The Mission

of the Robert B. Annis Water Resources Institute (AWRI) at Grand Valley State University is to integrate education, outreach, and research to enhance and preserve freshwater resources.
**Partridge Joins MLSA Board**

Dr. Charlyn Partridge was invited to join the Board of Directors of the Michigan Lakes and Streams Association. This exciting opportunity allows her to work more closely with statewide lake associations and private citizens to solve some of the most pressing environmental concerns facing our freshwater resources.

**AWRI Hosts Joint Aquatic Science Meeting**

AWRI Director Mark Luttenton and Al Steinman co-chaired a meeting of the Consortium of Aquatic Science Societies, a group of nine different societies with varying scientific interests that combine for a larger meeting once every seven years. Over 2,400 scientists, students, and vendors from 57 countries traveled to Grand Rapids, Michigan for a week in May to attend the conference. Almost 1,000 more attendees joined online via the meeting’s virtual platform. AWRI and GVSU faculty, staff, and students attended and gave poster and oral presentations of their research, attended workshops, and networked with other scientists spanning across academia, the private sector, and various local, state, federal, and tribal agencies. AWRI also hosted two cruises on the W.G. Jackson of Muskegon Lake and the Lake Michigan shoreline, first for a group of African women scientists and a second as a post-conference field trip.

**Biddanda Wins Award**

AWRI’s Dr. Bopi Biddanda was awarded the Distinguished Contribution to Discipline award by GVSU in 2022. Bopi was recognized for his contributions to advancing the field of Aquatic Microbial Ecology and Carbon Biogeochemistry. As the award commendation states: “Biddanda is an internationally recognized expert in the field of Microbial Ecology and Carbon Biogeochemistry, particularly in the Great Lakes. Biddanda’s activities, attitude, and productivity have brought distinction and recognition to GVSU.” Congratulations, Bopi!
Cyanobacteria in Muskegon Lake, MI on October 8, 2017 calculated with Sentinel-3 imagery. Image Credit: Jillian Greene.

GVSU faculty Amanda Buday (Sociology), Dani DeVasto (Writing), and Sean Woznicki (AWRI) developed a mail survey to understand Muskegon residents’ perception of Muskegon Lake’s environmental quality and their engagement in and barriers to recreation opportunities there. Surveyed residents were satisfied with some features at Muskegon Lake, particularly the Lakeshore Trail, although there were many suggestions to improve what the lake offers to the public.

Muskegon residents’ satisfaction with various public access features at Muskegon Lake, on a scale of 1 (very unsatisfied) to 10 (very satisfied). Image Credit: Amanda Buday, Dani DeVasto, and Sean Woznicki.

Re-Using Organic Wastewater and Environmental Impacts

Working with local agricultural producers, industry food processors, conservation districts, and state legislators, Dr. Kevin Strychar is studying agricultural safety and the use of natural organic fertilizers and irrigation water as a mechanism to reduce or eliminate dependence on synthetic fertilizers. Materials assessed include nutrients (e.g. nitrates), heavy metals (e.g. arsenic), and bacteria of concern (Escherichia coli) using novel methodologies called imaging flow cytometry (IFCM). The goal is to develop a rapid method to detect and potentially eliminate any pathogens infecting food-consumer sources and human health.

Simultaneous detection of (A) dead and (B) live E. coli using IFCM. Cells shown in “C” are beads used to help characterize size, shape, and concentration of cells of interest. Figure Credit: Kevin Strychar.

IFCM for E. coli Beach Monitoring

In Michigan, total reported cases of Escherichia coli (E. coli) appear to be increasing along beaches used by both local and visiting tourists. Molecular methods such as quantitative polymerase chain reaction (qPCR) offer a great opportunity to identify specific strains of E. coli. However, a newer method, called imaging flow cytometry (IFCM) combined with molecular tags offers another opportunity to improve the management of beach usage and avoid public health risks.
VALIDITY of qPCR CRITERION FOR E. COLI MONITORING

Many recreational beaches in Michigan are monitored weekly for fecal indicator bacteria (FIB), such as E. coli. State water quality standards specify the maximum FIB concentration considered safe for swimming. These FIB concentrations are measured via culture methods that require 24 hours to produce results and can inadvertently allow a full day of swimming at beaches that were unsafe when sampled. Michigan has proposed a new qPCR beach safety criterion for determining FIB concentrations that produces results in only 3-4 hours, making same-day safety decisions possible. AWRI assessed the validity of the proposed criterion using beach monitoring data from 2016-2020 comprising paired culture and qPCR-based concentrations. Beach safety decisions for the two methods agree in 91–95% of cases. Importantly, the proposed criterion correctly detects unsafe conditions in over 70% of cases where culture-based results available the next day show the beach had been unsafe.

FROM LAKE TO LAKE: A VISIT BY SENATOR PETERS

Dr. Al Steinman has continued his work on the National Academy of Sciences’ Committee on Independent Scientific Review of Everglades Restoration Progress (CISRERP) for the US Congress. His service has included site visits to the Everglades, numerous Zoom meetings, and considerable research and writing. Steinman’s contributions have been on the new regulation schedule for Lake Okeechobee, the phosphorus-reduction performance of the Stormwater Treatment Areas, and impacts of climate change on the inland water systems. The book is slated for publication in late 2022.

New Research on Yellow Perch in Eastern Lake Michigan

Yellow perch is a native species in Lake Michigan that is well below peak abundance. A new study, led by Dr. Carl Ruetz, will identify the proportion of yellow perch harvest in several drowned river mouth lakes that consists of migrants from Lake Michigan using a combination of isotopic and genetic analyses. This research is a collaboration with Purdue University and Michigan Department of Natural Resources. Ultimately, the goal is to better understand and manage yellow perch populations in Lake Michigan. This research is funded by the Great Lake Fishery Trust.

Student researchers sample yellow perch with boat electrofishing from a drowned river mouth lake. Photo Credit: Tyler Hoyt.

Grad Research Supports Re-Establishing Arctic Grayling in Michigan

Nick Vander Stelt, a graduate student working with Dr. Carl Ruetz, conducted fish and habitat surveys in tributaries of the Boardman River in collaboration with the Little River Band of Ottawa and Chippewa Indians. His research will help fishery managers identify which streams should be targeted for the reintroduction of Arctic grayling – a native species that was once abundant in Michigan’s northern Lower Peninsula but was extirpated by human activities in the early 1900s. Although the actual stocking of Arctic grayling in Michigan streams is still several years away, fishery managers will need to prioritize streams for reintroduction given the finite number of fish that will be available for stocking efforts. To be successful, streams where Arctic grayling are likely to thrive should be the focus of reintroduction efforts. Nick’s research identified many high-quality, coldwater streams in the Boardman River watershed that may be candidates for reintroduction.

Nick Vander Stelt holds a brown trout captured during an electrofishing survey. Photo Credit: Tori Vander Stelt.

Nick Vander Stelt measures a brown trout captured during an electrofishing survey. Photo Credit: Brett Fessel, Grand Traverse Band.

IMPROVING FISH PASSAGE

The Ruetz Lab continued its second year of conducting fish and habitat surveys in West Michigan streams to support habitat improvement efforts. This year’s efforts were focused on improving fish passage in Stony Creek and tributaries of the White River.

GVSU students and staff sample fish in Stony Creek with backpack electrofishers. Photo Credit: Carl Ruetz.

GVSU students and staff sample fish in Stony Creek and tributaries of the White River. Photo Credit: Tyler Hoyt.

A yellow perch captured during an electrofishing survey of a drowned river mouth lake. Photo Credit: Tyler Hoyt.

Technician Grayson Kosak measures water velocity in Swinton Creek, a tributary of the White River. Photo Credit: Carl Ruetz.

FROM LAKE TO LAKE: A VISIT BY SENATOR PETERS

Al Steinman (left) and U.S. Senator Gary Peters (right) onboard the W.G. Jackson. Photo Credit: Kendra Stanley-Mills, GVSU.

U.S. Senator Gary Peters visited AWRI in late August as part of his motorcycle tour through Michigan. Senator Peters highlighted his strong support of the Great Lakes Restoration Initiative, which has provided the funding to restore Muskegon Lake, among other Great Lakes Areas of Concern. Peters sailed on AWRI’s research vessel, the W.G. Jackson, where Dr. Al Steinman explained the restoration activities on Muskegon Lake, and how this has helped revitalize the area.

A yellow perch captured during an electrofishing survey of a drowned river mouth lake. Photo Credit: Tyler Hoyt.

GVSU students and staff sample fish in Stony Creek with backpack electrofishers downstream from culverts that increase water velocity at Marshallville Dam Road. Photo Credit: Carl Ruetz.
Dr. Sarah Hamsher and her graduate student Davis Fray, with Dr. Bopi Biddanda and technicians Ian Stone and Anthony Weinke, are continuing to study the fascinating microbial communities inhabiting the sinkholes of Lake Huron. These sites are fed by low-oxygen, high-sulfur groundwater, creating conditions comparable to those found in ancient seas. Microbes including cyanobacteria and diatoms form mats over the sediment here, working together to take advantage of the extreme water conditions using various metabolism strategies. Davis’ molecular investigation of these mat communities is providing a new level of detail of their taxonomic composition, including the discovery of new species. Additionally, Davis is using culture experiments to unravel the interactions between members of the mat community, revealing how they are maintained over time. Learning more about the composition and activities of these communities could provide insights on the microbial inhabitants of ancient seas that were responsible for oxygenating Earth’s atmosphere.

**Exploring an Analog of Earth’s Ancient Seas**

Rhopalodiales are a group of diatoms (microscopic algae with glass cell walls) that have obligate cyanobacterial endosymbionts (cells that live within cells like nesting dolls). These endosymbionts fix atmospheric nitrogen for the diatoms, allowing the diatoms to grow in low-nitrogen environments, a competitive advantage. However, the Rhopalodiales have lower reported diversity than other similar groups of diatoms. Dr. Sarah Hamsher and colleagues are exploring this perceived paradox and the evolution of this unique relationship.

Light microscope image of a live Epithemia cell with cyanobacterial endosymbionts (asterisks). The scale bar represents 10 microns. Photo Credit: Sarah Hamsher.

**Seeing Green**

AWRI again hosted a three-day Plankton Algae Course, which was sponsored by EGLE with Dr. Rick Rediske as the main instructor. Water treatment personnel from throughout Michigan were in attendance.

Adult learners working together to identify algae species. Photo Credit: Janet Vail.

The 2022 Outreach and Education season commenced with an adventurous start, as construction on a drawbridge in Grand Haven, Michigan delayed the beginning of the spring vessel season for the W.G. Jackson and resulted in a temporary docking location change for the D.J. Angus. However, the staff of both vessels met the challenge head on, and soon began what would become a successful year of trips!

**Vessel Program Surfs Wave of Change**

In 2022, the program happily returned to near pre-pandemic numbers of participants and a bustling cruise schedule. New staff to the program this year include four new science instructors, several new engineers and deckhands, and two new captains. Eric Heacock was promoted as the new AWRI fleet captain. Also new for the 2022 season was fully outdoor “classroom” programming for students visiting AWRI. Engaging outdoor activities were used to allow students to interact with their “place” using place-based education pedagogy and incorporated Michigan K-12 Science Standards for education.

**Daily Tango in Matworld**

Microbial mats found in submerged sinkholes of Lake Huron resemble life on early Earth. Here, sunlight-loving purple cyanobacteria and sulfide-loving white sulfur-oxidizing bacteria, take turns migrating to the surface during day and night, respectively. Oxygen and hydrogen sulfide measured at sub-millimeter depth intervals revealed that cyanobacteria rise daily to harvest sunlight for photosynthesis and sulfate-oxidizing bacteria rise nightly to utilize hydrogen sulfide for chemosynthesis – providing insights into how the early sunny and smelly biosphere functioned.

Micro-profiling of microbial mats using diver collected intact mat-sediment cores under simulated day-night conditions in the laboratory. Photo Credit: Janelle Cook.
1. Graduate student Ellen Foley samples a snowbank.
2. Technical call-in Sunny Charpentier holding two painted turtles (Chrysemys picta).
3. Tyler Hoyt, Nick Vander Stelt, Davis Fray, and Grayson Kosak take a fishing break in downtown Muskegon.
4. Partridge Lab undergraduate Kathryn Geller deploys her 3D printed eDNA traps.
5. Summer interns Margaret Evele and Alexis Deephouse collecting mussels.
6. Research assistant Travis Ellens and intern Jacquelyn Molloseau measuring water quality on Lake Macatawa.
7. Al Steinman on his last day as AWRI Director.
8. Education specialist Christina Catanese in an immersion survival suit.
9. AWRI students, staff, and faculty presenters at the 2022 Michigan Lakes and Streams Association conference.
10. Ruetz Lab undergraduate Jacob Yingling exhibits his perch research at GVSU’s first Chalk Art Symposium.
11. Technical call-in Colin Assenmacher holding a longnose gar (Lepisosteus osseus).
12. Biddanda Lab members Ian Stone, Janie Cook, Jillian Green, and Nate Dugener taking a boat ride to the Muskegon Lake Observatory Buoy.
AWRI Completes Year of Wastewater Monitoring

AWRI completed the first year in a two-year project to monitor the SARS-CoV-2 virus in wastewater samples from Muskegon and Ottawa Counties. The Rediske Lab obtained a $1.7M grant from the Michigan Department of Health and Human Services (MDHHS) to collect and analyze weekly wastewater samples from Spring Lake, Grand Haven, Muskegon, Allendale, and the GVSU Campus. AWRI used ddPCR (droplet digital polymerase chain reaction) technology to measure viral RNA and track the presence of the Delta and Omicron variants. Drs. Richard Rediske and Charlyn Partridge are leading the project and AWRI staff Alexs Porter, Renée Tardani, and Brian Scull are conducting the testing with the assistance of undergraduate intern Emma Piasecki and GVSU-MPH graduate student Tyler Chystek. The results are reported to the MDHHS, Center for Disease Control and Prevention, local health departments, wastewater utilities, and the GVSU Virus Action Team. AWRI was able to track the rise of the Omicron and the effectiveness of GVSU’s vaccine mandate.

USING MOLECULAR SOURCE TRACKING TO ID PROBLEMS IN WATERSHEDS

The Rediske Lab started a three-year project with the Ottawa Conservation District in the Crockery Creek and Sand Creek watersheds and a one-year project with the Two Rivers Coalition on the Black River and Paw Paw River watersheds using Molecular Source Tracking to determine the origins of high E. coli levels. AWRI will focus on determining the source of bacterial pollution by testing environmental DNA markers for human, cow, and ruminant fecal pollution.

AWRI staff member Renée Tardani and graduate student John Hart prepare sample plates for ddPCR testing of human and animal markers. Photo Credit: Alexis Porter.

PROTECTING COASTAL HEMLOCK FORESTS

HWA eDNA trap deployed in Huron-Manistee National Forest. Photo Credit: Charlyn Partridge.

Using environmental DNA (eDNA) to help monitor for HWA in high-risk areas. In addition, the lab is also exploring how the presence of HWA may drive community composition changes within these ecosystems.

Eastern hemlock is a keystone species that provides erosion control, water filtration, wildlife habitat, and regulates stream temperatures. In Michigan, coastal hemlock forests are under threat from the tiny invasive pest, hemlock woolly adelgid (HWA). HWA is an invasive, sucking insect that feeds on the nutrients contained in hemlock trees. Without treatment, this can result in the death of a hemlock tree within four to seven years. In the eastern United States, HWA has devastated hemlock-dominated forests and drastically shifted the community composition of these ecosystems. The current invasion of HWA in Michigan was first detected in 2015 and, since that time, it has spread to five counties. With a grant from the Michigan Invasive Species Grant Program, the Partridge Lab is using environmental DNA (eDNA) to help monitor for HWA in high-risk areas. In addition, the lab is also exploring how the presence of HWA may drive community composition changes within these ecosystems.

BEBOT AND PIXIE KEEP IT CLEAN

A.W.R.I., Meijer, and the Council of the Great Lakes Region are teaming up to remove microplastics at their source while educating the community about the impacts of plastics as part of the Great Lakes Plastic Cleanup. In the center of it all is the Bebot and Pixie drones, which are designed to remove debris from beaches and waterways. Watch for them in Summer 2023!

Wild Rice Genetics

Partridge Lab undergraduate students Elliot Fair and Carlin Moore are continuing to work with the Gun Lake Tribe to assess the population genetics of wild rice (manoomin) across Michigan. They are also evaluating how fungal disease and rice worm infestations vary across wild rice populations and how abiotic factors may be driving this variation.

Microplastics and Microbiomes

Microplastics are found everywhere in terrestrial and aquatic environments. When microplastics are ingested by aquatic wildlife, data evaluating health implications for individuals ingesting these pollutants are variable. Partridge Lab graduate student Maggie Petersen evaluated how microplastic ingestion impacts the health and natural gut microbial community of fathead minnows. Maggie found that microplastic ingestion significantly impacted growth rates in male fathead minnows, but there was no effect on the natural gut microbial community for these individuals.
Annual formation and breakdown of low-oxygen (hypoxic) bottom waters in Muskegon Lake is linked to warming of surface waters and excessive loading of nutrients. Graduate student Nate Dugener analyzed 12 years of data from the Muskegon Lake Observatory buoy (gvsu.edu/buoy) revealing high inter-year variability in hypoxia. A hypoxic severity index was developed to identify years that experienced more severe hypoxia than others. 2012 and 2021 were the most severely hypoxic years whereas 2015 and 2019 were the mildest hypoxic years. Years that were warmer and rainy in the spring and early summer resulted in more severe hypoxia, and vice versa. Thus, the environmental state before hypoxia begins plays a regulatory role in determining its severity in any given year. Severe hypoxia in a warm and wet 2021 released sediment-bound phosphorus as a side effect, leading to a historically late harmful algal bloom in surface waters that lasted into November.

The Steinman Lab has been studying Church Lake’s salt and nutrient issues for almost three years. Located in Grand Rapids, Michigan directly adjacent to the East Beltline Highway, this lake has received so much salt runoff from de-icer applications that the salt gradient prevents the lake from fully mixing. Studies by graduate student Ellen Foley, who recently defended her master’s thesis, as well as by undergraduate interns Jacque Molloseau and Allison Passejn, have shown that phosphorus concentrations have continued to accumulate in the bottom waters to alarmingly high levels, and that sediments in the inflowing tributary and the nearby floodplain can continue to release salt to the lake throughout the year. In addition, the two lakes downstream of Church (Middleboro and Westboro) also are experiencing salt issues, suggesting that a salt plume is moving via groundwater throughout this region. Dr. Steinman and the Lab have offered possible solutions to tackle the salt and phosphorus issues, which are currently being assessed by the local homeowners.

If you like to canoe, then you know to avoid logs in rivers. But if you are an aquatic insect, logs and other wood are invaluable. Graduate student alumnus Paul Dingman working with Dr. Mark Luttenton surveyed aquatic insect communities on every substrate type in the North Branch Au Sable River. Paul’s data strongly supports the conclusion that one square meter of submerged log supports more aquatic insects than any other type of substrate.

Great Lakes Estuaries

Commonly, Great Lakes Estuaries form drowned river mouth lakes that are hot-spots of primary productivity, anthropogenic problems, and socio-economic-ecologic potential. An essay in the 2022 summer issue of Lakes Letter published by the International Association for Great Lakes Research details the economic, social, and ecological importance of Great Lakes estuaries.
Mark Luttenton, Interim Director (8/2022 – current)
Alan Steinman, Allen and Helen Hunting Director and Professor
(stepped down 8/2022, currently faculty)
Carl Ruetz, Interim Assistant Director (for Steinman)

**Staff/Administrative:**
Tonya Brown, AWRI Assistant
Heidi Feldpausch, Office Coordinator
Roxana Taylor, Secretary

**Facilities/Maintenance:**
Len Wittlieff, Maintenance

**Information Services Center:**
Sean Woznicki, Assistant Professor

**Outreach & Education:**
Christina Catanese, Education Specialist
Paula Capizzi, Lead Instructor DJA
Jamie Cross, Lead Instructor WGJ
Doug Haywick, Science Instructor
Dave Heider, Science Instructor
Ann Hesselsweat, Science Instructor
Steve Jablonski, Science Instructor
Tom Jackson, Science Instructor
Bob Myers, Science Instructor
Amanda Syers, Science Education Specialist
Janet Vail, Research Scientist Emerita
Diane Veneklasen, Science Instructor

**Ecological Research, Environmental Biology:**
Bopaiah Biddanda, Professor
Janelle Cook, Technical Call-in
Ian Stone, Technical Call-in
Anthony Wayne, Technical Call-in
Sarah Hamsher, Assistant Professor
Mark Luttenton, Professor of Biology
Alexis Neff, Graduate Student (Biology)
Jim McNair, Associate Professor
Charlyn Partridge, Associate Professor
Kathryn Geller, Undergraduate Student
Calleen McClure, Undergraduate Student
Syndell Parks, Technical Call-in
Carl Ruetz III, Professor
Colin Assenmacher, Technical Call-in
Sunny Charpentier, Technical Call-in
Grayson Kosak, Technical Call-in

**GVSU Vessels/Fleet Operations:**
Eric Hecco, Fleet Captain
Bill Brezinau, Sr., Engineer WGJ
Emily Cegelis, Deckhand
Dave Fisher, Engineer WGJ
Ossian Foley, Captain DJA/WGJ
Tim Halloran, Deckhand WGJ
Petie Hewett, Engineer DJA
Brad Nieboer, Marine Electrician
Ed Pernault, Captain DJA/WGJ
William Young, Deckhand

**Ecological Research, Environmental Chemistry:**
Richard Rediske, Professor
Tyler Chystek, Graduate Student (Public Health)
Alexis Porter, Adjunct Research Assistant
Brian Scull, Laboratory Supervisor
Renee Tardani, Adjunct Research Assistant

**Robert B. Annis Foundation Interns (summer):**
Elliot Fair (Charlyn Partridge)
Jillian Greene (Bopaiah Biddanda/Sean Woznicki)
Audrey Whitaker (Christina Catanese/Rick Rediske)

**AWRI Interns (summer):**
Brianne Siple (Carl Ruetz)
Bill and Diana Wipperfurth Scholarship (fall):
Brianne Siple (Carl Ruetz)

**AWRI Science Advisory Board:**
Dr. Harvey Bootsma, University of Wisconsin – Madison
Dr. Carol Johnston, South Dakota State University
Dr. Gary Lamberti, University of Notre Dame, Chair
Dr. Jennifer Haverkamp, University of Michigan

**Graduate Students:**
Biddanda, major advisor
Nate Dugener
Hamsher, major advisor
Davis Fray
Luttenton, major advisor
Anna Brier
Bob Larson
Partridge, major advisor
Keely Dunham
Maggie Petersen
Rediske, major advisor
John Hart
Ruetz, major advisor
Travis Ellens
Ashley Fleser
Tyler Hoyt
Matthew Silverhart
Nick Vander Stelt

**NSF Intern (summer):**
Collin Toth (Sarah Hamsher)

**OURS Intern (summer):**
Carlin Moore (Charlyn Partridge)
Cianna Quatrini (Charlyn Partridge)

**SEWER grant Intern (summer):**
Emma Piascecki (Rick Rediske)

**Intenships and Scholarships**
AWRI provides opportunities for students to pursue their interests in our environment. The following students received internships during 2022.

**Herbert VanderMey Intern (summer):**
Alexis Deephouse (Ashley Elgin, NOAA-GLERL)
Amelia Heminger (Rick Rediske)

**Allen and Helen Hunting Interns (summer):**
Jacquelyn Molosseau (Alan Steinman)
Allison Passejna (Alan Steinman)

**M-STEP Center for Undergraduate Scholarly Engagement: Jacob Yingling (Carl Ruetz)**

**NOAA Intern (summer):**
Margaret Evelle (Ashley Elgin, NOAA-GLERL)


2022 Master of Science Theses

Petersen, M. (Advisor: Partridge) Marine mollusks and echinoderms: impacts of weathered microplastic ingestion by Fathead Minnows (Pimephales promelas)

Sanders, M. (Advisor: Partridge) Developing novel molecular detection techniques for herbicidal wood wool (Adelges tsugae)

Walt, J. (Advisor: Woznicki) Mapping the spread of invasive species in Michigan wetlands using remote sensing

Non Peer Reviewed Publications


2022 Master of Science Theses

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Walt, J. (Advisor: Woznicki) Mapping the spread of invasive species in Michigan wetlands using remote sensing
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