and Sustainability, the next decade represents a critical inflection point—one filled with both urgent challenges and promising momentum.



Silvia Santa Maria Newell

"The biggest challenge in the next 5–10 years is ensuring that the Great Lakes remain a top priority for investment in research, education, and outreach at both the state and federal levels," she explained. "The Great Lakes are the beating heart of our region… They support a $5 billion fishery, a $19 billion shipping industry, and millions in coastal tourism. Their ecological and economic importance cannot be overstated."

Michigan Sea Grant is uniquely positioned to help safeguard this future. As a collaboration between the University of Michigan, Michigan State University Extension, and NOAA's National Sea Grant College Program, MISG brings together research expertise, engineering innovation, and grassroots outreach. The result is a rare science-to-community pipeline—one that delivers real-world solutions directly to local leaders, educators, and industries who depend on the Great Lakes every day.

COASTAL RESILIENCE IN A CHANGING CLIMATE

As climate change accelerates, Michigan's shoreline communities are already experiencing the consequences: fluctuating lake levels, high-intensity storms, erosion, flooding, and infrastructure strain. MISG's proactive work in coastal resilience and stormwater management has become essential.

"Managing unprecedented growth along the Michigan shoreline, revitalizing urban waterfronts, and supporting coastal businesses are all part of our statewide efforts," Newell said. "We provide education about soft engineering, habitat protection, and restoration so leaders can develop solutions that recognize the ties between a healthy ecosystem and a vital economy."

One example is the Clean Marina Stormwater Toolkit, a resource designed to help marina owners implement best management practices to filter and manage runoff before it enters the lakes. Another is the Michigan Boating Pumpout Grants Program, which provides funding for marinas to build or upgrade sewage pumpout and dump stations—reducing pollution and improving water quality.

These programs are more than environmental safeguards. They support local tourism, protect fisheries, and strengthen the economic engines that sustain coastal towns.

SMALL HARBORS, BIG IMPACT

Michigan is home to more than 80 public marinas and harbors—critical infrastructure for recreation, shipping, fishing, and local commerce. Yet many small harbors struggle with aging infrastructure, economic shifts, or changing uses.

MISG's Sustainable Small Harbors (SSH) initiative has become one of the program's most transformative efforts. By helping communities identify barriers and create revitalization strategies, SSH supports long-term resilience.

"We work with land-use planners, citizens, and local government leaders to help communities revitalize their waterfronts to attract business and enhance quality of





MICHIGAN SEA GRANT PHOTO

MISG staff helps kids release Lake Sturgeon into Saginaw Bay.

life," Newell said. "We equip leaders with tools to assess and strengthen their waterfront assets." This approach has produced concrete results: stronger tourism economies, updated master plans, and infrastructure funding aligned with environmental best practices. The model is now being examined as a template for other Great Lakes states.

CONNECTING RESEARCH TO REAL NEEDS

One of MISG's most distinctive strengths is its Extension network. By placing educators and outreach specialists in Michigan communities, the organization maintains a feedback loop between local needs and research priorities.

"The way we are structured allows us to directly impact communities," Newell explained. "Extension staff work to understand community needs and ensure the results of our work are delivered in a format they can use."

For K–12 teachers, the Center for Great Lakes Literacy provides classroom activities, trainings, and connections with other educators across the basin. MISG also co-hosts a summer 4-H camp that immerses youth in hands-on Great Lakes science.

These examples illustrate what Newell emphasizes repeatedly: science is only powerful if people can use it.

DATA AND TOOLS FOR DECISION MAKERS

To help policymakers, engineers, and planners make informed choices, MISG developed a Coastal Resilience Hub—a curated, Michigan-specific portal that sifts through the overwhelming number of climate and infrastructure resources available nationwide.

"The hub gathers best-available resources and contacts for planning, policy, funding, and technical assistance," Newell said. It allows municipalities—especially small ones without dedicated environmental staff—to access credible, actionable information quickly.

MISG's research coordination extends beyond state borders. The program helped fund a region-wide sampling event led by Dr. Tristy Vick-Majors and partnered closely with Canadian agencies and the International Joint Commission (IJC). In 2024, MISG, the IJC, and the Great Lakes Commission launched a new Great Lakes Fellowship for early-career professionals. The inaugural cohort excelled so significantly that their contracts were extended for another year.

"These coordination efforts demonstrate how much we can achieve when we work across boundaries—even across national borders," Newell noted.

THE NEXT GENERATION OF GREAT LAKES STEWARDS

MISG invests heavily in education at every level—from elementary students to future PhDs.

This model has led to innovative, community-driven projects—from habitat restoration to invasive species management to infrastructure improvement.

A recent example: a Michigan Sea Grant graduate fellow, Dustin Brewer, collaborated with U.S. Fish and Wildlife Service biologists to test whether audio recordings could attract migratory rails to restored wetland areas. The work proved successful and shaped a new MDNR strategy for increasing rail populations.

At the undergraduate level, MISG interns partnered with the Michigan Department of Natural Resources to map user-created trails in state parks along Lake Michigan—information now being used to guide restoration and reduce habitat disturbance.

At the university level, fellowships and internships place students in research labs, state agencies, and field projects.

"All of our funded research includes students," Newell said. "Many of them go on to become the next generation of researchers and resource managers."

This continuity, education, research, and practice, creates a pipeline of talent that Michigan's water-driven industries will depend on in the decades ahead.

A MODEL FOR FRESHWATER STEWARDSHIP

When asked what lessons Michigan's approach offers to other states, Newell points to broad-based stewardship.



MICHIGAN SEA GRANT PHOTO

MISG Paddle Stewards Training.

"People here overwhelmingly say they care about protecting the Great Lakes, partly because they feel connected to them through education and recreation," she said. "We're working hard to build this stewardship from K–12 students to adult learners to graduate students."

That connection, rooted in identity as much as in science, is a major reason MISG's model has become a national benchmark.

A FUTURE BUILT ON PARTNERSHIP AND PURPOSE

Partnerships, Newell stresses, are the core of Michigan Sea Grant's success. Between 2018 and 2023, MISG collaborated with 86 government entities, 16 industry organizations, 11 Tribal groups, 34 academic institutions, 102 nonprofits, and 10 Sea Grant programs nationwide.

Through these efforts, MISG turned $19 million in state and federal funding into nearly $86 million in direct economic benefits. In 2024 alone, the program generated $10 in value for every $1 in core funding.

"Sea Grant is a national program with real, measurable impacts," Newell said. "We are proud to be working in so many communities and with so many partners throughout Michigan."

For a region defined by water, that work is not just valuable—it is indispensable.

Michigan's University Water and Tech Powerhouses

Great Lakes Research Center and Michigan Sea Grant (highlighted in the previous articles) are part of a much broader network—several other Michigan universities are driving significant freshwater research, technology development, and community-focused innovation across the state.

University of Michigan – Graham Sustainability Institute Water Center & Cooperative Institute for Great Lakes Research (CIGLR)

At U-M, the Graham Sustainability Institute's Water Center and the Cooperative Institute for Great Lakes Research (CIGLR) pair scientists with agencies to tackle issues like fluctuating lake levels, coastal resilience, and ecosystem health across the basin.

Michigan State University – Institute of Water Research

MSU's Institute of Water Research develops science-based tools, modeling, and outreach to address water quality, land use, and watershed management challenges in Michigan and the Great Lakes region.

Wayne State University – Healthy Urban Waters

Based in Detroit, Healthy Urban Waters focuses on water in urban settings, linking research on contamination, infrastructure, and public health to restoration and policy solutions along the Rouge and Detroit rivers.

Grand Valley State University – Annis Water Resources Institute (AWRI)

Located on Muskegon Lake, AWRI integrates research, education, and outreach on freshwater ecosystems, operating research vessels and offering robust hands-on opportunities in aquatic science and water quality.

Central Michigan University – Institute for Great Lakes Research (IGLR)

CMU's IGLR leads multidisciplinary studies of Great Lakes wetlands, nearshore zones, and coastal ecosystems, including immersive fieldwork at its Biological Station on Beaver Island.

Lake Superior State University – Center for Freshwater Research and Education (CFRE)

In Sault Ste. Marie, CFRE combines a teaching hatchery, research labs, and K–12 outreach to advance freshwater science and Great Lakes stewardship on the St. Marys River.