R.B. ANNIS WATER RESOURCES INSTITUTE

2017 YEAR IN REVIEW

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.

Located in Muskegon, Michigan, the Institute's work centers around three main focal areas:

RESEARCH

into major questions about aquatic ecology, chemistry and toxicology, fisheries ecology, hydrology, microbial ecology, aquatic molecular ecology, ecosystem restoration, and ecological modeling.

INFORMATION SERVICES

use state-of-the-art geospatial technology to collect and analyze data, and condense them into useful information for those who make critical decisions about natural resources management.

EDUCATION & OUTREACH

to graduate and undergraduate students, K-12 students, policymakers, educators, and the general public.

GRAND VALLEY STATE UNIVERSITY
ROBERT B. ANNIS WATER RESOURCES INSTITUTE

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2017: THE POWER OF PHILANTHROPY

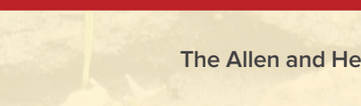
Dr. Alan Steinman,
The Allen and Helen Hunting Director

The Robert B. Annis Water Resources Institute, as evidenced by its very name, owes a disproportionate amount of its growth and success to the incredible generosity of its donors. This philanthropy dates from our earliest days, including Bob Annis' gifts and our first major grant—$1,000,000 from the Grand Rapids Community Foundation to study the Grand River—both of which allowed the Institute to establish itself and build a foundation, to the late 1990s as shown by the generosity of the Muskegon community, including Bill Jackson, Chuck and Pat Johnson, Bill Schroeder, and Roger Andersen, who donated and raised the funds for our second research vessel and our new home on Muskegon Lake.

That ethos of giving permeates west Michigan, and especially the lakeshore, where people are connected to the water in a very intimate way. Our mission at AWRI, to integrate research, education, and outreach to preserve and enhance our freshwater resources, resonates with our broader community, and we take that charge very seriously. While we rely heavily on competitive grants from state and local government for funding, philanthropy plays an absolutely essential role in helping us achieve our mission.

That is one reason why we are so delighted to recognize the recent gift from Allen and Helen Hunting, establishing the Hunting Research and Innovation Fund, as described on page 2. While we are thrilled to receive this gift, it is equally rewarding to recognize the Huntings, whose passion, sense of humor, and generosity help keep us motivated to continue protecting and preserving our precious water resources.

Writing on behalf of the faculty, staff, and students at AWRI, we thank you, and all our donors, for their incredible generosity; we are indeed blessed to live in this region. We are committed to do our absolute best to provide our west Michigan community with a return on your investment that will make you proud.



Alan Steinman,
The Allen and Helen Hunting Director, AWRI

STEINMAN RECEIVES NATIONAL GARDEN CLUB AWARD

Al Steinman received the 2017 Award of Excellence, the highest honor awarded by the National Garden Clubs Inc., one of the nation's most-recognized nonprofits, at their 88th annual convention in Richmond, VA.

HUNTING RESEARCH AND INNOVATION FUND

Allen and Helen Hunting, recipients of the 2017 GVSU Enrichment Award and long-time supporters of GVSU, established the Allen I. and Helen J. Hunting Research and Innovation Fund through a generous gift. This fund will be used to tackle high-risk, high-return research that could have significant impacts on water resources and science.

2017 SCIENCE ADVISORY BOARD REVIEWS AWRI

AWRI's external Science Advisory Board conducted their triennial review in March. Their report was extremely positive and is available online at: www.gvsu.edu/wri/science-advisory-board-25.htm

The AWRI Science Advisory Board members: left to right (Don Scavia, University of Michigan; Carol Johnston, South Dakota State University; Gary Lamberti, University of Notre Dame; Chair, Harvey Bootsma, University of Wisconsin-Milwaukee).

MAKING LAKE MICHIGAN GREAT 2017: ILLINOIS & INDIANA VISITS

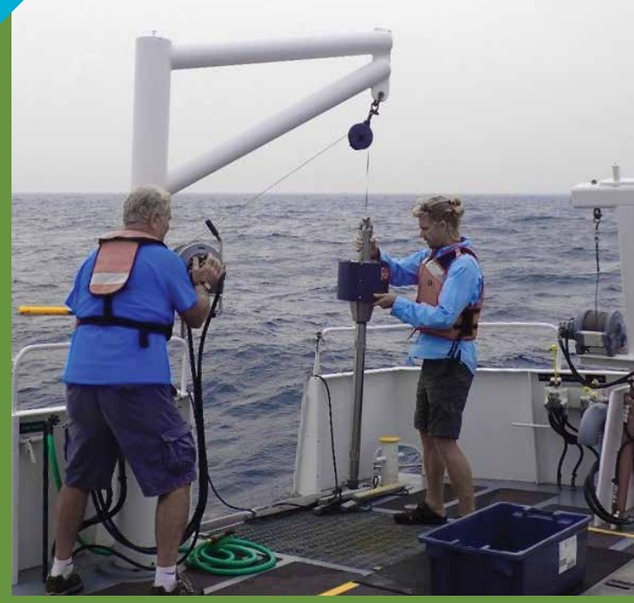
W.G. Jackson in Michigan City, IN.

Susie Schreiber (far right) with a group on the *W.G. Jackson* in Waukegan, IL.

The tradition of *W.G. Jackson* summer visits to various Lake Michigan ports of call continued in 2017. Susie Schreiber, Michael Kuss, and Michelle Caldwell made the trips possible to Waukegan, IL, Michigan City, IN, and Hammond, IN, respectively.

INVASIVE QUAGGA MUSSELS AND THEIR VIRAL "HITCHHIKERS"

Over the years, Lake Michigan populations have seen dramatic shifts among both dominant and less abundant taxa caused by invasive species such as quagga mussels, which are known to have arrived via ballast water dumping. Less known, however, is the impact of "hitchhikers" on invasive species – microbial invaders naked to the human eye – like viruses. In their studies, the Strychar lab has been investigating viruses that have been preserved (i.e. dead) and living in the sediments to those associated with invasive species. Studies show that while some viruses are not well described and may even be newly described, many are "recycled" between species, water column, and benthic substrate systems.



AWRI graduate student Nick Gezon (right) and *W.G. Jackson* marine engineer Dave Fisher (left) collecting cores from Lake Michigan to determine what viruses are "native" to Lake Michigan versus those associated with invasive species, such as quagga mussels.

PROJECT WET USA COMES TO MICHIGAN

Dr. Janet Vail served as chairperson for the annual Project WET (Water Education for Teachers) USA Coordinators Conference held in Traverse City, which drew coordinators from as far away as Alaska and Hawaii. Conference highlights included the keynote address by Mark Breederland from Michigan Sea Grant, a field trip to Sleeping Bear Dunes, and a workshop on the new Project WET early childhood curriculum. As the Michigan Project WET state coordinator, Dr. Vail will be presenting workshops on the new curriculum.

Julia Beck (left) from Project WET USA and Janet Vail (right) at Sleeping Bear Dunes National Lakeshore.

AWRI HOSTS A PLANKTON-ALGAE COURSE

After a year of planning by a committee consisting of personnel from water treatment plants, academia, and the Michigan Department of Environmental Quality, AWRI hosted a three-day Plankton-Algae course sponsored by the Michigan Section of the American Water Works Association. Participants in the course were staff from water treatment plants throughout Michigan. In this team effort, Dr. Rick Rediske was the lead instructor with assistance from Dr. Bopi Biddanda, his students, and Dr. Charlyn Partridge. Dr. Janet Vail coordinated the course and its materials.

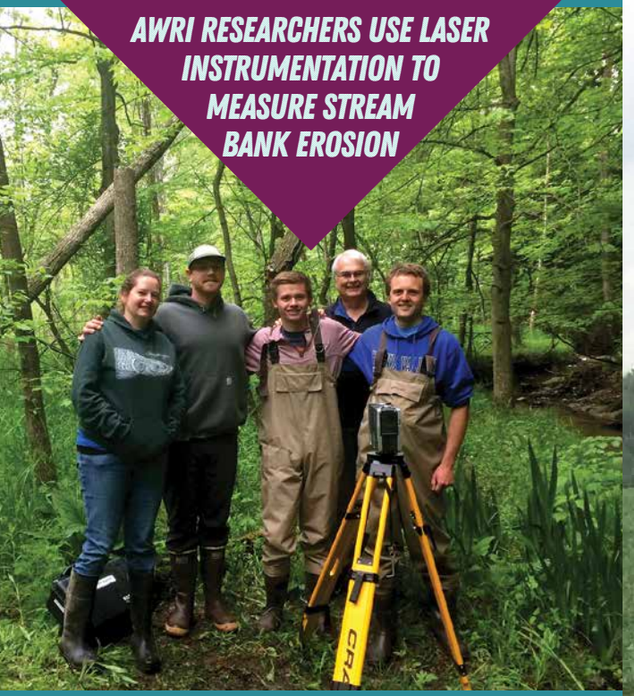
Dr. Rick Rediske (second from right) assisting Plankton-Algae course participants.

AARON PARKER: DISTINGUISHED ALUMNUS-IN-RESIDENCE

The College of Liberal Arts and Sciences' Distinguished Alumni-in-Residence Program provides a venue for departments to invite outstanding alumni back to campus to share their post-graduation experiences. AWRI honored Aaron Parker as its 2017 distinguished alum. Aaron earned his M.S. in biology at AWRI in 2007 studying the ecology and evolution of yellow perch. He is an aquatic biologist for the Michigan Department of Environmental Quality where he studies harmful algal blooms.

Aaron Parker during his AWRI seminar (below) and holding bighead carp (right).

AWRI RESEARCHERS USE LASER INSTRUMENTATION TO MEASURE STREAM BANK EROSION



Dan Myers, a graduate student working with Rick Rediske, is using surveying tools and light detection and ranging instrumentation (lidar) to assess stream bank erosion in the Indian Mill Creek watershed (Kent County). This instrument can measure very small changes to topography with great accuracy. The project team includes (from left to right) Dana Strouse (MDEQ), Matt Allen and Noah Cleghorn (AWRI summer interns), advisor Dr. Rick Rediske, and graduate student Dan Myers.

AWRI EXPANDS qPCR BEACH MONITORING TO INCLUDE INLAND LAKES

Graduate student Molly Lane preparing beach samples for qPCR analysis.

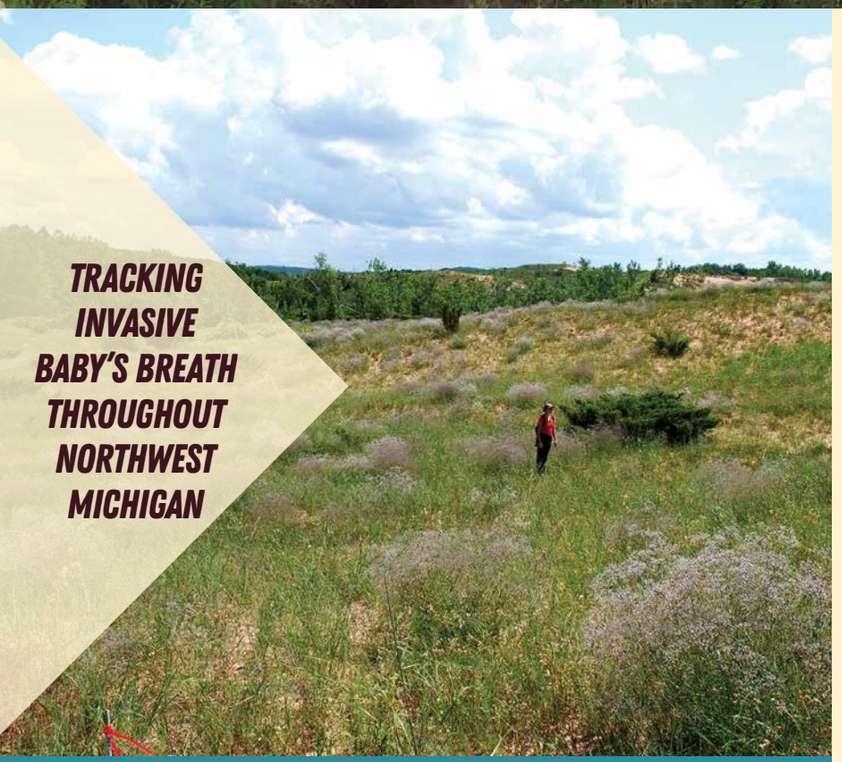
AWRI completed its third year of polymerase chain reaction (qPCR) testing of Muskegon County beaches for pathogens. qPCR is the quantitative amplification of DNA conducted in real time. For the 2017 program, AWRI collected and analyzed samples from 13 Lake Michigan and 15 inland lake beaches for *E. coli* using both traditional culture-based techniques and the qPCR method. Because qPCR detects DNA from both live and dead cells, inland lakes present more of a challenge due to local septic systems, smaller lake volume, and wildlife sources. AWRI research assistant Brian Scull and graduate student Molly Lane (left) presented their comparisons of qPCR and culture-based methods at the Great Lakes Beach Conference in Green Bay, WI. Molly is conducting her thesis research on the influence of landscape variables on the comparison of the two methods in inland lakes. AWRI has worked in partnership with Public Health Muskegon County on beach monitoring programs since 2001.

AWRI'S NSF-FUNDED REU PROGRAM PROVIDES SUMMER RESEARCH EXPERIENCES FOR UNDERGRADUATES

Student participants in AWRI's 2017 REU program. Back row: Drs. McNair (far left) and Strychar (far right).

2017 marked the third and final year of AWRI's Research Experiences for Undergraduates (REU) summer program, operated with funding obtained from the National Science Foundation by AWRI scientists Drs. Jim McNair and Kevin Strychar. The 2017 class of 10 students hailed from California, Louisiana, Maryland, Michigan, Minnesota, New Hampshire, North Carolina, and Pennsylvania. Further information about AWRI's REU program is available on its website (www.gvsu.edu/wri/mcnair/reuquest).

TRACKING INVASIVE BABY'S BREATH THROUGHOUT NORTHWEST MICHIGAN



Hailee Leimbach-Maus standing among clumps of baby's breath (lighter colored vegetation) in Sleeping Bear Dunes National Lakeshore.

A small floral adornment with a cute name is wreaking havoc throughout the coastal sand dunes in northwest Michigan. Baby's breath (scientifically known as *Gypsophila paniculata*) is an aggressive invasive species that outcompetes native vegetation, such as the federally threatened Pitcher's thistle. It is especially problematic around Sleeping Bear Dunes National Lakeshore and managers have been working tirelessly to get the species under control. A collaborative project between Charlyn Partridge's lab, The Nature Conservancy, and The National Park Service is looking into more effective ways to manage and contain the spread of baby's breath. Graduate students Emma Rice and Hailee Leimbach-Maus spent the summer working with The Nature Conservancy to examine the efficiency of two common treatment methods, manual removal and herbicide application. They are also looking to see how the plant is spreading through the region. This project is funded by an EPA – Great Lakes Restoration Initiative grant.

GRADUATE STUDENT BEN GIFFIN TESTING NEW *E. COLI* DETECTION METHODS

Graduate student Ben Giffin (above) is working to modify a method for rapid detection of fecal indicator bacteria. This method uses the compound propidium iodide to help differentiate live versus dead bacteria.

NEW AND IMPROVED TOOLS FOR ASSESSING STREAM FUNCTION

An instrument (sonde) used to automatically measure and record changes in stream dissolved oxygen concentration, water temperature, and light level over a 24-hour cycle. Note the dense bed of rooted aquatic plants, which are net producers of oxygen during daylight, but net consumers during nighttime.

The myriad living organisms in a stream, from bacteria and algae through rooted aquatic plants, invertebrates, and fish, produce and consume oxygen at rates that are high enough to create a clear daily pattern of daytime increases and nighttime decreases in dissolved oxygen concentration. By monitoring this daily pattern of production and consumption of oxygen, we can make useful inferences about stream health. AWRI graduate student Jay Zuidema, in collaboration with his advisor Dr. Jim McNair, is assessing different methods for making these inferences and how the estimated rates depend on properties such as the amount of shade and abundance of aquatic plants in a stream reach. His results to date show pronounced differences among rate estimates obtained in different reaches along a stream. He currently is considering how to account for these differences when extrapolating reach-scale estimates to an entire stream.

RESEARCH SUPPORTS ARCTIC GRAYLING RESTORATION

The Arctic grayling was extirpated from Michigan in the early 1900s due to logging activities, overharvest, and introduction of non-native trout. Recent conservation efforts elsewhere have focused on reestablishing native fish using incubators to hatch eggs in streams targeted for reintroduction. The in-stream incubators are small, flow-through units that allow eggs to rear at the site of reintroduction, allowing fry to acclimate and imprint on local conditions.

Carl Ruetz's laboratory, in collaboration with the Little River Band of Ottawa Indians (LRBOI), is testing egg incubators in tributaries of the Manistee River. In a "pilot" study, rainbow trout eggs were used as surrogates for Arctic grayling eggs, which are not yet available in Michigan. The preliminary results were promising, suggesting the egg incubators can be effective in Michigan streams. This research supports a broader effort by the Michigan Department of Natural Resources and the LRBOI to reintroduce Arctic grayling to Michigan.

Yolk-sac rainbow trout fry hatch in an egg incubator.

Egg incubators (black buckets) tested in a Manistee River tributary.

An Arctic grayling captured in a Montana lake.

IMPROVING MANAGEMENT OF INVASIVE BABY'S BREATH BY KNOWING WHEN ITS SEEDS MATURE

Baby's breath fruits with mature seeds. Each fruit contains four seeds.

Baby's breath (*Gypsophila paniculata*), that lovely plant of wedding bouquet fame, is an aggressive invader of coastal dune habitats in Michigan's northwestern Lower Peninsula, outcompeting rare and threatened plants such as fascicled broomrape (*Orobanche fasciculata*) and Pitcher's thistle (*Circium pitcheri*). Baby's breath reproduces mainly by seed, so reducing the production of mature seeds is an important part of managing this invader. To do this, plants must be removed or sprayed with herbicide before their seeds mature. But when do they mature? AWRI graduate student Emma Rice and her advisor, Dr. Jim McNair, are tackling this question. By conducting germination experiments with baby's breath seeds collected at different times during the growing season, Emma has shown that the proportion of mature seeds on untreated plants increases dramatically in late July, exceeding 90% by early August. Disturbingly, about 20% of seeds from plants sprayed with herbicide (Roundup®) in late July mature anyway.

GENETIC STOCK STRUCTURE OF YELLOW PERCH IN EASTERN LAKE MICHIGAN

Greg Chorak, a graduate student working with Dr. Carl Ruetz, examined the genetic structure of yellow perch populations in eastern Lake Michigan, focusing on populations in drowned river mouth (DRM) lakes (e.g., Muskegon Lake). Greg found that Lake Michigan yellow perch are genetically distinct from DRM-lake populations even though they use those habitats during particular times of the year. Fisheries managers should consider yellow perch population structure and movement patterns when setting fishing regulations.

Yellow perch captured during gill netting surveys for genetic sampling.

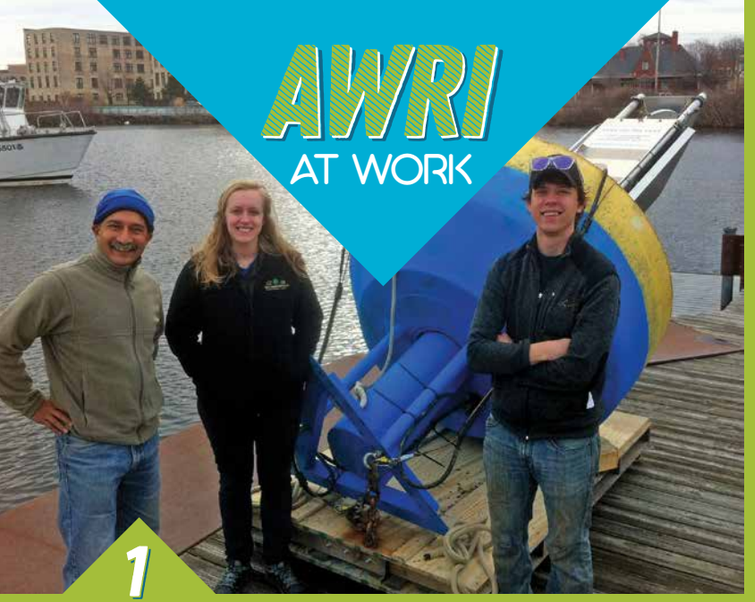
Graduate student Greg Chorak drives AWRI's electrofishing boat while conducting surveys of yellow perch.

SEASONAL ECOLOGY OF STREAM FISHES

Graduate student Suse LaGory conducts a backpack electrofishing survey to sample fish during winter.

Suse LaGory, a graduate student working with Dr. Carl Ruetz, assessed seasonal differences in survival, growth, and movement of two coldwater stream fishes in Stegman Creek (Kent County) focusing on differences between summer and winter. Her research is important because surprisingly few studies include field research during winter compared with snow/ice-free seasons. She found that winter environmental conditions were not particularly harsh for stream fishes in her stable, ground water dominated study stream.

AWRI AT WORK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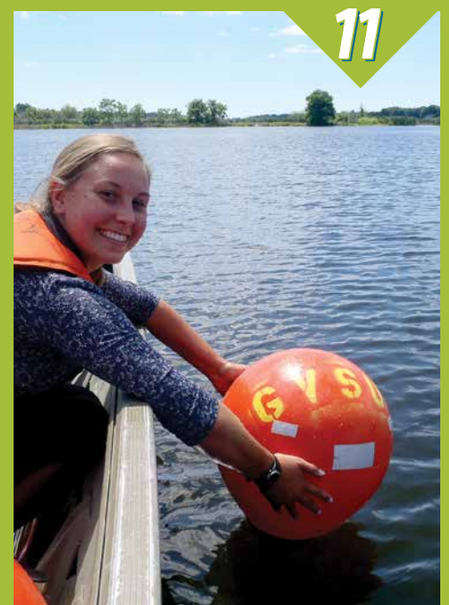
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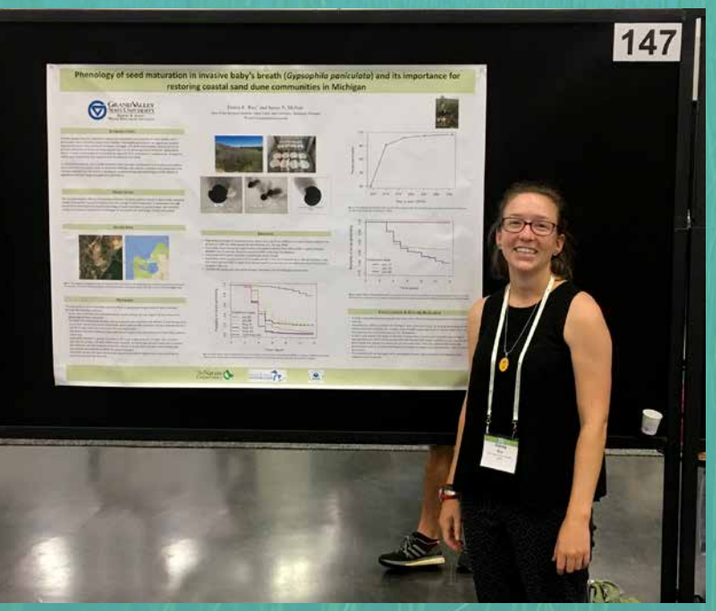
1. Dr. Bopi Biddanda (left), graduate student Katie Knapp (center), and technician Tony Weinke (right) pose with the Muskegon Lake Observatory buoy before its 2017 deployment.
2. Graduate student Travis Ellens holds a northern map turtle caught during fish sampling.
3. Graduate student Jay Zuidema calibrates a YSI water quality sonde.
4. Graduate student Hailee Leimbach-Maus collects baby's breath samples for genetic analysis.
5. Science instructor Shirley McIntire displays a water sample onboard the *W.G. Jackson* in Hammond, IN.
6. Graduate student Suse LaGory displays a brown trout.
7. Graduate student Molly Lane downloads temperature data from a field logger.
8. Graduate student Emma Rice collects baby's breath samples for genetic analysis.
9. Visiting Ph.D. candidate Xiaomei Su (front) and research assistant Maggie Oudsema (back) celebrate the successful completion of fieldwork in Spring Lake.
10. Summer interns Noah Cleghorn (left) and Matt Allen (right) collect GPS coordinates in Indian Mill Creek.
11. Graduate student Kim Oldenborg deploys a buoy in Bear Creek.

AWRI IMPLEMENTS RAPID ASSESSMENT PROCEDURES FOR CYANOBACTERIA

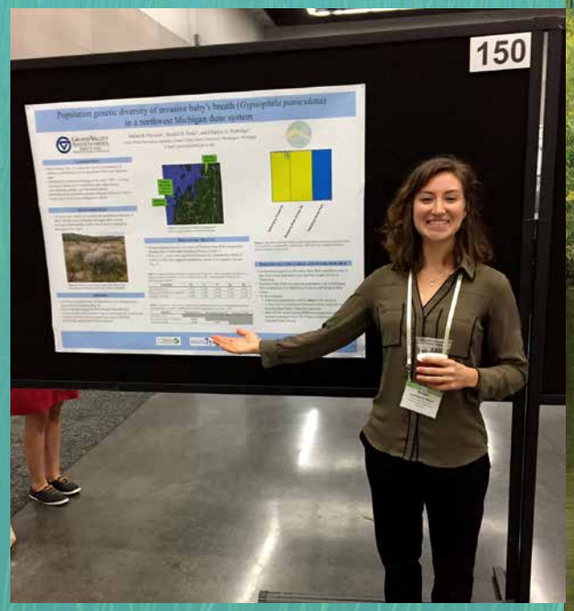
Graduate student Andrew Pyman preparing samples for qPCR analysis of cyanobacteria populations.

The labs of Rick Rediske, Kevin Strychar, and Charlyn Partridge evaluated rapid assessment methods for cyanobacteria in Muskegon Lake and Bear Lake. *Microcystis* is a cyanobacterium that is responsible for harmful algal blooms (HABs). The organism can produce a toxin called microcystin, which is harmful to human health. Open water and beach samples were collected during the summer and quantitative polymerase chain reaction (qPCR) and imaging flow cytometry (IFC) methods were used to study *Microcystis* populations and toxin production. qPCR techniques were employed to determine the presence of toxin-producing genes and their activity. IFC methods were used as confirmation of toxin production. When paired with water chemistry and toxin measurements, these rapid assessment methods can aid in forecasting HABs by tracking genetic changes and environmental triggers that influence toxin production. This project is funded by a grant through the Michigan Department of Environmental Quality.

THREE STUDENTS, GREG CHORAK, EMMA RICE, AND HAILEE LEIMBACH-MAUS, PRESENTED THEIR RESEARCH AT THE ANNUAL ECOLOGICAL SOCIETY OF AMERICA MEETING THIS YEAR IN PORTLAND, OR.

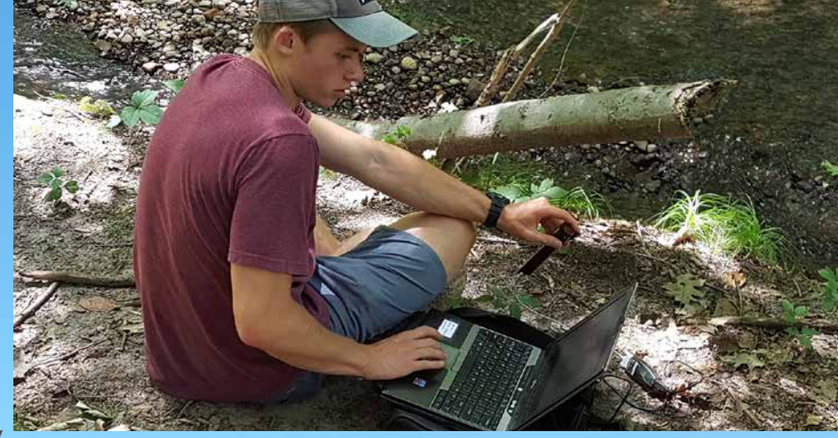


Graduate student Emma Rice at Ecological Society of America poster presentation.



Graduate student Hailee Leimbach-Maus at Ecological Society of America poster presentation.

AWRI USES L-THIA MODEL TO ESTIMATE POLLUTANT LOADING IN INDIAN MILL CREEK

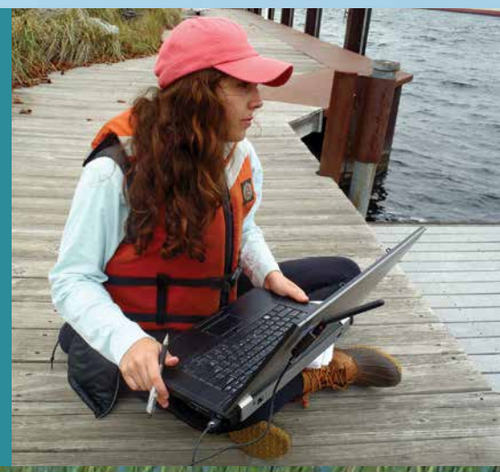


2017 AWRI summer intern Noah Cleghorn setting up a temperature sensor in IMC.

The Long-Term Hydrological Impact Analysis (L-THIA) model has been in use for decades as a tool to estimate water quality impacts. The model is available in three formats, including a new internet version. AWRI researchers were eager to try the web-based version on the Indian Mill Creek (IMC) watershed in Kent County.

Associate research scientist John Koches and 2017 AWRI summer intern Noah Cleghorn decided to supplement their temperature and rainfall data collection in IMC by using L-THIA to prioritize the seven subcatchments within IMC, with respect to their potential as sources of water quality pollutants. The online version of L-THIA proved very capable. Preliminary results point to the upstream, more agricultural subcatchment areas of the watershed as a potential source of sediments and nutrients, while the urban downstream areas are a more likely source of excess runoff.

GABRIELLE THELEN
WHERE IS SHE NOW?



Gabrielle Thelen shown monitoring the response of the "Boatbot" during lake trials on Muskegon Lake.

Former AWRI Intern Gabrielle Thelen assisted with the design and construction of AWRI's first Autonomous Surface Vessel (ASV) during the summer of 2015. As the recipient of a Michigan Space Grant Consortium Award, Gabrielle worked on the initial testing of AWRI's "BoatBot" during the fall of 2016. Gabrielle submitted a final report of her work with AWRI to the Michigan Space Grant Consortium in April 2017. She now looks forward to graduating from GVSU's School of Engineering, having completed her co-op involving the industrial application of robotic technologies.

WELCOME, LIDIIA!

Dr. Lidiia Iavorivska joined AWRI this year as a postdoctoral research associate in Dr. Al Steinman's lab, where she'll be using a Soil and Water Assessment Tool (SWAT) computer model to help inform land management decisions and water pollution control in local watersheds. By combining modeling tools with water quality data collected by AWRI, modelers will evaluate how land-use decisions (such as different agricultural management practices or stream and wetland restoration projects) can influence water quality and identify which practices are most effective in solving water quality problems.

Dr. Lidiia Iavorivska collecting a water sample from the north branch of the Macatawa River.

GREAT LAKES FUNGAL STUDY DRAWS TO A CLOSE

After four years of study, the Great Lakes fungal collaboration funded by the National Institutes of Health (NIH) has collected nearly 200 sediment samples in Great Lakes waters from as deep as 900 feet and produced over 6,000 fungal isolates. Most of the nearly 465 identified taxa are previously unreported from the Great Lakes, and many are new species. In addition, over 127 fungal extracts exhibit significant anti-pediatric cancer properties. This is the most comprehensive fungal study ever conducted on the Great Lakes.

Graduate student Justin Wegner checking a deepwater sample in a Van Dorn bottle aboard the *W.G. Jackson*.

DYNAMIC INSIGHTS FROM INSTRUMENTING A GREAT LAKES ESTUARY

Water draining from Michigan's 2nd largest watershed pauses temporarily in Muskegon Lake before entering Lake Michigan. Knowledge of Muskegon Lake's water circulation and residence time is vital to understanding issues including river loading, nutrient and pollutant retention, primary productivity, food web function, surface water algal blooms, bottom water hypoxia, and more. To quantify lake-wide water movement, the Biddanda lab and NOAA's Great Lakes Environmental Research Laboratory placed instruments throughout this lake ecosystem. In addition to AWRI's Muskegon Lake Observatory (buoy), an array of moorings that included temperature and water quality sensors, tilt meters, and acoustic Doppler current profilers were deployed during the 2016-2017 season. With the additional sensors, researchers will be able to better understand the spatial and temporal dynamics of this system. So far, time-series measurements and hydrodynamic models have shown intriguing intrusions of cold water from Lake Michigan well into Muskegon Lake, providing new insights into the lake's behavior.

AWRI technician Tony Weinke (left), graduate student Katie Knapp (center) and post-doctoral research associate Qianqian Liu (right) prepare mooring ropes for deploying instruments on Muskegon Lake.

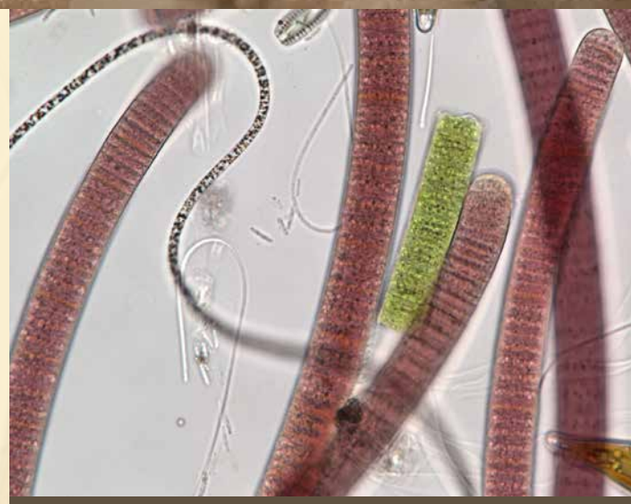
LAYERED LAKE: WHAT HAPPENS WHEN MIXED?

The onset of summer warms the surface waters that float over cooler and denser waters, creating "thermal stratification" or "layer effect" in temperate lakes. We can now track the formation of this layering effect in Muskegon Lake and study its ecosystem consequences – such as surface water productivity and bottom water hypoxia – over intervals of hours to years using the power of time-series weather and water quality data from the Muskegon Lake Observatory: www.gvsu.edu/buoy

Summer undergraduate research student Tom Claffey utilized the time-series data obtained by the Muskegon Lake Observatory (left, in background) to model the changing thermal structure of the lake over the seasons.

PEEKING INTO EARTH'S EARLY LIFE THROUGH LAKE HURON'S SINKHOLES

Time, water, and geology have converged to create low-oxygen, high-sulfur ecosystems characterized by filamentous microbial mats that thrive in submerged sinkholes in Lake Huron. A microscopic study revealed that these benthic (bottom) microbial mats are composed of not only the dominant photosynthetic purple-pigmented cyanobacteria (that appear green under stress), but also photosynthetic diatoms and chemosynthetic (energy obtained from chemicals, not sunlight) sulfur-oxidizing bacteria. In addition to being capable of different and complementary pathways of carbon and sulfur metabolism, these organisms can actively form aggregations that optimize sunlight capture for oxygenic and anoxygenic photosynthesis and carbon burial – processes that are likely to have played a key role in the evolution of Earth's early biosphere. The Biddanda lab and collaborators are trying to figure out if these ancient cousins of modern-day microbial mats could have oxygenated the Earth during life's turbulent childhood.



Microscopic images of photosynthetic cyanobacterial filaments (purple and green), diatoms (golden brown; bottom right) and chemosysnthetic bacteria (black and clear filaments) that comprise the benthic mats in Lake Huron's sinkholes (photo dimensions are ~100 µm × 60 µm). Photo credit: Tony Weinke and Rachel Ratliff.

AWRI FACULTY AND STAFF

THE ALLEN AND HELEN HUNTING DIRECTOR:
Alan Steinman, Professor

STAFF/ADMINISTRATIVE:
Tonya Brown, AWRI Assistant
Roxana Taylor, Secretary
Paula Wicklund, Office Coordinator

FACILITIES/MAINTENANCE:
Len Wittlieff, Maintenance

INFORMATION SERVICES CENTER:
John Koches, Associate Research Scientist

OUTREACH & EDUCATION:
Janet Vail, Research Scientist
- Paula Capizzi, Lead Instructor DJA
- Sherry Claflin, Science Instructor
- Cheri Gerhart, Science Instructor
- Ann Hesselsweet, Science Instructor
- Tom Jackson, Science Instructor
- Shirley McIntire, Science Instructor
- Maggie Pennell, Science Instructor
- Penny Reid, Science Instructor
- Michele Smith, Science Instructor
- Diane Veneklasen, Science Instructor

GVSU VESSELS/FIELD STATION OPERATIONS:
Anthony Fiore, Jr., Fleet Captain
- Terry Boersen, Deckhand WGJ
- John Bontrager, Captain WGJ
- Julia Carter, Relief Captain WGJ
- Dave Fisher, Marine Engineer WGJ
- Allan Girvin, Deckhand WGJ
- Roger Haynor, Captain DJA
- Pete Hewett, Deckhand DJA
- Tim Lucas, Relief Captain DJA
- Emily Morris, Deckhand
- Brad Nieboer, Marine Electrician
- Jim Rahe, Maintenance WGJ
- Peter Stoeckle, Deckhand DJA

ECOLOGICAL RESEARCH, ENVIRONMENTAL CHEMISTRY:
Richard Rediske, Professor
- Brian Scull, Research Assistant

ECOLOGICAL RESEARCH, ENVIRONMENTAL BIOLOGY:
Bopaiah Biddanda, Professor
- Scott Kendall, Technical Call-in
- Qianqian Liu, Postdoctoral Researcher
- Zakry O'Brien, Undergraduate Student Assistant
- Rachel Ratliff, Technical Call-in
- Anthony Weinke, Technical Call-in

Mark Luttenton, Professor of Biology

Jim McNair, Associate Professor

Charlyn Partridge, Assistant Professor
- Syndell Parks, Technical Call-in
- Brandon Wilson, Undergraduate Student Assistant

Carl Ruetz III, Professor
- Brittany Bajo, Undergraduate Student Assistant
- Nick Preville, Undergraduate Student Assistant

Alan Steinman, Professor
- Nicole Hahn, Technical Call-in
- Mike Hassett, Scientific Technician
- Lidiia Iavorivska, Postdoctoral Researcher
- Dave Kraff, Adjunct Research Assistant
- Maggie Oudsema, Research Assistant
- Kurt Thompson, Research Associate

Kevin Strychar, Professor

GRADUATE STUDENTS:

Biddanda, major advisor
- Katie Knapp, R.B. Annis Educational Foundation Assistantship

Luttenton, major advisor
- Barney Boyer, AWRI Assistantship
- Justin Wegner, AWRI Assistantship

McNair, major advisor
- Meagan McPherson
- Emma Rice, AWRI Assistantship
- Jay Zuidema, AWRI Assistantship

Partridge, major advisor
- Ben Giffin, GVSU Graduate School Special Assistantship
- Sarah Lamar, AWRI Assistantship
- Hailee (Pavisich) Leimbach-Maus, AWRI Assistantship
- Andrew Pyman, AWRI Assistantship

Rediske, major advisor
- Victoria Harris, AWRI Assistantship
- Molly Lane, AWRI Assistantship
- Daniel Myers, AWRI Assistantship
- Rajesh Sigdel, AWRI Assistantship

Ruetz, major advisor
- Greg Chorak, AWRI Assistantship
- Travis Ellens, AWRI Assistantship
- Kaitlyn Emelander, AWRI Assistantship
- Susanna LaGory, AWRI Assistantship
- Jason Lorenz
- Alan Mock, GVSU Graduate School Special Assistantship

Steinman, major advisor
- Emily Kindervater, AWRI Assistantship
- Paige Kleindl, AWRI Assistantship
- Kimberly Oldenborg, R.B. Annis Educational Foundation Assistantship
- Xiaomei Su, University of Chinese Academy of Sciences Assistantship

Strychar, major advisor
- Nick Gezon, AWRI Assistantship

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- Dr. Harvey Bootsma, University of Wisconsin – Milwaukee
- Dr. Carol Johnston, South Dakota State University
- Dr. Gary Lamberti, University of Notre Dame, Chair
- Dr. Don Scavia, University of Michigan

INTERNSHIPS & SCHOLARSHIPS:

AWRI provides opportunities for students to pursue their interests in our environment. The following students received internships during 2017.

SCIENTECH CLUB FOUNDATION INTERN
Emily Dusicska

HERBERT VANDERMEY INTERN
Evan Hausig

ROBERT B. ANNIS FOUNDATION INTERNS
Matthew Allen
Noah Cleghorn
Maria Scarborough

BILL AND DIANA WIPPERFURTH SCHOLARSHIP
Evan Hausig

RON WARD SCHOLARSHIP
Michaela Castleman
Noah Kiser
Madison Mitchell

NSF-REU QUEST STUDENTS
Rebekah Bryant
Thomas Claffey
Bethany Dennis
Meera Gandhi
Ellen James
Jennifer Kovach
Brady Nahkala
Brooke Ridenour
Brittany Schulz
Marisa Yang

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PEER REVIEWED PUBLICATIONS

AWRI staff in bold
Undergraduate Students*
Graduate Students**
Post-doctoral Fellows***

Biddanda, B.A. 2017. Global significance of the changing freshwater carbon cycle. Eos 98(6): 15-17. https://doi.org/10.1029/2017EO069751

Biddanda, B.A., **A.D. Weinke****, **S.T. Kendall**, **L. C. Gereaux****, **T. M. Holcomb***, **M. J. Snider****, **D. K. Dila****, **S. A. Long***, **C. VandenBerg***, **K. Knapp****, **D. J. Koopmans*****, **K. Thompson**, **J. H. Vail**, **M. E. Ogdahl**, **Q. Liu*****, T. J. Johengen, E. J. Anderson and S. A. Ruberg. In Press. Chronicles of Hypoxia: Time-series buoy observations reveal annually recurring seasonal basin-wide hypoxia in Muskegon Lake – a Great Lakes estuary. Journal of Great Lakes Research.

Cao, Q., **A.D. Steinman**, X. Su, and L. Xie. 2017. Effects of microcystins contamination on soil enzyme activities and microbial community in two typical lakeside soils. Environmental Pollution 231: 134-142. https://doi.org/10.1016/j.envpol.2017.08.013

Cao, Q., **A.D. Steinman**, L. Yao, and L. Xie. 2017. Increment of root membrane permeability caused by microcystins result in more elements uptake in rice (*Oryza sativa*). Ecotoxicology and Environmental Safety 145: 431-435. https://doi.org/10.1016/j.ecoenv.2017.07.066

Clement, D.R.** and **A.D. Steinman**. 2017. Phosphorus loading and ecological impacts from agricultural tile drains in a west Michigan watershed. Journal of Great Lakes Research 43: 50-58. https://doi.org/10.1016/j.jglr.2016.10.016

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Gerig, B.S., D.T. Chaloner, D.J. Janetski, A.H. Moerke, **R.R. Rediske**, **J.P. O'Keefe**, D.A. de Alwis Pitts, and G.A. Lamberti. In Press. Environmental context and contaminant biotransport by Pacific salmon interact to mediate the bioaccumulation of contaminants by stream-resident fish. Journal of Applied Ecology.

Gillett, N.D.***, **M. Oudsema**, and **A.D. Steinman**. 2017. Live diatoms as indicators of urban stormwater runoff. Environmental Monitoring and Assessment 189: 37. https://doi.org/10.1007/s10661-016-5747-8

Harris, B.S.**, **C.R. Ruetz III**, **A.C. Wieten****, **M.E. Altenritter****, and K.M. Smith. 2017. Characteristics of lake sturgeon *Acipenser fulvescens* Rafinesque, 1817 in a tributary of Lake Michigan, USA: status of the Muskegon River population. Journal of Applied Ichthyology 33: 338-346. https://doi.org/10.1111/jai.13365

Homola, J.J.**, **C.R. Ruetz III**, S.L. Kohler and R.A. Thum. 2016. Complex postglacial recolonization inferred from population genetic structure of mottled sculpin *Cottus bairdii* in tributaries of eastern Lake Michigan, U.S.A. Journal of Fish Biology 89: 2234-2250. doi:10.1111/jfb.13101

Moerke, A.H., **C.R. Ruetz, III**, T.N. Simon, and C.M. Pringle. 2017. Macroconsumer-Resource Interactions. Pages 399-412. In: Methods in Stream Ecology. Vol 1 (3rd Ed.) R. Hauer and G. Lamberti (editors). Academic Press. https://doi.org/10.1016/B978-0-12-416558-8.00019-6

Parks, S.R.**, **J.N. McNair**, P. Hausler, P. Tyning and R.A. Thum. 2016. Divergent responses of cryptic invasive watermilfoil to treatment with auxinic herbacides in a large Michigan lake. Lake and Reservoir Management 32: 366-372. doi:10.1080/10402381.2016.1212955

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Salk, K.R., P.H. Ostrom, **B.A. Biddanda**, **A.D. Weinke****, **S.T. Kendall** and N.E. Ostrom. 2016. Ecosystem metabolism and greenhouse gas production in a mesotrophic northern temperate lake experiencing seasonal hypoxia. Biogeochemistry 131: 303-319. https://doi.org/10.1007/s10533-016-0280-y

Sammarco, P.W., D.A. Brazeau, M. McKoin, and **K.B. Strychar**. 2017. Tubastraea micranthus, comments on the population genetics of a new invasive coral in the western Atlantic and a possible secondary invasion. Journal of Experimental Marine Biology and Ecology 490: 56-63. https://doi.org/10.1016/j.jembe.2017.02.003

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Sterner, R.W., P. Ostrom, N.E. Ostrom, J.V. Klump, **A.D. Steinman**, E.A. Dreelin, M.J. Vander Zanden, and A. Fisk. 2017. Grand challenges for research in the Laurentian Great Lakes. Limnology & Oceanography. doi:10.1002/lno.10585

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Su, X., **A.D. Steinman**, X. Tang, Q. Xue, Y. Zhao, and Xie, L. 2017. Response of bacterial communities to cyanobacterial harmful algal blooms in Lake Taihu, China. Harmful Algae 68: 168-177. https://doi.org/10.1016/j.hal.2017.08.007

Taylor (Schulte), L.L.**, **J.N. McNair**, P. Guastello, J. Pashnick, and R.A. Thum. 2017. Heritable variation for vegetative growth rate in ten distinct genotypes of hybrid watermilfoil. Journal of Aquatic Plant Management 55: 51-57.

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Uzarski, D.G., V.J. Brady, M.J. Cooper, D.A. Wilcox, D.A. Albert, R. Axler, P. Bostwick, T.N. Brown, J.J.H. Ciborowski, N.P. Danz, J. Gathman, T. Gehring, G. Grabas, A. Garwood, R. Howe, L.B. Johnson, G.A. Lamberti, A. Moerke, B. Murry, G. Niemi, C.J. Norment, **C.R. Ruetz III**, **A.D. Steinman**, D. Tozer, R. Wheeler, T.K. O'Donnell and J.P. Schneider. 2017. Standardized measures of coastal wetland condition: implementation at the Laurentian Great Lakes basin-wide scale. Wetlands 37:15-32. https://doi.org/10.1007/s13157-016-0835-7

Weinke, A.D.** and **B.A. Biddanda**. 2017. From bacteria to fish: Ecological consequences of seasonal hypoxia in a Great Lakes estuary. Ecosystems. https://doi.org/10.1007/s10021-017-0160-x

Xie, L.***, **R. Rediske**, **N.D. Gillett*****, **J.P. O'Keefe**, **B. Scull** and Q. Xue. 2016. The impact of environmental parameters on microcystin production in dialysis bag experiments. Scientific Reports 6:38722. DOI:10.1038/srep38722

NON PEER REVIEWED PUBLICATIONS

AWRI staff in bold
Undergraduate Students*
Graduate Students**
Post-doctoral Fellows***

Photo Credit: Kaitlyn Emelander

Biddanda, B. and **A. Weinke****. 2016. Finding a lake's productivity peak and nap time. InterChange: News magazine of the Regional Math and Science Center, GVSU. Connections for the STEM Classroom. http://www.gvsu.edu/rmsc/interchange/2016-november-connections-1188.htm

Biddanda, B., **A. Weinke****, and **S. Kendall**. 2017 "Postcard from the Field" entry onto the American Geophysical Union (AGU) Tumblr. "A view of Michigan's Muskegon Lake Observatory Buoy". Eos-Earth and Space News, AGU. March 1 2017, p 48. http://americangeophysicalunion.tumblr.com/tagged/postcards+from+the+field

Biddanda, B. and **D. Dila****. 2017. "Postcard from the Field" entry onto the American Geophysical Union (AGU) Tumblr. "Like stars in the sky: Lake Michigan's microbes glow in their lakescape". http://americangeophysicalunion.tumblr.com/tagged/postcards+from+the+field

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Partridge, C.G. 2017. Sneak copulations as an alternative reproductive strategy. In T.K. Shackelford & V.A. Weekes-Shackelford (Eds.), *Encyclopedia of Evolutionary Psychological Science*. Cham: Springer International Publishing. http://doi.org/10.1007/978-3-319-16999-6_3610-1

Ratliff, R., **K. Knapp****, **Q. Liu*****, and **B. Biddanda**. 2017. Girl to Geobiologist: Hope Jahren's spirited life in science journey. A book review of "Lab Girl" by Hope Jahren. InterChange: News magazine of the Regional Math and Science Center, GVSU. Connections for the STEM Classroom. http://www.gvsu.edu/rmsc/interchange/2017-september-connections-1278.htm

2017 MASTER OF SCIENCE THESES

Chorak, G. (Advisor: **Ruetz**). *Yellow perch genetic stock structure in eastern Lake Michigan: What is the importance of drowned river mouth lakes?*

Gezon, N. (Advisor: **Strychar**). *Surveying the Circular Rep Encoding Single Stranded (CRESS) DNA viral consortium found in invasive quagga mussels (Dreissena rostriformis bugensis) and sediments of the central Lake Michigan benthos.*

Harris, V. (Advisor: **Rediske**). *Determining the impacts of sawmill debris on benthic macroinvertebrate communities within Muskegon Lake, Michigan using traditional and genetic methods of identification.*

Kindervater, E. (Advisor: **Steinman**). *Phosphorus retention in west Michigan two-stage agricultural ditches.*

LaGory, S. (Advisor: **Ruetz**). *Seasonal ecology of mottled sculpin and brown trout in a coldwater Michigan stream.*

Potter, A. (Advisor: **Rediske**). *Polychlorinated Biphenyl concentrations in fish from Lake Michigan tributaries and a preliminary risk assessment concerning their consumption by sport and tribal fishermen.*

Sigdel, R. (Advisor: **Rediske**). *Assessment of environmental stressors in the Indian Mill Creek Watershed.*

Wegner, J. (Advisor: **Luttenton**). *Brook Trout behavioral thermoregulation and habitat selection in a small Michigan coldwater stream: implications for successful management.*

IF YOU WOULD LIKE MORE INFORMATION ABOUT AWRI'S PROGRAMS, PLEASE CONTACT US.

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