Great Lakes Research Consortium

2021-2024 Report

Great Lakes Research Consortium Member Institutions & Affiliates

The Great Lakes Research Consortium's 18 colleges and universities in New York State, and nine affiliates in Ontario, Canada, are dedicated to collaborative research and education to advance Great Lakes science and understanding. A Board of Governors directs Consortium-wide policy and direction. Campus representatives network to develop cutting-edge research and engage student involvement. State University of New York universities are identified here as SUNY.

SUNY University at Albany
Board: Thenkurussi Kesavadas, Ph.D., Vice President for Research
Campus: Open

SUNY Binghamton University
Board: Open
Campus: Weixing Zhu, Ph.D., Biological Sciences

SUNY Brockport
Board: Jose Maliekal, Ph.D., Vice Provost for Curriculum Innovation
Campus: Jacques Rinchard, Ph.D., Chair, Environmental Science & Ecology

SUNY Buffalo State College
Board: Open
Campus: Alexander Karatayev, Ph.D., Director, Great Lakes Center

SUNY University at Buffalo (UB)
Board: Open
Campus: Joseph Atkinson, Ph.D., Director, Great Lakes Program

Clarkson University
Board: Michelle Crimi, Ph.D., Acting Associate Vice Provost for Research & Technology Transfer
Campus: Center of Excellence

Cornell University
Board: Open
Campus: Lars Rudstam, Ph.D., Natural Resources

SUNY Cortland
Board: Open
Campus: Open

SUNY College of Environmental Science & Forestry (ESF)
Board: Lindi J. Quackenbush, Ph.D., Vice Provost for Research
Campus: Open

SUNY Fredonia
Board: J. Andy Karafa, Ph.D., Dean of Liberal Arts & Sciences
Campus: Open

SUNY Geneseo
Board: Anne Baldwin, Ph.D., Director of Sponsored Research
Campus: Open

Hobart and William Smith Colleges (HWS)
Board: Lisa Cleckner, Ph.D., Director, Finger Lakes Institute
Campus: Tara Curtin, Ph.D., Geoscience

SUNY Oswego
Board: Open
Campus: Lisa Glidden, Ph.D., Director, Great Lakes Institute

SUNY Plattsburgh
Board: Open
Campus: Timothy Mihuc, Ph.D., Environmental Science/Ecology

SUNY Potsdam
Board: Open
Campus: Robert L. Snyder, Ph.D., Biology

Rochester Institute of Technology (RIT)
Board: Open
Campus: Anthony Vodacek, Ph.D., Imaging Science

St. Lawrence University (SLU)
Board: Office of Institutional Research
Campus: Open

Syracuse University (SU)
Board: Open
Campus: Teng Zeng, Ph.D., Civil and Environmental Engineering

ASSOCIATE PARTNER: NEW YORK SEA GRANT
Board: Katherine Bunting-Howarth, Ph.D., J.D., Associate Director, New York Sea Grant; Assistant Director, Cornell University Cooperative Extension

CANADIAN UNIVERSITY AFFILIATES

Brock University • McMaster University

Queens University • Ryerson University

University of Guelph • University of Ottawa

University of Toronto • University of Waterloo

University of Windsor

Great Lakes Research Consortium
320 Jahn Lab, SUNY ESF, 1 Forestry Drive, Syracuse, NY 13210
315-470-6825 • www.esf.edu/glrc

Great Lakes Research Consortium 2024 Report

Thank You, Dr. Greg Boyer!

New York's Great Lakes' ecosystem, regional economy, and watershed communities have reaped Greg Boyer's devotion to environmental science. Arriving at SUNY's College of Environmental Science & Forestry (ESF) in 1985, he has worked as a chemist/biochemist to develop strategies and methods to help natural resource managers, water quality specialists, and citizens address both legacy and emerging challenges to the health & sustainability of the world's largest surface freshwater system, while becoming a pre-eminent algal blooms researcher and inspiring next-generation scientists.

"Through his constant attention to the melding of fundamental ecosystem research with applied science methods as a leading investigator and Executive Director with the GLRC, Greg Boyer has contributed not only to New York's Great Lakes waters and ecosystems but to all of the Great Lakes."
Don Zelazny, Immediate Past Great Lakes Program Manager, NYS Department of Environmental Conservation

Greg has coordinated NOAA's Monitoring & Event Response for Harmful Algal Blooms program for the lower Great Lakes, developed rapid analysis for algal toxins, analyzed samples from across New York, the U.S. & the globe, implemented NY's Great Lakes observing buoy system, led research aboard the EPA *Lake Guardian* on all five Great Lakes, authored 180 science journal articles, won several excellence in research and service awards, and advised government, NGO, and industry sectors from Save Our Sodus and NY's Great Lakes Basin Advisory Council to the National Institutes of Health and Congress.

Thank you, Dr. Gregory L. Boyer for being a champion for the Great Lakes!

Photo Credits:
Cover, clockwise from top: NYS DEC, NASA/Joshua Stevens, The Port/Anna Loria, Michael Twiss, Teng Zeng, NY Sea Grant, Michael Twiss, Kerri Dikun, Christopher Osborne; p. 4: Brian P. Whattam; p.5: Michael Twiss, Michael Milligan; p. 6: Brian P. Whattam (3); p.7: Upstate Freshwater Institute (2); p. 8: Brian P. Whattam; p. 9: Christopher Osborne (2); p. 10: Save Our Sodus, Jo Johnson/USFWS; p. 11: Clarkson University (2); p. 12: NYS GIS Clearinghouse; p. 13: Upstate Freshwater Institute (2), Anna McCartney/Pennsylvania Sea Grant; p. 14: Suzanne Hunt; p. 15: Kerri Dikun; p. 16: SUNY Brockport; p. 17: The Port/Anna Loria, Michael Twiss; p. 18: SUNY Brockport, NY Water Environment Association, U.S. Geological Survey; p.19: Alexander Karatayev/Buffalo State University, Coastal Carolina University; p. 20: NYSDEC, SUNY Brockport; p. 21: Teng Zeng, NASA/Joshua Stevens; p. 22: U.S. Geological Survey; p. 23: Roy Widrig/New York Sea Grant. Special thanks to Kara Lynn Dunn and Bill Woodruff.

Letter from the GLRC Director

GLRC Director Greg Boyer talks with a reporter during the launch of a remotely-operated research vessel along Lake Ontario at SUNY Oswego.

As I reflect on my time with the GLRC, I consider the parallels between my career and the life of the Consortium. I started teaching at SUNY-ESF in January 1985 just as the GLRC was being organized. Funding for research in the Great Lakes was just ramping up at the national level. The University of Michigan and the Ohio State University systems each had large signature universities with a major research presence in the lower Great Lakes. SUNY lacked a similar signature Ph.D.-granting campus, making it difficult to compete for funding. Furthermore, the size, complexity and interdisciplinary nature of Great Lakes research outstripped the capacity of any single institution. However, SUNY did not lack for scientists interested in working on the Great Lakes, with more than 300 scientists spread across its multiple campuses. Formation of a Great Lakes research consortium seemed a logical approach to bridge across campuses.

The GLRC was formally established in 1986 with five SUNY schools: Brockport, Buffalo, the College at Buffalo, the College of Environmental Science and Forestry, and Oswego. SUNY ESF due to its central location agreed to host the GLRC. The founding directors were Jack Manno and Richard Smardon. SUNY provided early funding. By 2000, the GLRC consisted of 16 New York State member colleges and universities and nine Ontario affiliates, all cooperating to improve understanding of the largest freshwater system on earth. The GLRC's three principal goals were 1) to facilitate research and scholarship on the chemical, physical, biological, and social processes that affect the Great Lakes, 2) to provide opportunities for the training and education of students, and 3) to disseminate information and research findings. At its peak, the GLRC supported as many as fifty seminars a year as a means for research dissemination and team building. Research support in the form of small seed grants led to larger federal grants with multiple GLRC members, and new faculty could get support to develop courses that benefited a range of GLRC members. The GLRC annual meeting was widely attended by members from across the state.

In the spring of 2006, during a return ride from the Lake Erie Millennium network meeting in Windsor, Ontario, Jack Manno convinced me to throw my hat in for the GLRC director's position. While I had certainly benefited from the GLRC small grants program, and given multiple seminars, I had not been that involved in GLRC day-to-day operations. With support from then-ESF Provost Bruce Bongarten, I assumed the GLRC director's position in 2007. GLRC activities ebbed and flowed with SUNY's different campus and consortium-funding models. When support from SUNY and the SUNY Research Foundation waned and members' dues and occasional NYS Legislative member items did not quite meet needs, New York State Department of Environmental Conservation (NYS DEC) Great Lakes Program Manager Don Zelazny (p. 23) recognized the GLRC's critical value and secured funding through the NY Great Lakes Protection Fund with a 2010-2024 series of five-year memorandums of understanding. Funding awards per research project increased from $10,000 to $25,000, and support for student research and student travel to meetings remained strong.

Per a recent GLRC members' survey (p. 20-22) by the GLRC and New York Sea Grant, the GLRC's original needs and goals remain pertinent. The results of this "Visioning the Future of GLRC" survey will help guide the Consortium forward to meet the legacy and emerging challenges to the Great Lakes' ecosystem and economy. Today, we are grateful for the support of Shannon Dougherty (p. 23) as Don's successor as NYS DEC Great Lakes Program Manager and acknowledge the critical need for the DEC funding stream that allows the GLRC to conduct its mission to be continually advancing the scientific and public understanding of the Great Lakes for the purpose of protecting the Lakes as an unparalleled natural resource that is so critical to the environmental, cultural, and economic well-being of New York as well as for all the Great Lakes states, and our Canadian neighbors.

"As I transition into retirement, I say *"Carry on, GLRC members! This is an exciting time and there is much yet to learn!"*

Sincerely,
Gregory L. Boyer
GLRC Director 2007-2024

Connecting Diverse Audiences to Great Lakes Science

GLRC leadership and researchers provide science-based data, information, and advisement to local, regional, state, federal, and international advisory committees on Great Lakes issues. The GLRC and its members provide expertise to diverse audiences on legacy and emerging challenges to Great Lakes water quality and sustainability.

From the inception of the Great Lakes Research Consortium (GLRC) by several campuses of the State University of New York in 1985, the GLRC has had a three-fold primary mission:

- facilitate Great Lakes research and scholarship
- provide student learning and research opportunities
- disseminate GLRC and Great Lakes research findings to grow the Great Lakes science-based knowledge database.

GLRC outreach programming and resources generate enthusiasm for Great Lakes science and environmental stewardship by diverse audiences. Here are some examples.

"Great Lakes Research Consortium Practicum in Applied Environmental Problem Solving: New Approaches and Techniques for Undergraduate Teaching Faculty"

With a $75,576 National Science Foundation grant, GLRC co-founders Jack Manno and Richard Smarden, James Pagano, and James Haynes created a foundational teaching tool for Great Lakes science faculty in 1997-98. Although models focused on Great Lakes Ecosystem Science/Issues and Lake Ontario Environments, Techniques for Analyzing Toxic Chemicals Commonly Found in the Great Lakes, Ecosystem Modeling with Spreadsheets: Mass Balance/ Bioenergetics, and Writing Environmental Impact Statements and Developing Problem-Solving Curricula for Undergraduates, this resource was of use universally.

GLRC Seminars and Mentoring Conferences

GLRC events provide students and faculty with opportunities to 1) showcase their research with speaking and poster presentations; 2) create discussions on timely issues, e.g., return on investment in ecosystem restoration, wind energy, *"Conversations in Disciplines: Resiliency of the Great Lakes to Climate and Storm Events"* - a GLRC, NY Sea Grant, NYS Departments of State and Environmental Conservation event; 3) hear regional-to-global perspectives from speakers with the Northeast Regional Climate Center; Sierra Club; Centre for Economic Research on Inclusivity and Sustainability, University of Galway, Ireland; Desert Research Institute, Las Vegas; New York Sea Grant; U.S. Fish & Wildlife Service, U.S. Geological Service, etc.; and 4) share ideas that create cross-campus collaborations, internships, and innovative blends of aquatic environment research with earth, imaging, computer, and other sciences and disciplines.

With GLRC travel grants, 30 students attended the "Future of the Great Lakes-St. Lawrence River" Conference at Clarkson University.

Student Presentations — GLRC visibility has been extended via students' participation at programs hosted by New York State legislators (Great Lakes Days), the International Association for Great Lakes Research, Geological Society of America Northeast, American Fisheries Society, Society of Environmental Toxicology and Chemistry, New York State Wetlands Forum, Northeast Algal Symposium, and GLRC member campuses.

Shipboard Science Workshops for Teachers

Teachers and environmental educators have worked alongside preeminent Great Lakes researchers during week-long Shipboard Science Workshops aboard the EPA *Research Vessel Lake Guardian*. The teachers collect water samples for analysis and other tasks on deck for analysis in the ship's labs, and develop Great Lakes-focused curricula and lessons in the ship's classroom with Sea Grant Great Lakes literacy specialists. GLRC has provided equipment and supplies.

EPA R/V Lake Guardian

GLRC Outreach

From 2012-2022, David G. "Dave" White II, New York Sea Grant (NYSG) Great Lakes Recreation & Tourism Specialist, served as GLRC Associate Director. Dave built partnerships and opportunities to showcase Great Lakes science at high traffic public venues, including The Great New York State Fair and Central New York Boat Show.

"The Fair and Boat Show provided perfect venues for showcasing Great Lakes research to the public, from science enthusiasts and people with no experience with the lakes to those with the Great Lakes in their 'backyard' and questions about the Lakes' fisheries, ecosystem, or economy," Dave points out.

Fair visitors were drawn to ask about GLRC sensor buoys floating in the reflecting pool at the New York State Park at The Fair and on the manmade pond at the fairgrounds. They could see water and air temperatures and water current transmitted from the buoy to a monitor where GLRC Director Greg Boyer and students answered questions about the buoys, the data, and Great Lakes research.

ROV launch on Lake Ontario; GLRC Director Greg Boyer, right, with Observing System Engineer Russ Miller, University of Michigan.

One of the GLRC's 8-foot-tall sensing buoys served as a conversation starter at the mid-February CNY Boat Show. The buoy attracted the curious and Lake Ontario boaters and anglers who had seen the the buoys deployed near Oswego, Oak Orchard, and Sodus Bay. An indoor pool at the show provided students with the opportunity to demonstrate remotly operated vehicles (ROV).

In 2019, the GLRC, NYSG, ESF, and U.S. Coast Guard Auxiliary presented four Ask the Experts: Great Lakes Days at the Fair. In 2022, Chemistry Day at the Fair included 4.5 hours of programming on the lakes' environment, algal blooms, invasive species, aquatic pollution, and other timely issues.

A GLRC, NYS Fair, NYS Parks, NYSG, and Oneida Lake Education Initiative collaboration invited middle school students to build Sea Perch ROVs and test their skill with navigating them through an underwater maze of "shipwrecks" at the Fair. Another year, with instruction from GLRC members' students, Fair goers tried their skill at operating an ROV on the Fair pond and learned how the technology is used for Great Lakes research.

Through a GLRC collaboration with schools and NY Sea Grant, middle school students used a monitor to maneuver the Sea Perch ROV they built with classmates through an underwater maze of "shipwrecks" at The Great New York State Fair.

Thank You, Dave White!

The GLRC thanks Dave White for 10 years of service as GLRC Associate Director and 38 years as a New York Sea Grant Great Lakes extension specialist.

Dave created opportunities to showcase Great Lakes research to diverse audiences by combining an unparalleled knowledge of and enthusiasm for all aspects of the Great Lakes region - from its ecosystems to its multi-faceted recreational and economic resources. His networking skills assembled many willing partners and 'hands on deck."

"Dave has a unique skill for communicating research in language that a broad range of non-technical audiences can relate to and understand."
— Don Zelazny, Immediate Past Great Lakes Program Manager, NYS Dept. of Environmental Conservation

"My approach to successful programming is don't do anything alone. Engage others with knowledge, skills, and a willingness to share. Call, ask how you can connect their interests to your project. Sometimes really great things will just happen," Dave says.

"Dave's practical and informative, yet entertaining way of communicating really connects with the public."
— CNY Boat Show Manager Drew Wickham

Dave and GLRC Director Greg Boyer provided information on Great Lakes science and tourism to the Lake Ontario National Marine Sanctuary (LONMS) Nominating Committee. LONMS status was granted by NOAA in 2024.

"Dave White was the common thread who tied the 6* (LONMS application pioneers) together and facilitated the progress forward at every step."
— Philip Church, Oswego County Administrator

Among the many venues to which "*Great Lakes Dave*" traveled are an invitation-only White House Briefing on Great Lakes Issues, and American Samoa to instruct National Marine Sanctuary personnel.

**LONMS application pioneers Phil Church, Dale Currier, Tom Raesbeck, and advisors Art Cohn, Ken Vrana, and Joe Zarzinski.*

GLRC Buoys: Data Generators

The Great Lakes Observing System (GLOS) is a bi-national nonprofit with a network of collaborators, including the Great Lakes Research Consortium (GLRC), that deploys sensor buoys. In 2024, the buoys stretched west from Minnesota's Pokegama Bay to Canada's Wolfe Island in Lake Ontario across the St. Lawrence River from Cape Vincent, New York; and from Slate Island off Lake Superior's northern shore to Ohio's Shallow Run Watershed south of Lake Erie. At any given time buoys sponsored by GLRC, ESF, Upstate Freshwater Institute (UFI), Buffalo State University, and others are deployed in New York's waters of Lake Erie or Lake Ontario.

View of Lake Ontario from Oswego buoy; map of buoy placements.

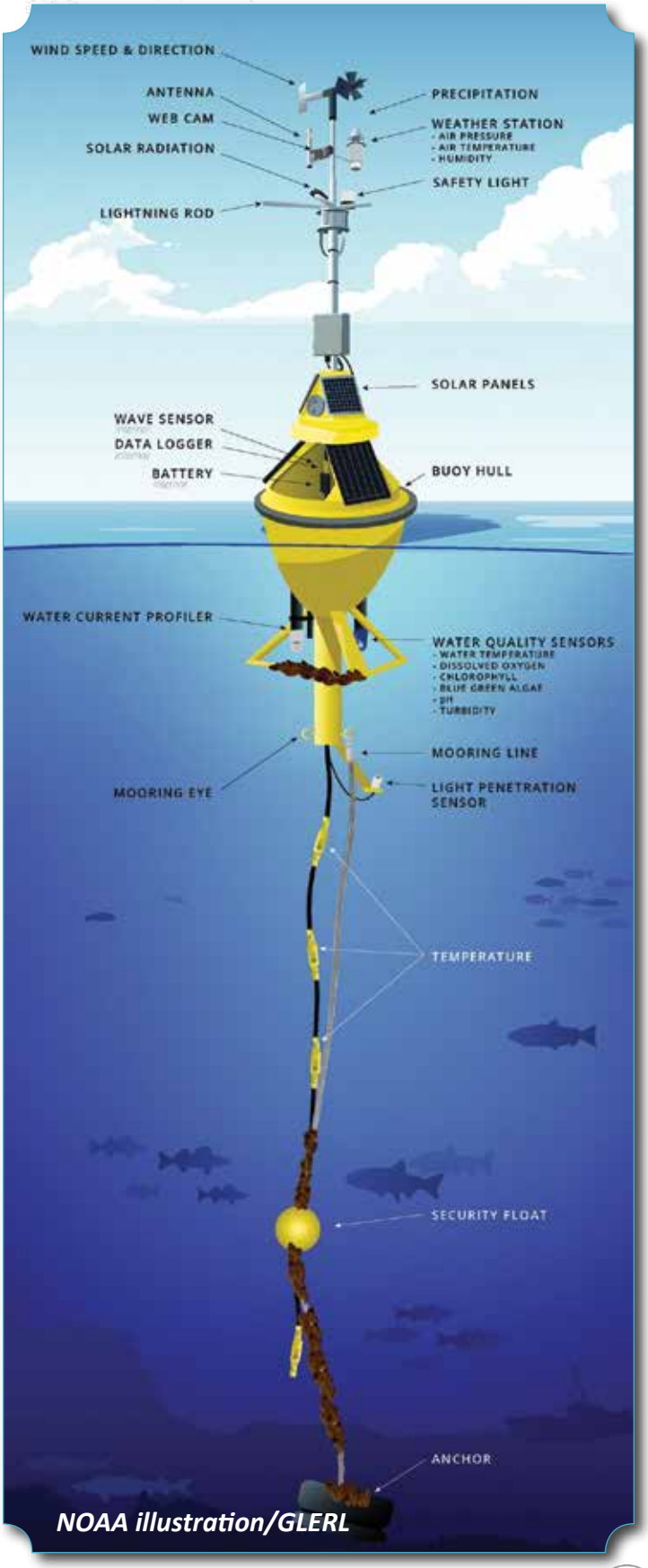
UFI Engineer David O'Donnell provided the following overview of the buoys and the data they collect and transmit to support the interests of the research community and diverse audiences interested in the health and quality of New York's Great Lakes.

How the Buoys Work

Sensors on the GLOS buoys monitor meteorological conditions, water quality, and current. The GLRC and partners joined GLOS in 2008 with deployment of a buoy on Lake Ontario at Oswego. Today, buoys are deployed at the mouths of the Oswego River and Oak Orchard Creek (20 meter depth isopleth) and near Sodus Point (7m depth isopleth) from May to November.

A meteorological station on each buoy measures air temperature and humidity, wind speed and direction, and solar irradiance. Sensors below the surface measure water temperature at 1m intervals from surface to lake bottom, specific conductivity, and turbidity. At Oswego and Oak Orchard, current velocity is recorded at 1m intervals throughout the water column; and wave height, period, and direction are collected with an acoustic Doppler current profiler on the lake bottom.

Dataloggers control the buoy's instruments, record, and send data onshore to the buoy host. Since 2019, data from NY's Lake Ontario buoys have supported nearshore modeling research by the UFI, the University of Buffalo, and others.



NOAA illustration/GLERL

GLRC Buoys: Data Generators

The Need for NY Great Lakes Buoy Data

Lake Ontario provides drinking water; food; and opportunities for recreation, commerce, and transportation. In a 2019 report, New York State estimated that Lake Ontario generates more than $120 million for the state economy annually through recreational activities such as fishing on the lake and its tributaries. In 2024, the National Oceanic and Atmospheric Administration designated the Lake Ontario National Marine Sanctuary that is sure to draw scuba divers and maritime history enthusiasts to Wayne, Cayuga, Oswego and Jefferson counties. All of these activities and the related economic impact are dependent on preserving the water quality of the Great Lakes.

Lake Ontario receives water from the upper Great Lakes, including the nutrient-rich waters of eastern Lake Erie that, due to cyclonic circulation, tend to flow near the southern shore. The nearshore is under threat from nuisance algae and cyanobacterial blooms in connected bays and along the shore. Sanitary and industrial wastes, invasive species, and climate change exert pressure on the lake ecology, open water, and nearshore environments. Of increasing concern is the potential loss of fish spawning habitat due to changes in benthic sediments, possibly due to increased suspended sediment loading.

In recent years, data collected by the buoys deployed by the GLRC, its members, and partners have been especially valuable for nearshore monitoring. Buoy data help identify trends and changes over time, and is of use to water quality, beaches, dunes, and fisheries managers; harmful algal blooms specialists; ecologists; and participants in lakewide action and management planning and implementation.

At left: A sensor buoy deployed at The Great New York State Fair by the GLRC and New York Sea Grant broadcasted live weather and water temperature data to Fair goers' phones.

Data for Diverse Users and Stakeholders

Clearly, the data from this network of sensing buoys on the Great Lakes serve many objectives and audiences. For example:

- Wave height, direction, and period have implications for shoreline erosion and potential flooding during periods of high water. Stakeholders include municipalities in need of ways to mitigate and prevent flood-related damage.

- Current velocity informs about water column motion, which impacts the transport of nutrients and suspended sediment. This data is valuable to watershed managers, e.g., County Soil and Water Conservation Districts.

Data collected from a buoy deployed at Dunkirk on Lake Erie sponsored by Buffalo State University's Great Lakes Center in 2012 helped explain a fish die-off.

- Water temperature profiles identify:
  (a) thermocline depth —of interest to anglers (recreational and tournament competitors) and modelers;
  (b) development of a thermal bar, which may influence nutrient transport nearshore to offshore;
  (c) upwelling events that can introduce nutrient-rich waters found below the thermocline to the nearshore, thus influencing growth of phytoplankton, benthic nuisance algae, dreissenid mussels — of interest to water quality, fisheries, and invasive species researchers.

- Specific conductivity serves as a conservative tracer to identify water origin and potential contaminant transport vectors (e.g., river inflow) — data valuable to researchers evaluating how land use impacts water quality.

- Turbidity is an indicator of suspended sediment concentrations, which may increase due to river inflows and wave-induced sediment resuspension - of interest to those in need of dredging for safe harbors and aquatic habitat.

Clarkson University and international partners have deployed sensor technology to study the aquatic environment of the St. Lawrence River and at the Moses-Saunders Power Dam.

Hatchery Rearing & Epigenetic Changes

Increasing evidence indicates that the unnatural conditions experienced by fishes during early-life stages in hatcheries cause epigenetic changes in gene expression in fishes and that the changes are heritable in offspring in the wild. A multi-entity research team led by Chris Osborne, a University at Buffalo Ph.D. candidate, evaluated Lake Trout in Lake Ontario for these changes in 2022-2024.

"Epigenetic changes in hatchery-reared fish often cause the fish to exhibit different phenotypic (observable) characteristics than their wild counterparts. These differences may be neutral or beneficial under hatchery conditions but are often disadvantageous in the wild."
— Lead Investigator Chris Osborne

Lake Trout Epigenetics Research & Outreach Team

Christopher Osborne, Ph.D. candidate; and Trevor Krabbenhoft, Ph.D.
Krabbenhoft Fish Genomics Laboratory, University at Buffalo

Stacy Furgal, Great Lakes Fisheries & Ecosystem Health Specialist;
Nate Drag, Great Lakes Literacy Specialist
New York Sea Grant

Jessica Goretzke, Aquatic Biologist
New York State Department of Environmental Conservation
Dimitry Gorsky, Ph.D., Fish Biologist
U.S. Fish & Wildlife Service

Efforts to re-establish once-extirpated populations of Lake Trout in New York's Great Lakes have built abundant populations of adults, but negligible wild reproduction means these lakes are maintained entirely by stocking of hatchery-reared Lake Trout. Epigenetic changes in the fish may be hindering the survival of Lake Trout as a native top predator. Impacted fish may exhibit difficulties with visual acuity and predator avoidance, and use of novel habitats, further suggesting reasons for reduced survival of Lake Trout stocked into the Great Lakes.

The research team compared genome-wide characteristics of four strains of hatchery-raised Lake Trout to wild Lake Trout of the Seneca Lake strain predominately stocked in the lower Great Lakes. A snapshot of data results shows the following differences between the hatchery fish and their wild counterparts.

Twenty genes were significantly different between the Seneca Lake strain of wild Lake Trout and those of four stains of hatchery-origin Lake Trout. Nine (45%) of those genes are involved with neurological processes and development in the fish. One gene that affects synaptic plasticity, learning, and memory differed between all hatchery-origin fish compared to wild fish, but was identical in all hatchery fish regardless of their genetic strain.

"These results suggest that the conditions experienced by hatchery-reared Lake Trout during early life stages alter the epigenetic programming of genes involved in neurological development, which may contribute to commonly-observed phenomenon of hatchery-reared fish having underdeveloped brains and exhibiting behavior abnormalities relative to their wild counterparts," said Chris Osborne

The preliminary data also suggest that the hatchery-induced epigenetic alterations persist into adulthood and may be passed on to offspring of stocked fish in the wild. The baseline data from this GLRC seed grant project serve as pilot data for further research to inform the management of hatchery environments so that they more closely reflect wild conditions. This supports the fish stocking, survival, and restoration goals for the Great Lakes ecosystem.

Taking Fishery Research to School

New York Sea Grant Great Lakes Literacy Specialist Nate Drag and Great Lakes Fisheries & Ecosystem Health Specialist Stacy Furgal are incorporating the epigenetics project data and insights into lesson plans for grades 8-12 teachers. The lesson plans apply the 5E strategy to: 1) engage students in 2) exploring through interactive activities, including practicing coding using data derived from the above epigenetics research project; 3) explaining the lessons in their own words; 4) elaborating on the topic beyond the lesson activities; and 5) evaluating the objectives of the lessons. The curriculum, to be published in 2025, includes an interactive story map and worksheets for learning about fish hatcheries, research facilities, and public resources related to Lake Trout restoration in the Great Lakes.

Assessing Cyanobacterial Types & Toxins in Canandaigua Lake

In 2022, the Canandaigua Lake Watershed Association (CLWA) partnered with the GLRC to assess lake samples for cyanobacteria morphotypes and toxins associated with harmful algal blooms (HABs). The analysis revealed some surprises and added more data to the CLWA's mission to further their understanding of what may be the unique reasons for HABs in their lake.

Volunteers collected end-of-dock water samples weekly from locations on both sides of the lake. The samples were shipped to a laboratory for toxin and nutrient testing. The samples were also matched with IoLight microscope images to determine which cyanobacteria (blue-green algae) were present. The cyanobacteria genus *Microcystis* was the dominant cyanobacteria in the samples. Dr. Greg Boyer, an internationally respected HAB researcher, was surprised that the *Microcystis* morphotypes present in oligotrophic (relatively low in nutrients) Canandaigua Lake were very distinct from those observed in nearby oligotrophic Skaneateles Lake.

More research is needed to match these morphotypes to the nutrient and toxin levels in the water column in Canandaigua Lake. The CLWA is also interested to compare its nearshore sampling with that of researchers working at mid-lake and to learn the role of dreissenid mussels and nutrient pulses delivered by rain events on the formation of cyanoHABs.

"Our blooms tend to be highly toxic. What is unusual about Canandaigua Lake is that we are considered a low nutrient lake and, by conventional thinking, should not be experiencing the harmful algal blooms we are. I'm glad CLWA can be part of advancing understanding of what causes these blooms in low nutrient lakes because until we understand what causes blooms, we really can't do anything to mitigate them."
— Sally Napolitano, Project Lead for CLWA and Past CLWA Board Member

Great Lakes Sediment and Lake Trout Gut Microbiomes

A vast diversity of microbes (microbiomes hereafter) live in the environment and mediate biogeochemical processes (free-living microbes) or contribute to animal/plant fitness (host-associated microbes). Microbiomes of the ocean-like Laurentian Great Lakes are far less studied compared to their counterparts in small lakes.

With GLRC support in 2024, and through collaboration with the U.S. Environmental Protection Agency Great Lakes Fish Monitoring and Surveillance Program and researchers at Clarkson University, Professor Yaqi You at SUNY ESF is characterizing microbiomes in sediment and the gut of a top predator fish, Lake Trout (*Salvelinus namaycush*), at different locations across the Great Lakes.

Findings from this research will advance our understanding of the gut microbiome in wild fish and its responses to environmental changes. It will provide novel baseline data to support the Great Lakes $7 billion fisheries, a key feature of the region's economy. Watch for more on this research in the future.

First Population Genetics Study of Mystery Snail

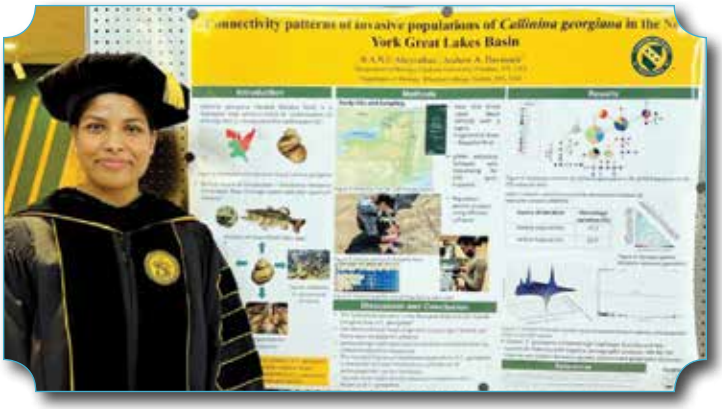
Professor Andrew Davinack of Clarkson University initiated the first population genetics study of *Callinina georgiana*, the freshwater banded mystery snail in New York's Great Lakes Basin watershed in 2021.

This mollusk species is native to the southeastern U.S. It was intentionally introduced into Erie Canal and Mohawk River in 1867 by an amateur conchologist (*one who studies mollusks*). Aquarium releases helped this snail spread. It was reported in Lake Erie in 1914 and in Lake Michigan in 1926.

C. georgiana* is a known egg-predator of fish native to Great Lakes' waters such as the largemouth bass. It can reach high densities in small lakes and ponds, and, as an intermediate host to trematodes (flatworms/flukes), was implicated in a mass die-off of aquatic birds in 2007 on a lake in northern Wisconsin *(Morningstar et al., 2024).

The Clarkson study assessed the connectivity patterns of *C. georgiana* for the first time in its invasive range using cellular (mitochondrial and nuclear) markers. Samples were collected in New York's Great Lakes basin watershed from Sodus Bay on Lake Ontario, near Ogdensburg on the St. Lawrence River (SLR), and in the Adirondack region along the Raquette River, Cypress Creek (Grasse River tributary), Wheelers Creek and Lower St. Regis Lake near Paul Smiths College.

DNA was sequenced from 14 different populations (229 individuals) from the New York waters for comparison with two native populations of *C. georgiana* supplied by colleagues in Alabama.



Graduate student Nimanthi Abeyrathna presented the mystery snail project results at a research showcase at Clarkson University's new college president inauguration.

Genetic diversity and demographic data were indicative of population expansion and diversification of groups of genetic markers/DNA variations inherited together through a single parent (called haplotypes). Ten of the 80 haplotypes identified were shared and 70 were unique in NY. The southern populations exhibited comparably lower haplotype diversity. Populations from the isolated water bodies of Lake George and Lower St. Regis Lake shared haplotypes with populations from the main Raquette River, indicating a complex pattern of dispersal or possibly independent secondary introductions.

Map of C. georgiana collection locations.

The 146-mile Raquette River is New York's third longest river. It is a highly fragmented river system with 27 dams. The occurrence of these dams might have been expected to impeded the snail's movement. However, the observed high levels of connectivity and expansion of the snail's populations suggest other factors are involved, such as human traffic and boat traffic.

***Callinina georgiana* is rare among gastropods in that it is ovoviviparous (hatching its eggs within its body), producing 4-80 live young with limited dispersal capabilities. Human activity has moved this species beyond its native and invasive ranges.**

This type of research often informs invasive species prevention and/or management strategies. This project shows that *C. georgiana*'s genetic diversity or connectivity was not restricted by dams nor distance between waters. The management of this invasive species may prove difficult.

Professor Kathleen Cleary, SUNY Potsdam, was a project collaborator. Student Nimanthi Abeyrathna is now an assistant professor at Rivier University.

Proof of Concept: Predicting Coastal Erosion Risk

Were the record high water events in 2017 and 2019 along Lake Ontario an anomaly?

With a Great Lakes Research Consortium grant, Binghamton University Professor Peter L.K. Knuepfer and graduate student Matthew Cameron developed GIS-based data sets for in-depth analysis of space-time variations in coastal erosion along Lake Ontario. Georeferenced aerial photographs and other imagery from 1875 to 2021 for the shoreline of Niagara and Orleans counties were rectified to Lake Ontario base maps (generally 2014-2015 digital orthoimagery). Short- and long-term rates of shoreline recession and accretion (increase) were calculated. The project was designed as a proof-of-concept effort to use imagery to identify patterns of increased risk of shoreline erosion.

A Snapshot of Findings

The study area spanned the shoreline from Fort Niagara east to the Orleans-Monroe county line (108.3 km). This stretch of shoreline was identified as having areas of high rates of bluff erosion. The evaluation focused on imagery between 1938 and 2021.

- The higher recession rates observed in Niagara County (1938-1951) and in Orleans County (1963) correlate directly to a mid-20th century period of above-average lake levels.
- Average shoreline recession rates from 1938-2021 were <0.1 meter/year (m/yr) to 0.94 m/yr in Niagara County and <0.1 to 1.08 m/yr in Orleans County.
- The greatest erosional rate observed in a single transect was 6.12 m/yr in Orleans County between 2015 and 2020
- The greatest accretional rate at a single transect was 2.23 m/yr in Niagara County between 1951 and 1966.
- In Niagara County, the maximum erosional rate was 3.7 m/yr between 1951 and 1966; the maximum shoreline advance in the county was 2.23 m/yr in that timeframe.
- In Orleans County, the maximum recession rate was 6.12 m/yr between 2015 and 2020 east of the jetties at Bald Eagle Marina; the maximum shoreline advance in the county was 1.95 m/yr between 1994 and 2005.
- Most accretion rates were a result of the installation of protruding structures, such as a groin or jetty. In Niagara County, significant erosion was limited after rip rap was installed in an area that was undeveloped from 1966 to 1994.

Conclusions: This study identified locations with consistently receding shoreline and locations sporadically impacted by erosional events. High water levels, whether persisting over time, as in the 1940s-1950s, or short-duration events superimposed on longer term increases, such as in the 2010s, produced the highest rates of recession in the study area.

Application of coastal engineering and natural/nature-based solutions were implemented in response to Lake Ontario high water events in 2017 and 2019. Hardening of the shoreline can retard erosion and prevent damage to the shoreline. However, this hardening can fail as evidenced by locations where pre-2017 rip rap or other protection fully separated from the shore. This prompts concern about the long-term effectiveness of the emplacement of rip rap at the base of bluffs, particularly if the pattern of long-term lake-level increase in the Great Lakes continues into the future.

These project results were shared with County Soil and Water Conservation Districts managers, legislators, the New York State Department of Environmental Conservation, and other coastal management entities. The project report is being updated in 2024 with the latest aerial imagery.

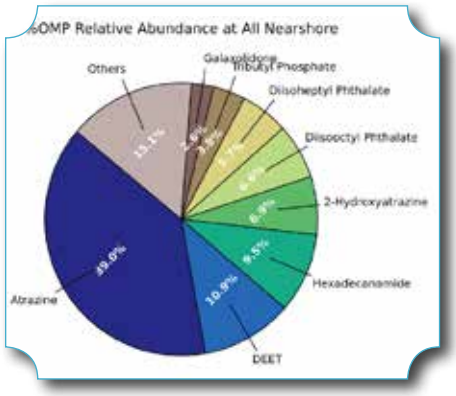
In Orleans County, the maximum recession rate was 6.12 m/yr between 2015 (top image) and 2020 east of the jetties at Bald Eagle Marina.

Identifying Microplastics & Contaminants in Nearshore Lake Ontario

A collaboration by Syracuse University (SU) and the Upstate Freshwater Institute (UFI) focused on the abundance and characterization of microplastics and organic micropollutants (OMPs) in Lake Ontario. Water samples were collected at three embayments: Lakeview Pond, North Sandy Pond, and Port Bay, and at offshore locations at Oswego, Sodus Bay, and Oak Orchard between May and November of 2023.

Microplastics Pervasive in Lake Ontario

More than 3,800 microplastics were identified from the field sampling. On average, the highest concentration was at Oswego; the lowest concentration at Sodus Bay. However, there was no significant difference in concentrations across all six locations.



SU Associate Professor Teng Zeng and Andrew Brainard and David Matthews with UFI hypothesized that microplastic concentrations would be higher in embayments with greater anthropogenic development, i.e., septic systems, shoreline development, treated wastewater discharges in the watershed. Lakeview Pond is within a NYSDEC Wildlife Management Area with no properties along the shoreline and an extensive wetland complex draining to the embayment. North Sandy Pond and Port Bay, however, are heavily developed with private properties and built structures along their respective shorelines. Contrary to the original hypothesis, there was not a statistical difference between microplastic concentrations in the three embayments.

Organic Micropollants Ubiquitous Nearshore

At the offshore locations, Polar Organic Chemical Integrative Samplers (POCIS) were attached to water quality buoys on Lake Ontario. Grab samples were collected at the embayment sites. OMPs were classified into three major groups: herbicides[1]; pharmaceuticals[2], and household and industrial chemicals[3]. Mass spectral features suggest several OMPs included transformation products less frequently targeted or never previously detected in the Great Lakes Basin.

There was a ubiquitous occurrence of 30 organic micropollutants in the nearshore waters of Lake Ontario. There no significant differences across sites, despite differences in land uses/activities.

The results from this GLRC-supported project have improved sampling approaches due to equipment loss under lake conditions and unexpected fiber contamination by filters. The project has created a scientific basis for new research and new funding.

[1]Atrazine co-occurred with three transformation products as a mix in all nearshore waters.

[2] The detected pharmaceuticals included the wastewater indicator compound caffeine, prescription drugs, a veterinary antibiotic, and a synthetic anabolic steroid.

[3] Seven household/industrial chemicals and atrazine accounted for nearly 85% of the total concentrations attributable to OMPs; however, OMP quantification based on isotope dilution was advised to further confirm the quantitative importance of these eight relative to other OMPs captured by POCIS.

Testing Phosphorus Removal Technique

In response to concerns about phosphorus (P) input into freshwater bodies, the Finger Lakes Institute (FLI) at Hobart and William Smith Colleges and Seneca Watershed Intermunicipal Organization collaborated to investigate the potential to use P sorption media (PSM) to remove P from tile drain water.

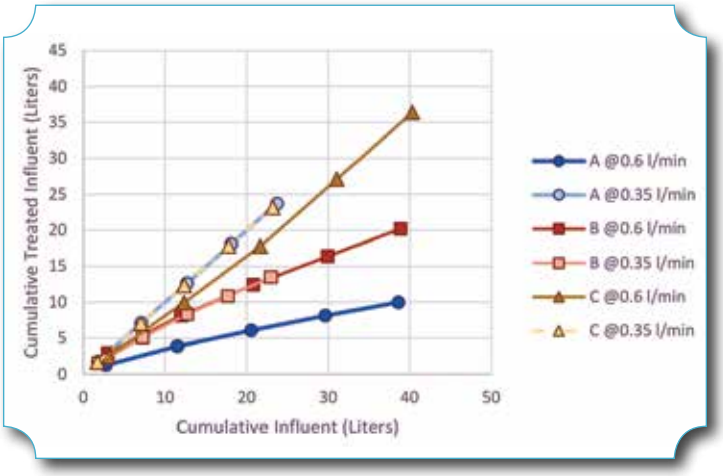
A combination of biochar and iron oxide-based acid mine drainage sludge (AMD) was tested for P removal from tile drainage effluent from agricultural land in the Seneca Lake and Cayuga Lake watersheds. This novel combination was selected as a potential low-cost and environmentally-beneficial medium for phosphorus removal.

Biochar - charcoal/black carbon produced by thermal or chemical conversion of biomass sources - has the ability to hold carbon in the soil. Seneca Biochar provided biochar made from ash and maple wood. The AMD was mixed 20% by volume with the biochar. Different biochar particle sizes were used to create three blends for testing. These blends were washed with deionized water to release soluble reactive P (SRP) and total P (TP).

The influence of sediment P levels and influent/effluent flow rates on the different blends were tested in a laboratory setting. The blends were gravity-driven through geotextile fabric and the resulting samples analyzed for SRP and TP.

Project Results Overview

- Net P removal efficiency rates for soluble reactive P varied widely: 95% to -3%.
- Lower permeability blends had higher rates of degradation in efficiency over time. However, no statistically significant relationship was observed between composition and influence sediment concentration or flow rate.
- An overly-enriched AMD and the susceptibility of the blend to the formation of preferential flow channels were implicated as the principal causes of the high variability of results.
- Total phosphorus reduction ranged from 90% to -260%. This variability was likely due to PSM loss through the geotextile fabric. Persulfate digestion caused the subsequent release of P from the biochar.



Proportion of influent treated under differing flow rates for each PSM blend.

- Increasing influent flow rate had a detrimental effect on P removal efficiency. For two blends, efficiency increased under low flow rates, while removal under high and low flow was similar for the third blend.

"In spite of the high variability of the data obtained in this initial testing, the observed level of P reduction efficiencies under low residence times in the treatment chamber suggested the potential to alter the PSM design to test under field conditions."
— Project leader Ian Smith, Seneca Lake Watershed Steward, Finger Lakes Institute, Hobart and William Smith Colleges

Hunt Country Vineyards in Yates County in New York's Finger Lakes region produces its own biochar for field application.

Lake Ontario Piping Plover Restoration Update

The Great Lakes region at one time attracted several hundred pairs of Piping Plovers, a native North American species found on coastal sand and gravel beaches. Over time, threats to the little shorebirds by predators, humans, and weather events caused a decline that led to federally endangered species listing for the Great Lakes plover population in 1986. There are also distinct Atlantic Coast and Northern Great Plains populations of Piping Plover.

"The Piping Plover is a North American natural heritage species that serves a unique ecological role as a sentinel of the health of our beach and dune systems."
— Jonathan Cohen, Ph.D., Wildlife Ecology & Management Professor, SUNY College of Environmental Science and Forestry (ESF)

This little bird has a big support network of researchers, government agencies, nonprofits, and citizens. With a Great Lakes Research Consortium research grant, Dr. Cohen and his students collaborated with New York Great Lakes Piping Plover Recovery Program members: Audubon New York, Onondaga Audubon, New York State Parks, NYS Department of Environmental Conservation, U.S. Fish & Wildlife Service, U.S. Animal & Plant Health Inspection Service and volunteers to conduct research and restoration efforts along Lake Ontario's eastern shore.

Interest in the species was re-energized in New York in 2015 with observation of the first nesting pair of plovers since 1984. The migratory birds tend to return to their nesting territory year-to-year. From 2017-2020, the team documented preferred habitat areas, monitored threats, tested the use of exclusion protection over nests, produced plover habitat management guidelines, and conducted "Share the Shore" public education that reached more than 50,000 people. This work attracted funding from the U.S. Fish and Wildlife Service to support monitoring and conservation efforts to restore the Great Lakes population.

"We have proven that we can do things to attract Piping Plover nesting pairs with reproductive success, but it requires constant effort. Numbers across the Great Lakes region in the U.S. and Ontario have reached a record high of 82 nesting pairs. This bird is among the unique success stories in that there are not a lot of endangered species that we can prove we know how to help recover."
— Professor Jonathan Cohen, SUNY ESF

Restoration efforts continue with hope. In 2024, after a predator killed the female of a nesting pair of plovers at the Lakeview Wildlife Management Area, Cohen notes, "It was a good sign that the male remained, foraging on his own, and then his male offspring appeared and stayed the rest of the season." *Members of the New York Great Lakes Piping Plover Recovery Program, await its return in 2025.

New "Waterbodies" Podcast, by ESF Professor Roxanne Razavi, Features Great Lakes Science

Episode 101: Mercury in Wetlands along Lake Ontario and the St. Lawrence River
NYS Water Resources Institute Postdoctoral Associate Evie Brahmstedt talks about her research as part of the 2023 Lake Ontario Cooperative Science and Monitoring Initiative (CSMI).

Episode 102: Monitoring Strategies for Cyanobacteria and Other Harmful Algal Blooms (HABs)
Gregory L. Boyer, GLRC Director/ESF Professor of Biochemistry, shares his experience with HABs within NYS and with the GLRC.

Episode 103: Lake Ontario Fisheries and Food Webs
Ontario Ministry of Natural Resources & Forestry Senior Research Scientist Tim Johnson shares long-term insights from CSMI research and monitoring.

Episode 104: Research and Outreach on the Great Lakes
New York Sea Grant Great Lakes Literacy Specialist Nate Drag talks about the Shipboard Science Workshop for teachers aboard the EPA *Research Vessel Lake Guardian.*

Episode 105: Shipboard Science Workshop Panel
NYSG's Nate Drag and a teacher panel, recorded at the 2023 Science Teachers Association of New York State Conference, talk about their experiences alongside Great Lakes researchers aboard the EPA *R/V Lake Guardian.*

Episode 106: Answering Students Questions about the Lake Ontario CSMI
U.S. Environmental Protection Agency Life Scientist/Watershed Management Specialist Daniel Gurdak answers questions from Marcellus High School and Rochester Virtual Academy students.

Listen to this podcast at www.esf.edu/glrc.

Invasive Species Removal and Methane Reduction

Courtney Scoles Telvock, right, and SUNY Brockport Professor Rachel Schultz, Ph.D., measure methane emissions in a wetland along Lake Ontario near Braddock Bay.

Wetlands in North America are a significant source of methane (CH_4) emissions and freshwater marshes with invasive cattail (*Typha x glauca*) infestation release ~300 percent more CH_4 from the soil than marshes with native vegetation.

SUNY Brockport graduate student Courtney Scoles Telvock assessed how invasive cattail treatment affected CH_4 emissions from areas within Braddock Bay Wildlife Management Area along Lake Ontario. She compared CH_4 release from a cattail monoculture control plot, an uninvaded meadow marsh, and sites where cattail was removed and native species restoration was completed in 2016 (Buck Pond) and in 2018 (Braddock Bay).

The project found that CH_4 emissions from coastal wetlands may be mitigated through restoration and strong establishment of native plant communities. CH_4 production was not significantly different among the sites in 2019 a record-high water year on Lake Ontario. Under lower water conditions the following year, the cattail monoculture emitted more CH_4 than the replanted sites. The uninvaded plot had the lowest average flux during the growing season.

The cattail-invaded plots on average stored a larger amount of carbon in aboveground biomass. However, soil organic carbon percentage and carbon stored in aboveground biomass did not significantly predict CH_4 flux.

A small-scale controlled experiment evaluated methane release from different soil types with and without cattail and a grass species. Substrate type was a more important factor contributing to CH_4 emissions than plant species. This has management implications in that it suggests that mowed cattail should be removed to reduce organic matter accumulation and may shorten the time to return the wetland to pre-cattail invasion levels, thereby reducing the opportunity for CH_4 release.

The results of this work provide a basis for further investigation into the complex interactions that influence methane release. The reporting highlights the impact of a Lake Ontario high water event and other factors. More research on the impact of repeated and long-term cattail harvest on belowground biomass that may hold and release methane is needed.

Courtney Scoles Telvock successfully defended her Master's thesis and is now an Environmental Analyst with the New York State Department of Environmental Conservation.

GLRC Student Support Programs

GLRC Student Research Grants

	Student	Research Focus	GLRC Member
2024	[1]Sarah Caltabiano	Role of nitrogen in harmful algal blooms (HABs) development	ESF
	[2]Abby Webster	PSP (paralytic shellfish poisoning) toxin in benthic HABs	ESF
2023	[3]Adelia Baker	Wetland restoration impacts on native & invasive grasses in the wet meadow zone in Lake Ontario coastal wetlands	Brockport
2022	^[5]Thomas Blowers	Does vitamin E concentration relate to vitamin B1 concentration in lake trout eggs?	Brockport
	^[6]Colin Clark	Do lake trout eggs & free embryos acquire thiamine during development in wild populations?	Brockport
	^[7]Nicholas Farese	Assessing the diet of lake trout from Otsego Lake using stomach content fatty acid and stable isotope analysis	Brockport
	^Presented their combined research efforts at SUNY Graduate Research Conference, February 25, 2022.		
	[9]Abby Webster	Characterizing benthic cyanobacteria community in NY's Finger Lakes	ESF
	Presented at U.S. HAB Meeting, Portland, Maine, November 2024.		
2021	[4]Rene Belleville	Assessing survivorship of planted and seeded species within restored Great Lakes coastal wetlands along Lake Ontario Brockport	Brockport
	[8]Aaron Heisey	Is thiamine deficiency in lake trout related to a lipid-rich diet?	Brockport
	[10]Devin Sonne	Quantifying microplastics in NY State freshwater bodies	ESF
	[11]Thornton Ritz	Understanding fish distribution over horizontal dissolved oxygen gradient	ESF
	[12]Cole Beale	Recreational exposure to microcystins	Oneonta

GLRC Student Travel Grants

These awards cover a portion of travel costs for students to attend local, national, and international conferences/meetings. Seventeen student travel grants were awarded in 2021-2024. Students used the support to attend events that included the International Association for Great Lakes Research (IAGLR), New York Chapter meetings of the American Fisheries Society, and other prestigious events.

GLRC Student Internships:

GLRC member institution students may apply for an internship to assist researchers on their home campus or to fill a research positions at another GLRC member campus and co-funded by that institution.

---

[1] *Presented at 2nd Annual Central NY Conference on Environmental Science & Studies, 2024.*

[2, 9] *Awarded $5,000 SUNY Graduate Research Empowering and Accelerating Talent Award, 2023; received Limnology & Oceanography Research Exchange scholarship to study in New South Wales, Australia.*

[3] *Presented at New York State Wetlands Forum, 2023.*

[4] *Presented, with faculty advisor Rachel Schultz, at International Association of Great Lakes Research, Toronto, 2023; published in Mitchelliana, quarterly journal, New York Flora Association, 2024 Winter Issue, Vol. 35.1.*

[5] *Collaborated with USGS Fish Biologist Brian Lantry and faculty advisor Jacques Rinchard on "Great Lakes lake trout thiamine monitoring program report" for the Great Lakes Fishery Health Committee, 2022; presented at American Fisheries Society meetings, 2022, 2023.*

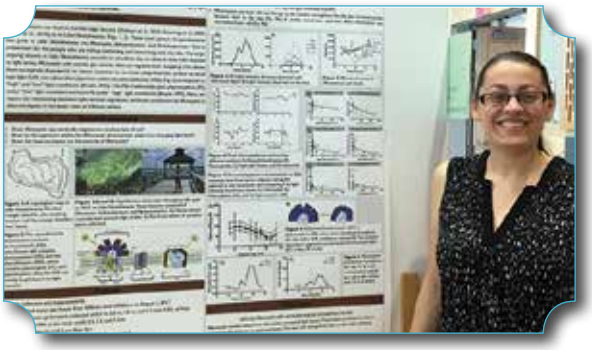
[6] *Student leader on study of lake trout in Lake Champlain, presented on his behalf by fellow student M. Futia, American Fisheries Society: NY Chapter Meeting, 2023, other student collaborators: E. Marsden and C. Suffridge; faculty advisor Dr. Jacques Rinchard.*

[7] *Presented at American Fisheries Society: NY Chapter Meeting, 2024; poster, SUNY Graduate Research Conference, 2024.*

[8] *Co-published article in Journal of Great Lakes Research, August 2023, Vol. 49:4, with C. Osborne (University at Buffalo), B. Lantry (USGS), D. Tillitt (USGS), J. Rinchard (Brockport).* [10] *Now a chemistry instructor, Mohawk Valley Community College School of Science, Technology, Engineering & Mathematics, 2024.* [11] *Current study: fish ecology on the Upper St. Lawrence River to understand how abiotic conditions influence early life stages of fish in Great Lakes coastal wetlands.*

[12] *Manuscript submitted: "Potential Exposure to Cyanotoxins While Recreating, Seasonally Dynamic Indicators of Microcystin Production."*

GLRC Alumni: Graduating to Environmental Careers



Dominique Derminio, Ph.D.,
Assistant Professor of Biology, Keuka College

As a Ph.D. research student in Dr. Greg Boyer's Lab at ESF, Dr. Derminio received GLRC travel grants to attend conferences and network with harmful algal blooms (HABs) researchers. As student and professor, Dr. Derminio has worked alongside Dr. Boyer aboard the EPA *Research Vessel Lake Guardian* on the Great Lakes. In 2024, she was lead scientist for phytoplankton research aboard the ship during its Cooperative Science & Monitoring Initiative year on Lake Erie. Dr. Derminio was recognized by Keuka College for Excellence in Teaching in 2021.

"As a student, I received travel grants to attend conferences that I otherwise would not have been able to attend. The experiences I had at Great Lakes and algal science conferences and networking with researchers in the HAB field would not have been possible without the help of the GLRC." — *Dominique Derminio*

Khris Dodson, Executive Director, New York Water Environment Association, Inc.

Khris served for 4 years as graduate assistant to GLRC co-founder/Director Dr. Jack Manno and then Dr. Greg Boyer. Khris managed GLRC member relations, administrative & programmatic activities, and GLRC student conference logistics. He created GLRC award rubrics, kept Great Lakes Basin Advisory Council minutes, edited & designed the Great Lakes Compact document and organized public hearings about the Compact. As Co-Director of Syracuse University's Environmental Finance Center, Khris led a 2018 GLRC grant-funded project that developed participatory models to empower Great Lakes community-level climate resiliency planning.

"The networking opportunities to share your research, interests, and experiences with others and to hear the same from them through the GLRC is invaluable. Working with the GLRC gave me a long list of contacts and colleagues, from high level state and federal agency workers to folks who focused on specific issues or specific geographies. Many of these contacts I am still in touch with today, some 20 years later." — *Khris Dodson*

Stacy Furgal, Great Lakes Fisheries & Ecosystem Health Specialist, New York Sea Grant

Stacy's GLRC-funded research, conducted at the U.S. Geological Survey Lake Ontario Biological Station at Oswego, analyzed young-of-year alewife diets. She presented her findings of a shift in the size & condition of Lake Ontario alewife at an America Fisheries Society NY Chapter meeting. AFS Women of Fisheries recognized her as a co-author of an article on the use of acoustic telemetry in fisheries research conducted in collaboration with the U.S. Fish & Wildlife Service in 2022. Today, Stacy is helping to mentor the next generation of aquatic researchers.

"My GLRC experience was great for building confidence and skills that would later be vital for my success in graduate school. The project provided networking and skill-building opportunities that benefited me in my career path toward New York Sea Grant." — *Stacy Furgal*

GLRC Student Alumni Now in Environmental Careers

- **Nimanthi Abeyrathna, Ph.D.: Assistant Professor, Biology, Rivier University, New Hampshire**
- **Cole Beale: Director of Conservation, Squam Lakes Association, New Hampshire**
- **Samuel Byrne, Ph.D.: Assistant Professor, Biology & Global Health/Environmental Epidemiologist, Middlebury College, Vermont**

"My experience taught me the value of building collaborative research teams to inform management of the Great Lakes, I continue that work today studying Lake Ontario fisheries."

— Michael Connerton, Ph.D., Aquatic Biologist, New York State Department of Environmental Conservation

- **Nicholas Farese: Aquatic Invasive Species Program Manager, Western NY Partnership for Regional Invasive Species Management**

GLRC Alumni: Graduating to Environmental Careers

Lillian Denecke, Great Lakes Center Research Technician, SUNY Buffalo State
Lillian received a GLRC student research grant and internships to study Chinook salmon in Lake Ontario at SUNY Brockport and Buffalo State. That experience included interaction with the NYS DEC Salmon River Fish Hatchery and a pen rearing site. The data evidenced smoltification with increased ATPase (enzyme) activity from earlier to later in the year.

"Handling a project from start to finish, conducting original research, collaborating with academic researchers and agencies, and delivering a final report product to the GLRC was a meaningful experience to have as an undergraduate student looking to a career in academic research. My GLRC experience influenced my desire to work in an academic research setting and provided me with the experience necessary to obtain the position I have today." — *Lillian Denecke*

Derek Crane, Ph.D., Professor of Biology/Fish Ecologist, Coastal Carolina University
Derek's research as a Ph.D. candidate and post-doc student at ESF in NY's Great Lakes region helped earn him the honor and responsibility of building a freshwater science program to complement the marine science curriculum as a professor at Coastal Carolina University (CCU).

With a GLRC travel grant, Derek presented his study of the spring habitat of walleye in Great Lakes tributaries at an American Fisheries Society (AFS) meeting in Minneapolis. He says, "The opportunity to travel to an AFS meeting early in my career allowed me to share the research I was doing with a broader scientific community and to meet and network with scientists and potential employers." In 2024, some of his CCU students attended the AFS meeting in Honolulu.

"The skills I developed along the Niagara River I now teach — how to sample and how to identify the diversity of fishes. My students are currently applying their focus to sandhills chub, a freshwater Species of Conservation Concern found only in North Carolina and South Carolina. I use Great Lakes research examples in my classes, everything from work on non-native species to projects funded through the Great Lakes Restoration Initiative. My Great Lakes experience on the restoration of native species to their native habitats is one of universal application." — *Derek Crane*

GLRC Student Alumni Now in Environmental Careers

- **Colby Fisher, Ph.D.: Managing Member, Research & Development, Hydronos Labs, LLC, New Jersey**
- **Ben Gallo: Associate Scientist, Biologics Research, Visterra Inc., Massachusetts**
- **Aaron D. Gerace, Ph.D.: Research Faculty, Carlson Center for Imaging Science, Rochester Institute of Technology**
- **Alison Kocek, Ph.D.: Wildlife Biologist, U.S. Fish & Wildlife Service Southern New England Coastal Program**
- **Jarrod Ludwig: Aquatic Biologist, New York State Department of Environmental Conservation**
- **Chris Nack, Ph.D.: Ecology Scientist, Ramboll global engineering, design & sustainability consultancy, Denmark/Syracuse, NY**
- **Margaret Pavlac, Ph.D.: Instructor, Biochemistry/Chemistry/Environment/Physics, Suffolk University, Massachusetts**
- **Isabel Porto-Hannes, Ph.D.: Teaching Assistant Professor, Environment & Sustainability, University at Buffalo, New York**
- **Nicholas Sard, Ph.D: Professor, Great Lakes Biology/Evolutionary Ecologist, SUNY Oswego, New York**
- **Courtney Marie Scoles Telvock: Environmental Analyst, New York State Department of Environmental Conservation**

Visioning the Future of the GLRC

Organizations with an interest in the health and sustainability of the Great Lakes met in 2022 to brainstorm the future of the Great Lakes Research Consortium (GLRC). The gathering included representatives of the GLRC, Great Lakes Basin Advisory Council, New York State Departments of Environmental Conservation and State, and New York Sea Grant. Additionally, 32 scientists from across the GLRC's 18 New York member institutions responded to a survey developed by New York Sea Grant and GLRC. Here is a summary of this visioning effort.

GLRC Mission

Those surveyed affirmed the GLRC mission to support, expand, and facilitate research for New York's Great Lakes and other water bodies within New York's Great Lakes watershed. This research informs, advances, and leverages implementation of Great Lakes-focused state and regional plans and policies as well as Great Lakes interests of its Canadian affiliates.

The preferred function for the GLRC was identified as the provision of small grants, by competitive application, to support small-scale research projects, noting that these projects are often the basis for applying for larger funding. E-mail was selected as the preferred method of communication, and strong interest in networking via in-person meetings, either Great Lakes basinwide or by sub-basins, was expressed.

Participants shared comments related to the existing and potential functions of the GLRC and on barriers and opportunities of working across multi-campus collaborations and as a consortium. Ideas were invited for increasing the attractiveness for conducting Great Lakes research and potential services and functions that the GLRC could provide going forward.

GLRC Strengths Identified

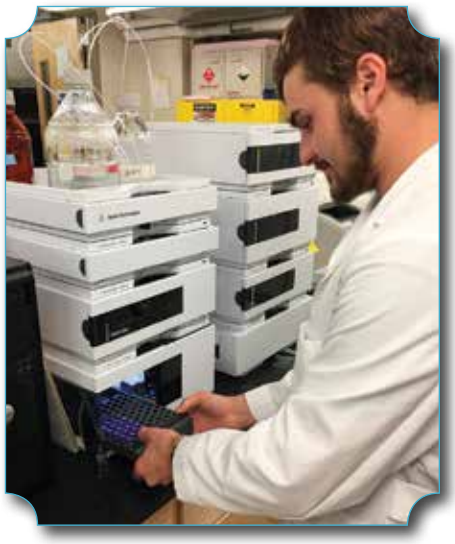
- Serves multiple higher education institutions in New York State.
- GLRC research informs, advances, and leverages implementation of the goals of state and regional plans and policies re: New York's Great Lakes and its watershed.
- Fosters the next generation of Great Lakes-focused researchers and environmentally-focused workforce, e.g., natural resource managers, fisheries specialists, environmental engineers, policy experts, and environmentally-aware citizens and stewards.
- Provides opportunities for cross-member and multi-disciplinary collaboration by faculty and students.

GLRC Membership and Participation Ideas

- Incentivize participation by all member institutions by supporting contractual, communication, networking, and other mechanisms that facilitate direct support of, and partnership with, GLRC member universities and colleges, state agencies, and other potential partners.
- Increase the amount/number of grants available for research investigator and institution participation.

GLRC Fosters Great Lakes Scientists

GLRC mentoring of students and funding of student research, internships, and conference travel/presentation opportunities have helped scores of students to reach their environmental career goal. Likewise, the GLRC has advanced the careers of new faculty conducting innovative and investigative research on Great Lakes issues. The GLRC's support of first-time research efforts has often provided a vital foundation for leveraging larger funding from other sources to continue and expand the research.



Visioning the Future of the GLRC

Ideas to Expand the Community of Students, Faculty and Partners in Great Lakes Research

- Continue funding student research and travel to incentivize interest in working in the Great Lakes environment.
- Engage students from underrepresented groups in the sciences through scholarships, research support, etc. to diversify participants in Great Lakes research.
- Actively recruit community college students interested in a 4-year degree in Great Lakes science.
- Utilize the GLRC grants program as an entry point for new researchers.
- Promote mentoring of new faculty, staff, and students as a means for recruiting and increasing diversity; assist in identifying how their research interests align with Great Lakes issues.
- Support open-access fees for scientific publications based on GLRC-funded research.
- Assist New York State academic institutions, faculty, and students in pursuing support from the New York Great Lakes Protection Fund, EPA Great Lakes Protection Fund, National Science Foundation, and other funding opportunities.

"The GLRC is a wonderfully collaborative network well suited to facilitate our understanding of the Great Lakes. I absolutely recommend the GLRC to today's environmental science students."
— Stacy Furgal, Great Lakes Fisheries and Ecosystem Health Specialist, New York Sea Grant

GLRC Organization into 2025 and Beyond...

- Adapt GLRC organizational/leadership structure to manage the GLRC and engage the full GLRC membership across its multiple universities and institutions. Establish an Executive Director/program leader position to administer and coordinate the GLRC; establish an executive/leadership group to help develop and drive the GLRC research agenda, justify and leverage funding, and ensure that research is responsive to major developing issues.
- Continue GLRC support of applied and original research to ensure that existing Great Lakes issues and emerging and future issues are addressed.
- Enhance GLRC's position as scientific advisory partner to NY's Great Lakes the Great Lakes Action Agenda (GLAA) and New York's Great Lakes Basin Advisory Council; maintain GLRC capabilities to continuously update the Council and other decision-makers on Great Lakes issues and scientific developments.
- Prepare scientific briefings to educate and engage policymakers and decision-makers on Great Lakes issues.
- Recruit and coordinate New York researchers' participation in Great Lakes programmatic and policy areas in support of New York's GLAA, the Great Lakes Water Quality Agreement (GLWQA), etc.
- Coordinate and align GLRC members' research with, and participation in, initiatives including, but not limited to, the GLWQA Annexes, the bi-national Cooperative Science and Monitoring Initiative, International Joint Commission Science Team, Great Lakes Compact Science Agenda, New York State Harmful Algal Blooms research agenda, etc.
- Promote and integrate GLRC research findings with management programs, e.g. fisheries stocking, etc.
- Explore hosting a statewide research conference with GLRC members.
- Seek opportunities to collaborate on research opportunities with major science institutions across the Great Lakes basin and with major watershed programs nationally.

Visioning the Future of the GLRC

Build Partnerships and Knowledge Sharing Across All Great Lakes Sectors
The following ideas were suggested for developing, promoting and disseminating GLRC research, with emphasis on knowledge transfer among the Great Lakes science community and to Great Lakes managers and decision-makers.

- Develop a clearinghouse of Great Lakes data and research.
- Develop and facilitate implementation of an integrated/complimentary Great Lakes science agenda that supports the priorities of state and regional policies with flexibility to address new issues as they arise
- Facilitate ad-hoc and multi-disciplinary scientific collaboratives to address timely and pressing Great Lakes issues and related New York State priorities, using a social-ecological-systems perspective that emphasizes sustainability and resilience (e.g., coastal processes, ecosystem resilience, harmful algal blooms response, climate change, wind energy development...)
- Promote community-based learning and co-production of knowledge across all Great Lakes sectors, e.g., academic, business, faith-based, social, etc.; work with New York Sea Grant extension and others to link research to educational and extension programming.

Special thanks to New York Sea Grant Associate Director Katherine Bunting-Howarth, Ph.D., J.D., for coordinating the GLRC member's survey.

Lake Ontario Nearshore Hydrodynamic-Ecological Model Update

The 2015-2017 GLRC Report highlighted the development of a combined hydrodynamic and ecological model. The Lake Ontario Ecosystem Model was completed by a collaboration of the University at Buffalo (UB) and LimnoTech, Ann Arbor, MI. The model is designed to assist Lake Ontario nearshore research and monitoring. It was developed with a focus on the nearshore lower food web. Much of the data used to calibrate and test the model was drawn from the binational Cooperative Science and Monitoring Initiative years of 2008, 2013, and 2018 on Lake Ontario.

The model can be used to simulate the eutrophication processes in the lake to evaluate "what if" management questions, such as how might the lake react to 1) changes in phosphorus/nutrient loading, 2) movement of nutrients in the nearshore, or 3) strategies for nutrient abatement.

The research and development team members included Joseph Atkinson, Ph.D., Yuan Hui, Ph.D., and Zhenduo Zhu, Ph.D., of the UB Department of Civil, Structural and Environmental Engineering; and Derek Schlea, ecological engineer, and Todd Redder, technology officer, with LimnoTech.

The Lake Ontario Ecosystem Model now resides with the U.S. EPA which provided development funding through the Great Lakes Restoration Initiative. UB and LimnoTech. have copies of the model. The GLRC and U.S. Geological Survey also supported this project.

"Models are of value when they increase the likelihood that choices will be based on the best available science and when they facilitate the selection of policies that achieve goals in the most efficient and effective manner."
—"The Use of Models in Great Lakes Decision Making: An Interdisciplinary Synthesis,"
J. Manno, R. Smardon, J. DePinto, E. Cloyd, S. Del Granado

GLRC Grants & America's Blue Economy

GLRC 2021-2022 Grants Distribution

- Syracuse University, Upstate Freshwater Institute
- University at Buffalo
- Binghamton University
- Clarkson University
- Hobart and William Smith Colleges (HWS)
- Seneca Watershed Intermunicipal Organization (HWS)
- SUNY ESF: 2021
- SUNY ESF: 2022

A Sampler of Recent GLRC Grants

A random sampling over 11 grant award years shows 16 universities/entities received a total of 48 small grants:

Binghamton • Buffalo Niagara Riverkeeper
Buffalo State • Brockport • Clarkson • Cornell
ESF • Fredonia • Hobart and William Smith
Niagara • Oswego • Stony Brook • SUNY ESF
Syracuse • University at Buffalo
University of Rochester

"If American coastal counties were an individual county, they would rank third in the world in GDP, surpassed only by the United States and China. The prosperity and security of this nation is therefore predicated on the understanding, health, and sustainable use of our oceans, coasts, and Great Lakes."

National Oceanic and Atmospheric Administration
www.noaa.gov/blue-economy

Thank You, NYS DEC, NY EPF, and ESF!

The Great Lakes Research Consortium (GLRC) thanks the New York State (NYS) Department of Environmental Conservation (DEC) and NYS Environmental Protection Fund (EPF) for funding the GLRC in support of Great Lakes research and the mentoring of the next generation of environmental scientists; and thanks the SUNY College of Environmental Science & Forestry for hosting the GLRC.

"The GLRC is a key scientific partner in New York's Great Lakes watershed, leading collaborative research and education since 1986. Under New York State Great Lakes Action Agenda 2023,New York State Department of Environmental Conservation (NYS DEC) looks to continue the important work of the GLRC to better understand and manage the complex environmental issues of today and prepare to the challenges of tomorrow."
— Shannon Dougherty, Great Lakes Program Manager, New York State Department of Environmental Conservation (NYS DEC)

"The Great Lakes Research Consortium started with the premise that the ecology of the Great Lakes is constantly evolving, necessitating the implementation of constant environmental monitoring and research to understand not only the state of the immediate ecosystem but the causes and impacts of occurring and emerging changes."
— Don Zelazny, Immediate Past Great Lakes Program Manager, NYS DEC

Great Lakes Research Consortium

320 Jahn Lab, SUNY ESF
1 Forestry Drive, Syracuse NY 13210
315-470-6825 • www.esf.edu/glrc

Report Editing & Design: Kara Lynn Dunn. Photos: Kara Lynn Dunn, Save Our Sodus, SUNY Brockport, SUNY Buffalo State College, SUNY Fredonia, SUNY ESF, Tao Tang, Michael Twiss, USGS, Wayne County Tourism, Brian P. Whattam