

# Great Lakes Research Consortium 2015-2017 Report

***32 Years of Collaboration & Excellence in Great Lakes Science***









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# Great Lakes Research Consortium
# 2015-2017 Report

*32 Years of Excellence in Working Together*
*to Advance Great Lakes Research, Outreach & Education*

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# Advancing Great Lakes Science

## *A message from Great Lakes Research Consortium Director Dr. Gregory L. Boyer*

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The Great Lakes ecosystem is a critical resource of immense environmental, cultural, and economic value to the states and provinces that border the system. Millions of people depend on the Great Lakes for drinking water; the waters carry commerce and generate hydropower. The system provides habitat for diverse wildlife and supports multi-million dollar fishery and recreational industries.

Properly managing the Great Lakes ecosystem is essential. The natural uncertainty associated with any environmental system requires diligent attention to research, monitoring, and, when needed, a well thought-out, science-based response to natural and manmade challenges.

I believe the Great Lakes benefit from an "*It takes a consortium*" approach. The Great Lakes Research Consortium (GLRC) integrates multi-disciplinary scientists, from ecologists to economists, to address toxic algal blooms, fish die-offs, shoreline and wetland degradation, aquatic invasive species, manmade pollution including microplastics and pharmaceuticals contamination, aging infrastructure, water quality, coastal economic impacts, and other critical issues.

The core mission work of the GLRC and its member institutions is steadily advancing our understanding of the components, complexities, and interactions of the Great Lakes ecosystem.

This report highlights projects that are contributing valuable information to our knowledge base; testing new technologies, such as airborne and underwater sensors; and proactively anticipating the impact of an impending release of legacy loads of mercury sequestered by wetlands about to be reduced by nearly one-third by new water level regulations. We are excited about funding the early stages of the development of a super model that will support nutrient management of the lakes.

The grants awarded by the GLRC kickstart innovative exploration and often proactive versus reactive investigations. You will see examples herein of how these small-scale projects establish preliminary data for leveraging additional grants from larger entities to conduct broader research.

Dr. Richard Smardon, who helped form the GLRC in 1986, recently offered this perspective: "*The Consortium (GLRC) has grown from a grassroots organization with just a couple of academic institutions doing research on the fisheries food chain in New York's Great Lakes to now addressing invasive species, toxicity and pollutant issues and their impact on the ecosystem and human and animal health. The early research by GLRC member institutions sparked the creation of a critical mass of science and knowledge that has enabled better results from cleanup and restoration efforts in Great Lakes hot spots, and that work has given researchers a foundation for accessing extramural grant funding.*"

In recent years, we have seen a tremendous response from legislative and agency leaders providing funding to support Great Lakes research. We invite our member institutions to take a renewed look at how the GLRC grants can support faculty and student research interests in the Great Lakes basin, fund student travel to workshops and conferences where they can present their work, and underwrite internships that provide students with on-the-job, resume-building experience.

This is an exciting time to be involved in Great Lakes science and research! Learn more at www.esf.edu/glrc.

***— GLRC Director Gregory L. Boyer***

# Great Lakes Research Consortium (GLRC)
# Member Institutions & Affiliates

The Consortium's 18 colleges and universities in New York State, and nine affiliate campuses in Ontario, Canada, are dedicated to collaborative research and education to advance the science and understanding of the Great Lakes. A Board of Governors directs Consortium-wide policy and direction.

### University at Albany
Board: James Dias, Ph.D., Vice President for Research
Campus: Ellen Braun-Howland, Ph.D., Environmental Biology Laboratory Director

### Binghamton University*
Board: TBD
Campus: TBD

### The College at Brockport*
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Campus: Jacques Rinchard, Ph.D.,Environmental Science & Ecology Interim Chair

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Campus: Joseph Atkinson, Ph.D., Great Lakes Program Director

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Campus: Michael Twiss, Ph.D, Biology/Limnology Professor

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Campus: Sherri Mason, Ph.D., Department of Geology & Environmental Sciences Chair

### Geneseo*
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Campus: Robert Simon, Ph.D, Biology Professor

### Hobart and William Smith Colleges
Board: Lisa Cleckner, Ph.D, Finger Lakes Institute Director
Campus: Tara Curtin, Ph.D., Geoscience Associate Professor

### Oswego*
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Campus: Timothy Mihuc, Ph.D, Environmental Science/ Ecology Professor

### Potsdam*
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Campus: Robert Snyder, Ph.D.,Biology Associate Professor

### Rochester Institute of Technology
Board: TBD
Campus: Anthony Vodacek, Ph.D, Imaging Science Professor

### St. Lawrence University
Board: Valerie Lehr, Ph.D., Vice President & Dean of Academic Affairs
Campus: Carolyn Johns, Ph.D, Environmental Studies Professor

### Syracuse University
Board: Zhanjiang (John) Liu, Ph.D., Vice President for Research
Campus: Teng Zeng, Ph.D., Assistant Professor of Civil and Environmental Engineering

### Partner: New York Sea Grant
Board: Katherine Bunting-Howarth, Ph.D., Associate Director, New York Sea Grant; Assistant Director, Cornell Cooperative Extension
Campus: David G. White, Coastal Recreation and Tourism Specialist^

^ *GLRC Associate Director*

* *State University of New York institution*

### 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 Small Grant Awards 2015-2017

## 2015 Awards

**Project: Non-native bloody red shrimp in the Great Lakes Basin: Developing novel methods for early detection and quantifying interaction with fish in New York State**
**Principal Investigator:** Meghan Brown, Hobart and William Smith Colleges

**Project: The use of low-altitude unmanned helicopter remote sensing to detect invasive plant species in the Erie Canal System: method development applied to water chestnut (*Trapa natans*)** *(see p. 8)*
**Principal Investigator:** Tao Tang, Buffalo State College*

**Project: The past is the key to the future: Can we use water isotopes to reconstruct rain and lake effect snowfall during past warm climates?**
**Principal Investigator:** Elizabeth Thomas, University at Buffalo*

## 2016 Awards

**Project: Assessing causes and impacts of thiamine deficiency in salmonid fish from Lake Ontario** *(see p. 6)*
**Principal Investigator:** Jacques Rinchard, The College at Brockport*

**Project: Analysis of a large multi-lake dataset to advance understanding and management of harmful algal blooms in New York State**
**Principal Investigators:** David A. Matthews, Upstate Freshwater Institute; Kimberly L. Schulz, ESF College of Environmental Science and Forestry*

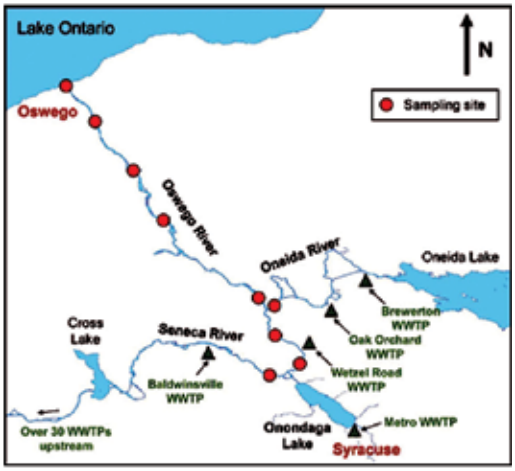
**Project: Testing a metabarcoding approach to food web analysis: application to mysid diets in Lake Ontario**
**Principal Investigators:** Matthew Hare, Lars Rudstam, Cornell University

## 2017 Awards

**Project: Assessing the role of nitrogen in harmful algal blooms in the Great Lakes Basin (Honeoye Lake)**
**Principal Investigator:** Lisa B.Cleckner, Finger Lakes Institute at Hobart and William Smith Colleges

**Project: Economic value of controlling aquatic invasive species in New York State**
**Principal Investigator:** Martin Heintzelman, Clarkson University

**Project: Studies on mercury mobilization from wetlands along the upper St. Lawrence River in support of ecosystem-based management** *(see p. 9)*
**Principal Investigator:** Michael Twiss, Clarkson University




**Project: Influence of spawning and nursery habitat in shaping the northern pike gut microbiome**
**Principal Investigators:** Brian Leydet, ESF College of Environmental Science and Forestry*; John Farrell, Thousand Islands Biological Station

**Project: Informing restoration of the endangered piping plover to Lake Ontario**
**Principal Investigator:** Jonathan Cohen, ESF College of Environmental Science and Forestry*

**Project: Screening and risk assessment of contaminants of emerging concern in the Onondaga Lake-Three Rivers system**
**Principal Investigator:** Teng Zeng, Syracuse University

**State University of New York institution*

# Building a Nearshore Super Model for Lake Ontario

*Top: a model grid. Above: GLRC Research Support Specialist Michael Satchwell launches an autonomous underwater vehicle to collect data in Lake Ontario.*

Imagine a computer model simultaneously helping Lake Ontario ecologists, water quality superintendents, fisheries managers, binational Lake Ontario Lakewide Action and Management Plan participants, and others making decisions related to nutrient dynamics in the lake's nearshore.

With a Great Lakes Research Consortium grant and Great Lakes Restoration Initiative funding in cooperation with USGS, Dr. Joseph F. Atkinson is developing just such a super model as an integrated hydrodynamic, water quality and ecological modeling framework for modeling nearshore nutrients and assessing the potential for harmful and nuisance algal blooms.

"*We have taken the first steps toward creating a super model that will advance our understanding of the lake system's behavior, parameters and interactions with the ability to propose and assess 'what if' management scenarios,*" says Atkinson, Great Lakes Program Director, professor and Civil, Structural and Environmental Engineering Department Chair at the University at Buffalo.

**Phase 1** reviewed existing hydrodynamic and water quality models for Great Lakes application, accessbility of desired model components, and opportunities for coupling hydrodynamics with water quality and ecological models with capabilities for adding processes, e.g., a higher tropic level food web, in the future. Desired components include high spatial resolution of the nearshore; 3-dimensional mapping of variables, e.g., nutrient concentrations, dissolved oxygen levels, suspended and benthic algal biomass, concentrations of such ecological matter as phytoplankton and zooplankton; and hydrodynamic function. Data for the models will generally be available from NOAA, the National Weather Service, US Coast Guard, Great Lakes Cooperative Science and Monitoring Initiative, and similar sources.

**Phase 2** calibrated and tested a thermal-hydrodynamic model using the Environmental Fluids Dynamics Code to work in tandem with the Advanced Aquatic Ecosystem Model (A2EM) developed by Limnotech. The model was evaluated for simulating Lake Ontario flow characteristics and water temperature and capturing the thermocline locations for both shallow and deep areas. Atkinson notes, "*We believe the model performs at a satisfactory level and can reproduce the basic hydrodynamics of the lake. Importantly, it provides a solid foundation on which to build a water quality and eutrophication model.*"

**Phase 3** is now in progress to develop, test, and add that water quality and eutrophication model appropriate for the lower food web and nearshore region of Lake Ontario to the super model construction.

When complete, this super model will serve as a support system for decision making within the frame of the binational Lake Ontario Lakewide Action and Management Plan and the Nutrients Annex 4 of the 2012 U.S.-Canada Great Lakes Water Quality Agreement.

## Project Notes

- The initial focus area is the New York-side nearshore region between the Niagara River and Rochester. Project scope will eventually extend the length of NY's freshwater shoreline, and, in collaboration with Canadian scientists, will circle Lake Ontario.
- Nearshore is defined as 30m isobath (Lake Ontario Nearshore Nutrient Study, Makarewicz, et al., 2012), however, whole-lake processes driving nearshore circulation are also in focus.
- Cladophora (a filamentous green algae) is a component of interest due to its primary importance as part of the most up-to-date modeling for Great Lakes applications.

# Emerging Contaminants: Unprecedented Study Defining Microplastics Threat to Great Lakes, Freshwaters

"Microplastic counts in Lakes Erie and Ontario rival those within the world's oceans," says Dr. Sherri A. Mason, the world's go-to scientist on freshwater microplastics pollution.

"*The Great Lakes Research Consortium (GLRC) support was critical to establishing research on microplastics in freshwater systems. GLRC's recognition of smaller institutions allowed Fredonia, an undergraduate institution, to take the lead*," says Mason (*above left*), *Chair of the Department of Geology and Environmental Sciences at Fredonia*.

Microplastics, currently defined as particles <5mm in longest length, arise from the breakdown of larger plastic items, but some are made microsized (microbeads) to add abrasiveness to such items as toothpaste, deodorant, and hand, face, and body washes. Given their small size and adsorption of well-established Great Lakes pollutants, e.g., PCBs and polyaromatic hydrocarbons, microplastics threaten the aquatic food web with extended implications for human health.

Mason initially became interested in how microplastics impact freshwater fish to help biology student Rachel Ricotta (*above*), who posed the question unaddressed by scientific literature.

From 2013 to 2014, with support from the 5 Gyres Institute, GLRC, Lake Erie ice anglers, the New York State Department of Environmental Conservation, and Ottawa National Wildlife Refuge, Mason and her team of undergrads, especially Rachel, analyzed gastrointestinal samples from 26 species of fish for primary ingestion of plastics, from predatory fish for indicators of migration up the food web within the Great Lakes, and from culled cormorants for insight on plastic bioaccumulation in the fish-eating fowl.

"*Every species we examined contained plastic: on average, 1-3 particles in smaller fish, 8-10 in larger fish, and more than 25 in the birds, demonstrating a ubiquitous problem in the freshwater system. Our initial investigation was to identify the breadth of impact. We definitely saw breadth and bioaccumulation*," Masons explains.

***This unprecedented research has drawn interest from such entities as the Alliance for the Great Lakes, NOAA's Marine Debris Program, USEPA, USGS, and the New York State Attorney General's Office.***

The research quickly attracted the attention of media, environmental groups, and legislators.

"*The early funding by the Consortium supported the opportunity to evaluate the system without having to battle for the money to support work that had never been done before. That timely response was proactive in that the situation is not so far gone that we cannot make positive changes*," notes Mason.

In 2018, the Microbead-Free Waters Act becomes fully effective, banning microbeads within personal care products. Mason notes, "*It is encouraging to see the science prompt societal level change by legislators, industry, and the public. Some packagers are using glass again; other manufacturers are now looking at how they can reduce the microfibers released from clothing.*"

New York Sea Grant has recently provided funding for Mason to study microplastics impact on plankton native to the Great Lakes and to understand the chemistry of plastic degradation. Dr. Mason serves on a U.N. Working Group on ocean plastic pollution, rated second only to climate change on the U.N. list of threats to the human species. She is encouraging the integration of freshwater plastics pollution research into that arena.

# Evaluating Vitamin B1 Deficiency in Lake Ontario Salmon

*Dr. Jacques Rinchard*

Major species of sportfish, particularly salmonines, are suffering from a deficiency of the essential vitamin B1 (thiamine), obtained only through diet. A lack of thiamine causes odd swimming behavior, lethargy, and mortality in the fish.

"*This deficiency is linked to a diet that depends largely on alewives which have the enzyme thiaminase that degrades thiamine content. While other fish eat alewives, salmon are most severely impacted*," says Dr. Jacques Rinchard, associate professor in the Department of Environmental Science and Ecology at The College at Brockport: State University of New York.

Rinchard has recently reported the results of his Great Lakes Research Consortium (GLRC)-funded investigation of how thiaminase concentration and fat content of common prey fish (alewife, round goby, rainbow smelt) correlate with salmonine consumption of those prey fish. In collaboration with the U.S. Geological Survey at Oswego, New York State Department of Environmental Conservation (NYSDEC) Salmon River Fish Hatchery in Altmar, and NYSDEC Fisheries Station at Cape Vincent, Rinchard's research team evaluated mature fish collected near Hamlin and Oswego, NY; prey fish collected at Hamlin; and offspring raised from fertilized eggs under laboratory setting. Eggs, liver and muscle samples were analyzed for thiamine concentrations.

GLRC projects are intended to develop the initial foundation for future work. This project fostered a new three-year study funded by the NYSDEC. The study includes a comparison of thiamine variability in steelhead and lake trout and Chinook and coho salmon with diet analyses using stable isotopes/fatty acid signatures (FAS), and analysis of the spatial, temporal, and inter-annual variability in alewife thiamine concentration, thiaminase activity, FAS, and vitamin E concentration.

Matthew H. Futia, left, received a GLRC Student Research Grant to evaluate the treatment of adult steelhead trout and their eggs, respectively by injection and immersion, on thiamine levels and offspring mortality.

Futia's project[1] identified treatment related impact, vulnerabilities, and the research potential to support fish stocking and management decisions.

[1] *Futia, M.H., et al., 2017. Thiamine deficiency and the effectiveness of thiamine treatments through broodstock injections and egg immersion on Lake Ontario steelhead trout. Journal of Great Lakes Research, 43, 352-358.*

**Salmon Project Highlights**:

- Total thiamine (TTH) was significantly lower in coho salmon eggs than in Chinook salmon, steelhead or lake trout eggs.
- Results suggest that relatively limited thiamine (TH) in coho salmon and steelhead trout may result in great impacts on offspring development and survival.
- Steelhead trout had the highest average thiamine deficiency complex (TDC)-induced mortality; nearly 1/2 of families (offspring from a single mother) had 100% mortality due to TDC.
- Of the prey fish analyzed, round goby had the highest TH concentration, rainbow smelt the lowest.
- Fatty acid signatures (FAS) were assessed to analyze trophic transfer from prey to predator, with added power from signatures from prey collected in Lake Ontario in previous years.
- FAS differed significantly among prey species. Comparing FAS of prey and predators indicated Chinook and coho salmon feed nearly exclusively on alewife; alewife is a dominant component of steelhead trout diet; lake trout have a mixed diet of alewife and round goby.

# GLRC Research Responds to Harmful Algal Bloom Proliferation

*Algal bloom, Sodus Bay, 2012*

Not every algal bloom is harmful, but how do you know which is and which isn't, and can we take steps to prevent the ones that are toxic harmful algal blooms (HAB)?

"*Early on as algal blooms became more recognized across the state, it was clear that standardized assessment techniques were needed to address questions about freshwater algal bloom in New York's lakes and waters, nearshore areas, and embayments*," says Great Lakes Research Consortium (GLRC) Director and College of Environmental Science and Forestry biochemist Dr. Gregory L. Boyer. "*Over time, GLRC members have utilized and refined the use of everything from basic mapping to highly-sensitive monitoring sensors (see p. 9), satellite and cell phone imaging for data collection, analytical and molecular bioassay, and complex modeling* (*p. 4*)."

GLRC-funded research has involved GLRC member faculty and students, public agencies, and citizen scientists ready to respond when the call comes asking "*What is this pea soup in the water at our marina?*"

***Cyanobacteria, also known as blue-green algae, deplete oxygen and produce a number of different toxins, including microcystins that can be deadly to the aquatic environment and threaten drinking water quality and aquatic, wildlife, pet and human health.***

"*When the Sodus Bay area became concerned about their water, we were ready with the science to set up a monitoring program that provides weekly water quality bulletins. Longer-term and on a broader geographical basis, the GLRC-funded Great Lakes Observing System buoys are providing data to Dr. Joseph Atkinson, who is developing a Lake Ontario ecosystem super model the functions of which will include alerting to factors that may lead to algal bloom*," Boyer says.

***Although the first "green water" animal (cow) fatality was reported in 1931, more recently, the mortal threat to "man's best friend," the dog, has generated new public interest in HAB beyond water resource managers and coastal business owners concerned about drinking and recreational water quality, public safety, and economic impact.***

The GLRC small grants that encourage and support proactive, anticipatory investigations also encourage researchers to rethink and rework assumptions, e.g., the role of nutrient runoff in HAB formation.

"*A scenario we are now considering proposes that if we 'shut off' the creeks into Sodus Bay in our present models, blooms in the upper bay fail to develp, but still occur near the village. If we close the channel to Lake Ontario, the blooms near the village stop*," Boyer explains. "*Modeling gives us a tool to test our assumptions and propose 'what-ifs' for science-based evaluation. This becomes especially important because we cannot physically sample every body of water all the time*."

In 2017, GLRC awarded a $25,000 grant to the Finger Lakes Institute at Hobart and William Smith Colleges to study the role of nitrogen in HAB formation on Honeoye Lake. The lake was selected due to the frequency and severity of its bloom events and as representative of NY's Finger Lakes, of which more than half experienced harmful algal bloom in 2016.

The GLRC's collaborative approach provides scientists with access to a "think tank" of binational expertise and experience to address freshwater issues in the Great Lakes-St. Lawrence River region as a unique ecosystem and essential economic engine for New York State and Ontario, Canada.

# Testing the Aquatic Research Potential of Emerging Technologies

Could low-altitude, unmanned aerial vehicle (UAV) technology offer researchers a faster, less expensive, more efficient way to detect aquatic invasive species?

In the summer of 2016, Dr. Tao Tang and his State University of New York Buffalo State College team tested the use of drones to assess the status of invasive water chestnut along a stretch of Tonawanda Creek in western New York. Water chestnut forms dense floating mats to the detriment of native plant communities, fisheries, recreational activities, and local economies.

Dr. Tang's earlier work tested the use of drone technology over land to survey for invasive Japanese knotweed.

Tang's team included Buffalo State biologist Dr. Christopher Pennuto and GIS Lab Supervisor Mary Perrelli, three graduate students, and US Fish & Wildlife Service (USFWS) fishery biologist Heidi Himes. Preparation included securing an FAA drone license and drone operation training.

For the Great Lakes Research Concsortium-funded investigation, the drone was equipped with a camera and weather data logger. A notice about the drone-facilitated research was distributed to, and well-received by, waterfront owners in the survey area. Launched from aboard a boat, the drone was flown at 1.5-2 meters above Tonawanda Creek and its tributary Ellicott Creek.

The images captured showed four patches of water chestnut in the Ellicott Island Park area, where the invasive plant has been removed by USFWS since 2010 in steadily declining numbers from 2,052 plants in 2011. By comparison, however, the USFWS land survey team found nine patches of invasive species in the same survey area.

## Lessons Learned

- "*The potential to use UAVs integrated with GIS technology to study Great Lakes' issues is very high, but depends on how you design the equipment and project. The UAV worked very well for land survey of Japanese knotweed, but our first choice of UAV model was not suitable to working over water.*" — Dr. Tao Tang
- The drone model selected for this project was lost when the control signal lapsed and the drone tried to return home to its launch point aboard the boat. The boat was no longer at its starting coordinates; the drone went to the creek bottom. A more "intelligent" model could rectify this issue.
- The use of UAV technology over water was restricted by its lowest safe flying altitude and camera resolution for capturing the small water chestnut leaves and, in this case, small patches of the plants. However, the images captured by the project evidence the success of USFWS management of water chestnut in the area.
- Collateral data on land use and land cover (LULC) along the water showed human activity (public parks, boat docks) in areas with water chestnut patches. While LULCs may impact temperature and relative humidity (T/RH), T/RH data from the project do not suggest an influence upon water chestnut growth.

***See page 9 to learn how remote sensors in the Robert Moses Power Dam are assisting the GLRC-funded monitoring of the St. Lawrence River.***

## St. Lawrence River Research: Anticipating Mercury Release Impact

How will the wetland marshes of the St. Lawrence River, the third largest river in North America, mobilize 60 years' worth of legacy deposits of the mercury (Hg) they have naturally sequestered since the Moses-Saunders Power Dam was built in 1958? And will mercury methylating microbes (MMM) convert that Hg to methyl-mercury, the most hazardous form of mercury?

With a Great Lakes Research Consortium (GLRC) grant, limnologist and biology professor Dr. Michael R. Twiss at Clarkson University initiated a plan to investigate how an expected 29% reduction of the marshes will impact how much, how rapidly, and in what form Hg may be released into the Upper St. Lawrence River.

***Methyl-mercury biomagnifies in the food chain, making this research critical to the sportfishing industry and St. Lawrence River region economy that welcomes anglers from around the world.***

Twiss's team is quantifying the capacity of upper river wetlands to support MMM by measuring total Hg, sulfur, phosphorus, and organic matter, and characterizing the microbial community in wetland hydric soils from barrier beach, drowned rivermouth, and sheltered and open embayment wetlands. Sixteen sites were tested in 2016; with funding from the New York and Ontario governments, 80 wetlands were sampled in 2017. This testing is being correlated with a new technological approach to St. Lawrence River water quality monitoring and how water level impacts quality.

"*The main ecosystem performance indicators selected years ago to evaluate the ecological changes from the new water level management scheme (Plan 2014) were long-term outcomes, e.g., changes in muskrat lodge density, northern pike spawning success, and wetland biodiversity*," Twiss says. "*We evaluated approaches for measuring shorter-term (days to seasons) water quality changes, and settled on using sensors located in the Moses-Saunders hydropower dam.*"

The first sensor of the River Environment and Sensor Observational Network (REASON) project was installed at Massena, NY, in 2014. Data is now generated 24/7 by sensors in the dam at the main channel and, in collaboration with the St. Lawrence River Institute (SLRI) at Cornwall, along the Ontario nearshore. Water samples are collected at 1-3 week intervals at each site for Hg testing and measurements to enhance the electronic data set.

"*The use of water quality sensors in hydropower dams is novel. We can now detect environmental change at several scales with minute-by-minute data that can be coupled with our observations upstream*," Twiss notes. "*We need to know how the nearshore mercury release will impact the food web from fish to birds to humans so it can be properly addressed as a management issue not only for the St. Lawrence River but for the Great Lakes Basin's complex ecosystem.*"

*This wetland project is the thesis focus for former GLRC-intern Evie Brahmstedt, now a PhD student at Clarkson University's Institute for a Sustainable Environment.*

Postdoctoral fellow Dr. Amine Mimouni at the SLRI is collaborating with Twiss and colleagues to develop statistical modeling methods to process the 'big data' for analysis and to support broad ecosystem modeling. This GLRC project has leveraged new funding from water institutes, New York Sea Grant, state and provincial governments, and industry. In time, the project will extend its value to other Great Lakes' waters, such as the St. Marys, Detroit, St. Clair, and Niagara rivers, and other applications including the study of algal blooms.

# Educating the Public about Great Lakes Science

The Great Lakes Research Consortium (GLRC) partners with New York Sea Grant (NYSG) to engage the public and students of all ages in learning about Great Lakes science through outreach events, demonstrations and activities. In recent years, GLRC has staged in-water ROV (remotely-operated underwater vehicle) Demo Days at The Great New York State Fair and Central NY Boat Show.

Middle, high school and college students have built and operated SeaPerch ROVs in demonstrations of the science-based educational tools. The students, and event visitors, have operated the ROVs through an obstacle course and used ROVs with cameras to "discover" submersed objects.

The GLRC deployed a 24/7 Great Lakes Observing System weather-sensing buoy in the Fair's pool or pond to transmit real-time weather data to a monitor in the exhibit tent that also featured NY freshwater diving resources, Great Lakes shipwrecks, and water-related children's activities.

***"In-water, hands-on ROV demonstrations provide viewers with a closeup look at technology and its practical application for understanding the unique water resources and aquatic ecosystems of New York State." — GLRC Associate Director and NYSG Coastal Recreation and Tourism Specialist David G. White***



*Photos from top: Youngsters visiting SUNY Oswego get a closeup look at an autonomous underwater vehicle used for GLRC research; ROV student demo at CNY Boat Show with GLRC Associate Director Dave White (right); and at The Great New York State Fair: ESF graduate student Frances Knickmeyer pre-pares to launch an ROV as GLRC Director Greg Boyer checks the readout; monitor with images from the ROV; NY school students launch Sea Perch ROV they built and adapted.*

# Mentoring the Next Generation of Aquatic Scientists

*Intern Stacy Furgal deploying a USGS fish egg mat at Stony Island reef.*

The mission of the Great Lakes Research Consortium (GLRC) includes providing students with advanced learning and field experiences. Students are encouraged to visit the websites below to learn how to access these career-building opportunities.

**Student Research Grants:**
***http://www.esf.edu/glrc/students/studentresearch.htm***
GLRC has supported Great Lakes-related student research with small grants since 2013. Undergraduate and graduate students are eligible to apply and may conduct their work at any GLRC-member institution.

Student Robert Pattridge's GLRC-supported examination[1] of prey fish fatty acid profiles has added valuable data to the study of predator-prey dynamics, the understanding of which is critical for informed fisheries management. His work, advised by Dr. Jacques Rinchard at The College at Brockport (*see p. 6*), found the profiles of each species studied to be highly distinct and seasonal, allowing for the creation of specific trophic markers for each prey species; highlighted the importance of alewive, and perhaps rainbow smelt, in the Great Lakes food web; and provided insights into predator species' diets.

*Dominique Derminio, Chemistry Ph.D. candidate at ESF.*

**Student Travel Support: *www.esf.edu/glrc/students/travel.htm***
Since 2008, selected students have received GLRC travel awards to attend and present their research at significant conferences, including the International Association for Great Lakes Research and American Fisheries Society annual meetings. Dominique Derminio received travel support to attend a 12-day algal identification workshop at Fordham University at the Louis Calder Center. As an ESF Ph.D. candidate, Derminio has applied that training to identifying weekly water samples submitted to ESF's Algal Toxins Lab for algal species identification, specifically those that could be toxic. Testing identifies any toxins with the data reported to the New York State Department of Environmental Conservation (NYSDEC). Derminio's workshop and lab experiences support her career goal as a biochemist interested in promoting harmful algal awareness and water quality education.

***"Without the GLRC grant I would not have been able to attend that great learning opportunity. Applying that experience in the Boyer Lab has allowed for a better understanding of how to do field work and identify freshwater algae. In the field, I am given the opportunity to speak with local citizens about the different algal species, how we collect samples, how certain species can produce toxins that can affect water systems, and the impacts, both positive and negative, that algae can have on their lives." — Dominique Derminio***

**Student Internships: http://www.esf.edu/glrc/students/interns.htm**
As an ESF undergraduate, Stacy Furgal worked as a New York Sea Grant (NYSG) Dune and River Steward, a seasonal employee with the NYSDEC Salmon River Fish Hatchery, and a GLRC intern with the USGS Lake Ontario Biological Station conducting alewive diet research. Now pursuing a Fisheries and Wildlife Management Masters degree, Furgal is investigating a shift in lake trout spawning and habitat on Stony Island reef for her thesis while also working as a Career Pathways intern at USGS.

***"My experiences with NYSG and GLRC provided opportunities to be involved with different research, manage my own data, and share that data with a broad collaborative, and solidified my connections in fisheries as a career opportunity." — Stacy Furgal***

See p. 6 re: GLRC Student Research Grant recipient Matt Futia's investigation of thiamine deficiency treatments for Lake Ontario fish; and p. 9 for a note on 2016 GLRC summer intern Evie Brahmstedt now a Ph.D. candidate at Clarkson's Institute for a Sustainable Environment.

[1] *Happel, Austin; Pattridge, Robert; Walsh, Maureen; Rinchard, Jacques. 2017. Assessing diet compositions of Lake Ontario predators using fatty acid profiles of prey fishes. Journal of Great Lakes Research, 43-5, 838-845.*

## 2015-2017 Great Lakes Research Consortium Student Research Grant Awards

Undergraduate and graduate students are eligible to apply and may conduct their work at any GLRC-member institution. See details at ***http://www.esf.edu/glrc/students/studentresearch.htm***

### *2015*

- Isabel Hannes, Buffalo State College State University of New York: Species boundaries and levels of intermixing between freshwater mussel species: Implications in conservation and restoration
- Jeremy Kraus, The College at Brockport State University of New York: Interpreting predator-prey interaction in Cayuga Lake fishes using fatty acid signature analysis
- Jeremy Pike, The College at Brockport State University of New York: Effects of dietary fatty acids on lake trout fatty acid signature and thermal stress response

### *2016*

- Dominique Derminio, ESF: Identification of harmful algal blooms across New York State (*see p.11*)
- Matthew Futia, The College at Brockport State University of New York: Causes and impacts of thiamine deficiency in Lake Ontario salmonid fish (*see p. 6*)
- Kinsey Irvin, The College at Brockport State University of New York: Use of fatty acid signatures to explore the river continuum concept

### *2017*

- Cassandra Wolfanger, The College at Brockport State University of New York: Nutrient and carbon processing through Lake Ontario coastal wetlands: An assessment of biogeochemical function and wetland restoration efforts

## 2015-2017 GLRC Research Grant Projects: Selected Publications


Brown, M., et al.; 2017. The light at the end of the funnel? Using light-based traps for the detection and collection of a nearshore aquatic, invasive invertebrate, *Hemimysis anomala*. Journal of Great Lakes Research, 43-4, 717-727.

Futia, M.H., et al.; 2017. Thiamine deficiency and the effectiveness of thiamine treatments through broodstock injections and egg immersion on Lake Ontario steelhead trout. Journal of Great Lakes Research, 43-2, 352-358.

Happel, A., et al.; 2017. Assessing diet compositions of Lake Ontario predators using fatty acid profiles of prey fishes. Journal of Great Lakes Research, 43-5, 838-845.

Happel, A., et al.; 2016. Evaluating quantitative fatty acid signature analysis (QFASA) in fish using controlled feeding experiments. Canadian Journal of Fisheries and Aquatic Sciences, 73-8, 1222-1229.

Murphy, M.H., et al.; 2017. Comparison of growth and survival of sea-run and landlocked strains of Atlantic salmon *Salmo salar* in the Lake Ontario watershed. Journal of Great Lakes Research, 43-5, 953-962.

Perri, K.A., et. al; 2015. Harmful algal blooms in Sodus Bay, Lake Ontario: A comparison of nutrients, marina presence, and cyanobacterial toxins. Journal of Great Lakes Research, 41-2, 326-337.

# Great Lakes Research Consortium
# Budgets 2015-2017

**The Great Lakes Research Consortium fiscal year runs parallel with the calendar year. The GLRC Small Grant Program was reinstituted in 2014 along with awarding small grants in support of student research (*see p. 5, 6, 9, 11, 12*).**

**The request for membership dues was reactivated in 2014. Member institutions' financial contributions support the grant and program activities noted below.**

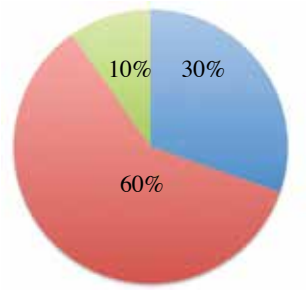
### 2015 GLRC Income: $108,664

Member Contributions: $33,017

NYGLPF*: $65,000

Other Grants/Residuals: $10,647

*New York Great Lakes Protection Fund



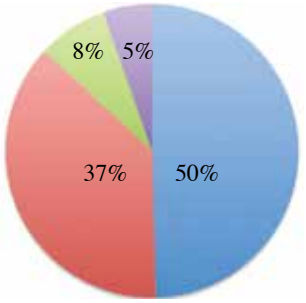

### 2015 GLRC Expenses: $108,664

Administration: $53,908

Small Grants Program: 40,464

Student Services: $8,437

Other GLRC Program Activities: $5,855



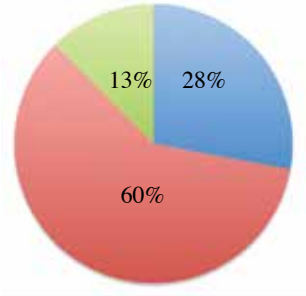

### 2016 GLRC Income: $109,188

Member Contributions: $30,517

NYGLPF*: $65,000

Other Grants/Residuals: $13,671

*New York Great Lakes Protection Fund



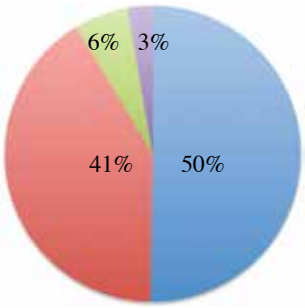

### 2016 GLRC Expenses: $109,188

Administration: $54,867

Small Grants Program: $44,819

Student Services: $6,492

Other GLRC Program Activities: $3,010



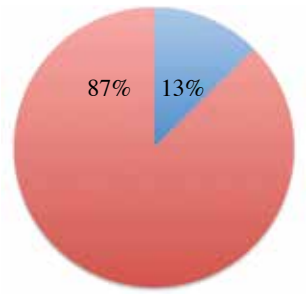

### 2017 GLRC Income: $228,907

Member Contributions: $28,907

NYSEPF*: $200,000

Other Grants/Residuals: $0

*New York State Environmental Protection Fund



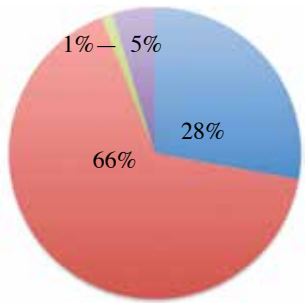

### 2017 GLRC Expenses: $206,560

Administration: $57,557

Small Grants Program: $136,591

Student Services: $2,709

Other GLRC Program Activities: $9,703



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Cornell University

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ESF College of Environmental Science and Forestry

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