2011 R.B. ANNIS WATER RESOURCES INSTITUTE Year in Review

Photo credit: Janet Vail

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 biogeochemistry, aquatic ecology, environmental chemistry and toxicology, fisheries biology, hydrology, limnology, microbial ecology, stream ecology, watershed ecology and management, and wetlands ecology.

Information Services uses 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 and 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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2011: Water and the Economy

Dr. Alan Steinman, Director

Michigan has recently embraced the concept of a "blue water economy", which refers to taking advantage of our abundant fresh water supply to help generate economic growth. While the name may be new, the concept is not, as commerce in this state has traditionally centered on water. Whether it was Native Americans angling for lake trout and herring, European trappers seeking beaver pelts, lumber barons using waterways to transport downed timber, or industries employing water for manufacturing purposes, water has long served as the lubricant of our state's economic machinery.

We, at the Annis Water Resources Institute, of course recognize the value of water—after all, this resource keeps us in business. Indeed, the supporters who championed our move in 2001 from GVSU's main campus in Allendale to Muskegon, did so in the hope that our research, education, and outreach activities associated with water would help catalyze a knowledge-based economy on the lakeshore. I believe we have fulfilled, if not exceeded, that hope. While some of this is evident in quantifiable metrics—we now employ more than 70 full and part-time personnel, account for $3 million in new spending annually, and are responsible for ~3,500 visitors annually to our facility—many of our daily activities have economic implications that may not be evident at first glance.

As you look over AWRI's 2011 Year in Review, and read about the Institute's remarkable accomplishments this past year, please take a moment to consider how these activities also helped stimulate our local, regional, and state economy. Whether it is our research utilizing a new state-of-the-art floating observatory; understanding what influences the growth and abundance of critical fish species; generating the key scientific information to de-list Muskegon Lake as a Great Lakes Area of Concern; or identifying new ways to control invasive aquatic plants in our inland lakes, our findings relate to improved management of our natural resources. In addition, the research grants that fund these activities directly result in new dollars flowing into our region and help to support students and staff. And our outreach activities, including both the use of our research vessels for experiential learning and the generation of geospatial information to visually convey the world around us, help to ensure that our research findings get into the hands of the public, resource managers, and elected officials in a way that is useful and understandable.

Fresh water will continue to increase in value and, by that, I mean more than just in economic value. It is critical that as we "take advantage" of this resource, we do so in a sustainable and wise fashion, to ensure that it is available for future generations. To learn more about water and economy, take a peek at my Muskegon TEDx talk: www.youtube.com/watch?v=88kmoepAL1g

Clean Water in Rural Haiti:

Biosand Filters Provide Safe Drinking Water

Contamination of drinking water wells is a major concern in rural Haiti; here, Andrew Sisson (far right) and Peter Wampler (second from right) sample well water for *E. coli*.

AWRI graduate student, Andrew Sisson (advisor Dr. Richard Rediske), traveled to Haiti in March 2011 to study the performance of water treatment systems in rural villages and to evaluate the status of local water supplies. The rural villages get their water from springs, boreholes, and hand dug wells, which often are contaminated. Biosand filters are one of the most common treatment methods used in developing nations to reduce the impact of waterborne diseases. Their effectiveness is based on sand filtration and the activity of a biological layer at the surface of the filter. Andrew is studying the field and laboratory performance of the biosand filter as part of his Master's Thesis.

Andrew traveled with Dr. Peter Wampler (GVSU Geology Department) to 55 locations using biosand filters, with an average service time of 7 years. Water samples were collected and returned to the laboratory to measure the *E. coli* removal efficiency and to assess the quality of local water supplies. Andrew found that 29 of the 55 sites had biosand filters that were currently in use, and the average *E. coli* removal efficiency was 34%. Most of the filter failures were due to improper use or high levels of *E. coli* in the source water. Ten of the filters had 100% removal efficiency with source concentrations up to 500 times greater than Michigan water quality standards for drinking water. The oldest filter evaluated was in service for 12 years and still had >99% removal efficiency. This filter was

Andrew Sisson (second from right) and Peter Wampler (far right) visiting a rural home in Haiti where biosand filters are in use.

constructed from a 55-gallon drum and was maintained by a hospital employee. Andrew's results show a clear relationship between proper maintenance of the filter by the user and performance. Andrew presented some of his preliminary data at the Thirsting to Serve-International Clean Water Conference at Calvin College. Funding for the project was provided by the Annis Water Resources Institute, Padnos International Center, and Center for Scholarly and Creative Excellence.

REACHING OUT

Dr. Richard Rediske (back row, fifth from left) led a study abroad trip to Ghana for 7 weeks during the summer of 2011. Eighteen GVSU students studied at the University of Ghana in Accra for two weeks and worked at Challenging Heights, a non-profit group that rescues and provides rehabilitation for victims of child slavery. The students engaged in teaching elementary school, public health, nursing, and social work projects.

GVSU's New Muskegon Lake Observatory Stands Watch Over a Great Lakes Area of Concern

> "A lake is the landscape's most beautiful and expressive feature. It is the Earth's eye."
> ~ Henry David Thoreau (1854)

Long ago, Henry David Thoreau (1854) captured the essence of a lake with his observation that lakes are Earth's eyes. Today, we see numerous signs of the surrounding landscape and regional climate reflected within these "Earth's eyes". Thus, lakes serve as true sentinels of changes taking place in their airsheds and watersheds.

If you happen to be boating in the middle of Muskegon Lake or looking from shore, you will see a large 5-foot diameter yellow surface buoy and several smaller buoys. Earlier this year, Dr. Bopi Biddanda added an advanced technology buoy-based observatory to AWRI's ongoing monitoring program of Muskegon Lake. Managed by AWRI Research Assistant Scott Kendall, the Muskegon Lake Observatory (MLO) is EPA-funded and NOAA-supported with their research vessel "Laurentian". The main buoy is equipped with a meteorological sensor that measures wind, temperature, rain, and snow using its unique radar. Below surface, water sensors measure over 13 parameters, such as dissolved oxygen, temperature, light, turbidity, nitrates, and photosynthetic algae and bacteria at multiple depths. Data are collected every 5 minutes by weather sensors and 15 minutes by water sensors. The best part of this technology is that it is wirelessly transmitted to the internet so that everyone including researchers, educators, boaters, and fishermen can make use of the information.

With these data, researchers are able to evaluate short- and long-term trends taking place in the lake and examine relationships between physical, chemical and biological forces to determine what drives this ecosystem. So far the data, available from May 2011, have allowed researchers to track seasonal temperature cycles, lake mixing, low-oxygen conditions, and algal and cyanobacterial blooms. We hope to keep the observatory "standing watch" beyond the end of the current funding period in 2013. For more information, please visit the MLO website: www.gvsu.edu/buoy.

Fish Communities Reveal Healthier Lakes

Jessica Comben and Alex Wieten pull a fyke net from Muskegon Lake, in preparation for identifying fish captured in the net.

AWRI researchers under the direction of Dr. Carl Ruetz completed the third year of fish monitoring in Muskegon and White Lakes. Both lakes are classified as Areas of Concern (AOCs), which means they were among the most environmentally degraded sites in the Great Lakes.

After considerable remediation, both lakes appear to be much healthier than they were when they were listed originally as AOCs.

Fish monitoring focused on whether fish populations and habitats have recovered in the lakes. Dr. Ruetz's team sampled fish in shallow areas of lakes to provide information on the community and measure ecological

Fish Contaminant Study to Begin in Muskegon Lake and White Lake AOCs

Richard Rediske, Carl Ruetz, and Jim O'Keefe were awarded a grant from the Michigan Department of Environmental Quality to examine PCB and mercury levels in fish from the Muskegon Lake and White Lake AOCs. AWRI will collect smallmouth bass and carp from the two AOCs and compare concentrations of PCBs and mercury to those found in fish from Pentwater Lake, a reference system. If contaminant concentrations are similar to Pentwater Lake or show a decreasing trend, the Beneficial Use Impairment of Restrictions on Fish Consumption can be removed from the AOCs.

health. Their data show that the ecological health of the fish community in both lakes is on par with a nearby "reference" lake—Pentwater Lake—and suggest that both lakes have met the numerical targets set for delisting with respect to the fish community, which is one of several criteria used to determine whether the lakes still should be classified as AOCs.

Benthic Invertebrate Monitoring Shows Improved Sediment Conditions in Muskegon Lake

Sediment contamination resulting from the direct discharge of industrial and municipal wastes led to the designation of Muskegon Lake as a Great Lakes Area of Concern (AOC). As a part of her graduate work, Whitney Nelson, a graduate student working with Dr. Al Steinman, assessed the response of the benthic invertebrate community to historic sediment contamination in Muskegon Lake. Benthic invertebrates are useful indicators of ecosystem health, particularly sediment quality, since they spend much if not all of their lives in direct contact with sediments.

The Muskegon Lake Long-Term Monitoring Project was started in 2003, with the goal of achieving a better understanding of the short- and long-term ecological dynamics in the lake. As part of this project, samples of the lake bottom were taken from six locations in the lake and archived. Whitney analyzed the benthic invertebrate community in samples collected from 2004-2010. She compared her results to historical data to determine if there were any discernable patterns related to the ecological recovery of benthic invertebrates.

Her results were consistent with the continued improvement in the environmental condition of Muskegon Lake. She found changes in community composition, abundance, and survival of the benthic invertebrate populations that indicated a healthier lake. However, it remains to be seen if some patterns are a result of a single-year event or are indicative of changing conditions in Muskegon Lake. The analysis of future data will allow for this determination and hopefully aid in the delisting of Muskegon Lake as an AOC. Whitney co-authored a manuscript with Dr. Al Steinman summarizing her research findings, which has been submitted to a peer-reviewed journal.

Whitney Nelson preparing to collect benthic invertebrates from a Muskegon Lake sediment sample. The device used to retrieve sediment from the lake bottom is called a Ponar dredge.

BENTHIC INVERTEBRATES include worms, insects, and mollusks that live in lake and stream sediments.

A burrowing mayfly found in a Muskegon Lake sediment sample, signaling improved lake health.

Making the Great Lakes Great:
More Ports, More People, More Partners

Dave Fisher (middle), ***W.G. Jackson*** Marine Engineer, collecting a plankton sample while on a cruise out of Port Washington, Wisconsin.

A Great Lakes Restoration Initiative (GLRI) grant has expanded the Making Lake Michigan Great outreach tour to Lakes Huron, Erie, St. Clair, and the Detroit River. The two-year project involves onboard education about the GLRI, stewardship, and water quality through public and student cruises, as well as teacher workshops. The partners include AWRI, Inland Seas Education Association, BaySail, and MSU Michigan Sea Grant. Also, AWRI partnered with another GLRI project (Earth Partnership for Schools training through the University of Wisconsin) to host a week-long educator workshop. According to the Project Manager, Janet Vail, "in the first year AWRI was able to reach six ports in four states and the other partners added another 15 ports of call." AWRI's *W.G. Jackson* research and education vessel visited ports in White Lake; Muskegon; Milwaukee; Michigan City, Indiana; Waukegan, Illinois; and Port Washington, Wisconsin. Plans are underway for summer 2012.

After being with the vessel program since 1993, Chuck Vanderlaan has retired. He served as the lead instructor on the ***W.G. Jackson*** since 1996. AWRI thanks Chuck for his many years of service and dedication to student learning.

Janet Vail received an award at the Project WET (Water Education for Teachers) Annual Conference in Bozeman, Montana for her service as the Michigan Coordinator of Project WET since 2000.

Student Intern Gets Her Feet Wet

Erika Arndt and members of the Duck Creek Watershed Assembly preparing for a monitoring event.

Every year the Information Services Center (ISC) is blessed with one to several student interns. Because ISC projects range from the development of watershed management plans and the use of hydrologic and ecosystem models to the production of educational videos and the deployment of information programs, we have found a place for students from almost every academic discipline. While we have had some outstanding students, we were unprepared for the enthusiasm and talents of one of last summer's Scientech Internship Award winners, Erika Arndt.

Erika ended up doing a bit of everything during her internship. She organized meetings, took minutes, and spent a lot of time talking and working with our stakeholders. But what she wanted more than anything else was a chance to work on the Duck Creek Watershed Management Plan. Erika dove into this project feet-first, literally. Not only did she help to organize the required social profile and draft the first two chapters of the final report, she also spent many hours walking the stream, cataloging where erosion sites were prevalent in preparation for future pollution controls.

In Erika's words, "By working together on the Duck Creek Planning Project...I have absorbed valuable information on what it takes to be successful in the environmental field and as an administrative catalyst for regional change." Erika is majoring in Public Administration with plans to graduate in 2012.

Bluebells in Muskegon? Yes, Virginia!

AWRI has been working with the Land Conservancy of West Michigan and Martinus & Associates to identify potential conservation areas within the 160 square-mile Crockery Creek watershed. "We are looking for lands that are essential to the maintenance and protection of the local ecosystem," said Rod Denning, AWRI Project Manager. "Priorities are identified using a two-pronged approach. We developed a landscape-scale assessment that identified lands that meet certain criteria. This was followed by field surveys that revealed plant and animal communities."

This approach has paid off in dividends. We found extensive populations of the endangered species *Mertensia virginica* (Virginia bluebells). These plants were found within the rich floodplain forests along Crockery Creek. They number in the millions. Many are within Muskegon County, making these sightings the first documented case in the area. This endangered species is ranked in the State as S1S2, being critically imperiled to imperiled.

Photo credit: William Martinus, Land Conservancy of West Michigan

Kent Trails Bridge over the Grand River

In July 2011, Rod Denning, AWRI Research Associate, received an award from the West Michigan Trails and Greenways Coalition in recognition for his work in the creation of the *Fred Meijer Map Atlas for Non-Motorized Trails.* The award was given *"with great appreciation for [his] creativity and dedication in helping to promote the trails of West Michigan".*

Where are they now?

Student Success Highlights:
Hannah Tavalire and Matthew Zuellig,
Past AWRI Graduate Students

Hannah Tavalire sampling invasive variable leaf watermilfoil in New England for her Master's thesis.

Hannah is currently in a PhD program at Oregon State University's Zoology Department. Hannah's dissertation research is developing, but currently focuses on the effects of environmental pollutants on host resistance to parasites causing schistosomiasis. Hannah strongly believes that her graduate studies at AWRI laid the groundwork for success in her PhD program. "The invaluable experience in experimental design and execution, grant writing, and general writing I got while at AWRI definitely prepared me for the challenges I have faced thus far in my PhD program."

Matt is currently working toward his PhD at the University of Georgia Department of Genetics, where he is furthering his technical and analytical skills in genetics research to study the genetic basis of 'weediness' and herbicide resistance in plants. Matt's PhD interests represent a natural extension of his research experiences at AWRI studying the genetics of invasive Eurasian watermilfoil. "While at AWRI I was encouraged to write grant proposals, participate in scientific conferences, and write peer-reviewed research articles. My involvement in these activities led to a greater understanding and love of science, which greatly influenced my decision to pursue a doctorate in genetics."

Matthew Zuellig sampling watermilfoil for a field study demonstrating herbicide resistance in hybrid watermilfoil during his Master's thesis.

THE PROFILES SERIES

AWRI was selected by the Discovery Channel to be featured on their Profiles Series, hosted by Lou Gossett, Jr. The 30-minute feature, which includes interviews with AWRI personnel and community leaders, will focus on the sustainability of freshwater resources and is scheduled for airing in 2012.

2011-2012 A LASTING LEGACY FACULTY & STAFF CAMPAIGN

Photo credit: Yakuta Bhagat

AWRI Staff Give Back

AWRI staff dedicate themselves not only to AWRI's mission but also to Grand Valley's mission of educating students to shape their lives, professions, and societies. One way they express that dedication is through GVSU's annual Faculty/Staff Fund-raising Campaign. AWRI has achieved 100% participation during the past two campaigns, demonstrating not only a professional but also the personal commitment of each of AWRI's staff.

HARD TO KILL:

HYBRID WATERMILFOILS ARE LESS SENSITIVE TO HERBICIDE

Liz LaRue planted different genotypes of watermilfoil after exposure to 2,4-D for her thesis research. The experiment ultimately demonstrated that hybrid watermilfoils are less sensitive to 2,4-D than Eurasian watermilfoil.

Liz LaRue setting up her experiment in AWRI's mesocosm facility.

Invasive aquatic plants can become the dominant species in freshwater ecosystems, sometimes making drastic changes to aquatic ecosystems and impeding human recreation. Chemical herbicides are often used to control invasive aquatic plant growth, but are both expensive and controversial. Therefore, it behooves government regulatory agencies to develop policies that utilize the least amount of herbicides effectively.

Eurasian watermilfoil is a widespread invasive aquatic plant species in the Great Lakes region. It can hybridize with a native species, northern watermilfoil, to create yet another invasive plant. Both Eurasian watermilfoil and hybrids are routinely managed with aquatic herbicides.

Recent research on invasive plants has led to the hypothesis that hybridization may lead to the evolution of plant populations that are more invasive than their parents. In fact, several lake managers and herbicide applicators have reported anecdotally that hybrids are more difficult to kill with herbicides in comparison to pure Eurasian watermilfoil. A major focus of research in Dr. Ryan Thum's lab is the evolution of herbicide resistance in milfoils, representing the first formal scientific studies on the subject.

As part of ongoing projects, AWRI graduate student Liz LaRue recently conducted experiments in AWRI's mesocosm facility to experimentally show that hybrid milfoils are less sensitive to one routinely-used aquatic herbicide (2,4-D) in comparison to Eurasian watermilfoil. In addition, Liz and past AWRI graduate student Matthew Zuellig conducted a field study that demonstrated hybrid watermilfoils occur more frequently in 2,4-D treated lakes whereas pure Eurasian watermilfoil is more common in untreated lakes.

Liz's work has important intellectual and practical implications. Her research provides an example of herbicide resistance evolution through hybridization, and this is the first known documentation of this phenomenon. Also, her research has strong implications for determining best management practices for hybrid versus Eurasian watermilfoil.

Ryan Thum (left) and Research Assistant Dustin Wcisel (right) weigh and measure plants during an experiment to test the response of different milfoil genotypes to herbicides.

AWRI's Dr. Ryan Thum received the Distinguished Early-Career Scholar Award at the Faculty Awards Convocation in February (along with Dr. Rachel Powers from Chemistry). GVSU's Center for Scholarly and Creative Excellence produced a short video on Dr. Thum's teaching and research, which can be viewed at vimeo.com/26446707.

AWRI at Work 2011

Graduate students Neal Swanson (left) and Alex Wieten (right) with an adult lake sturgeon that was captured and released unharmed in the Muskegon River.

Eric Tidquist, lab technician, assisting with long-term water quality monitoring on Muskegon Lake.

Leah Borns, a Herbert VanderMay intern, giving it her all while gathering data to map Ruddiman Creek.

Post-doctoral researcher Nadia Gillett taking water quality measurements in Ruddiman Creek to inform her research on diatoms.

Research Assistant Brian Scull and graduate student Whitney Nelson collecting macroinvertebrate samples for evaluating pre-restoration conditions in an area of Muskegon Lake proposed for mill debris removal.

Research Assistant Maggie Weinert collecting sediment cores on Garden Island.

Lab technicians Tom Holcomb (left) and Steve Long (right) perform maintenance on the subsurface buoy sensors of the Muskegon Lake Observatory.

AWRI undergraduate students assist with setting up a herbicide exposure experiment (front: Jessika Blackport; back left: Heather Hayward; right: Benjamin Sikkenga).

Research Assistant Mary Ogdahl waist-deep in the aquatic plants she is surveying at Grand Trunk, in an effort to gather post-restoration data in Muskegon Lake.

Undergraduates Michael Bredeweg and Allison Kneisel measure water quality variables and record data as part of fishing sampling surveys of drowned river mouth lakes.

How fast are stream beds fed?

What are the signs of a healthy stream? For many people, the key is a diverse fish community. But while most scientists would agree that a diverse fish community is important, there is more to a healthy stream than fish.

Much of the food that sustains the fish community comes from the multitude of small organisms—bacteria, fungi, algae, and invertebrates—that live on and in the stream bed. Many of these organisms survive by eating their neighbors, but vital external sources of nutrition are nutrients and tiny organic particles called seston that are delivered to the bed from the overlying water.

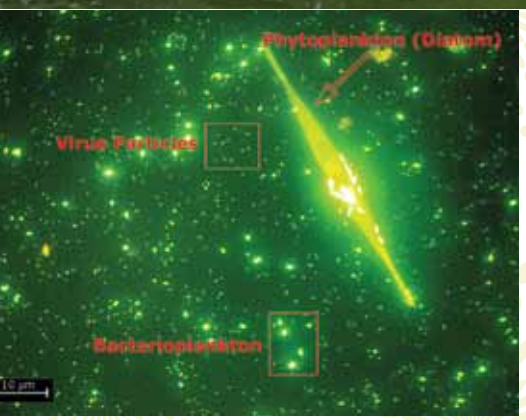
The rate at which nutrients and seston are delivered to the stream bed is important in determining how rapidly biological growth occurs in the bed. Scientists have therefore devised a method for measuring this rate. The basic idea is to inject a large amount of nutrient or seston into a stream and then measure its disappearance from the water (caused by delivery to the bed) as it is carried downstream. One then assumes the pattern of decrease with distance has a special shape known as exponentially decreasing, and it is simple to estimate the delivery rate to the bed.

But this shape is assumed mainly for simplicity. While it sometimes provides a good description of the observed pattern of decrease, if often does not. Nor is there any good reason to expect this shape based on the principles of fluid mechanics.

AWRI scientist Dr. Jim McNair examined data from numerous published studies of seston delivery. He found that most deviate significantly from an exponentially decreasing pattern but are well described by a model he developed based on fluid mechanics. Results of his study also indicate that standard methods probably underestimate seston and nutrient delivery rates.

Photo credit: Stacy Provo

Zach Madaj, a Robert B. Annis Foundation undergraduate intern, carried out computer studies of Dr. McNair's particle transport model in summer 2011. His results help explain why the model describes published data sets so well.



A microscopic view of the Muskegon River microbes in springtime. Plankton float among a sea of viruses - which serve to keep plankton populations in check.

Myriad Microbial Communities in a West Michigan Watershed

It's a beautiful day on the Muskegon River and you're the only angler in sight, but if you believe it's just you and the trout in the river, think again. From the smallest tributary to offshore Lake Michigan, every cubic inch of water in the Muskegon River watershed contains millions of microorganisms. Microscopic primary producers (phytoplankton) and recyclers (viruses, bacteria, and zooplankton) are hard at work keeping the watershed healthy. Graduate student Deb Dila and her advisor, Dr. Bopi Biddanda, have identified a couple of ways how:

- Cedar Creek gets a big dose of organic matter from the surrounding landscape, but actively respiring bacteria in the creek efficiently recycle organic matter by the time it enters Muskegon River.

Al Steinman (right) and Don Uzarski (left) collecting a sediment core on Garden Island.

Al Steinman and Mary Ogdahl adding water to sediment cores to simulate re-flooding of dried wetland sediments.

What do water level changes mean for Great Lakes coastal wetlands?

Water levels in the Great Lakes affect virtually all of us living in the basin through their impact on recreation, commerce, and the environment. The health of our coastal wetlands is particularly susceptible to water level changes.

AWRI Director Al Steinman spent part of his 2011 sabbatical on Beaver Island at the Central Michigan University Biological Station. Collaborating with former AWRI professor Don Uzarski, who now oversees the Biological Station, Steinman and his lab examined the effect of Great Lakes water level changes on sediment nutrient release in coastal wetlands on Beaver and Garden Islands. This work builds on research Steinman and his colleagues conducted in 2010 as part of the International Joint Commission's Upper Great Lakes Water Level Study.

As water levels go up and down, sediments in coastal wetlands experience periodic wetting and drying, respectively. When dried sediments are re-flooded, they can release a considerable amount of nutrients to the water, which in turn can fuel the growth of organisms. By modeling measured release rates under different water level scenarios, Steinman and his colleagues will be able to predict the effect of water level change on important processes influencing the growth of fish and wildlife in these critical habitats.

Welcome! AWRI welcomes Géraldine Nogaro to the Steinman lab. Géraldine, a native of France and who received her Ph.D. from the University of Lyon, will be studying the influence of benthic invertebrates, including zebra and quagga mussels, on nutrient cycling and water quality in eutrophic Bear Lake sediments. Her results will help to improve our understanding of the ecological consequences of nutrient pollution and has important implications for on-going restoration efforts in the Muskegon Lake watershed.

- Muskegon Lake has bursts of phytoplankton primary production that provide the base for a rich food web and allow export of needed nutrients to Lake Michigan, where primary production is usually much lower.

Work supported by: Michigan Space Grant Consortium and Grand Valley State University Presidential Grant.

Deb Dila is a graduate student at AWRI investigating microorganisms that inhabit the surface water along a land to lake gradient from Cedar Creek to offshore Lake Michigan. She is fascinated with the critical role that microbial activity plays in maintaining the local watershed - not to mention the entire biosphere!

Photo credit: Mary Ogdahl

Algicide Treatment Influences Toxin Release

AWRI researchers Dr. Richard Rediske and James O'Keefe completed field and laboratory studies to assess the potential release of toxins, called microcystins, from cyanobacteria (blue-green algae) as a result of algicide application in Muskegon County lakes. The project was in collaboration with Public Health Muskegon County and funded by the Michigan Department of Environmental Quality.

Dissolved microcystin concentrations were observed 24 hours and 48 hours after an algicide application in early July. The results indicated that microcystins were released into the water column after application and that the cyanobacteria populations were able to recover in 45 days, reaching a maximum in August. Microcystin concentrations were reduced by 80% one week after algicide application, but gradually increased and peaked at pre-algicide application levels approximately 1 month later.

AWRI also evaluated the use of a new screening test to measure microcystins in water. The Envirologix QualiTube Test Kit provided comparable results to a reference method (Liquid Chromatography/Mass Spectrometry) in a subset of 50 samples from Bear Lake, Muskegon Lake, and Mona Lake. The test costs approximately $15 and can be completed in 1 hour. Public Health Muskegon County conducted a public education program for the lake associations and prepared informational materials about cyanobacteria and their toxins. The results of the project were posted on the National Oceanic and Atmospheric Administration's Cyanobacteria Monitoring Web Site: www.glerl.noaa.gov/res/Centers/HABS/sampling_data.html.

Graduate student Elizabeth Tromp collecting water from Bear Lake for microcystin analysis.

FISHERIES RESEARCH:

Undergraduate evaluates methods for estimating stream fish abundance

The successful management of fish requires unbiased information on their population status. When fisheries managers conduct sampling and employ statistical techniques to estimate fish abundance, they are asking "what is the true number of fish in a stream?" Recent research by Brandon Harris, an undergraduate student working with Dr. Carl Ruetz, helped to determine how to answer that question.

Brandon received support from GVSU's Student Summer Scholars program to evaluate two common approaches for estimating mottled sculpin abundance in local streams this past summer. The mottled sculpin is a small, bottom-dwelling fish that is a positive indicator of ecological health. Thus, healthy coldwater streams tend to have thriving populations of mottled sculpin. Brandon's research is unique in that it evaluated methods for estimating the abundance of a ubiquitous, non-game species, whereas previous studies focused on popular game species such as trout and salmon.

Brandon's research suggests that the mark-recapture approach for estimating fish abundance was superior to a less time-consuming approach called the removal method, where fish are sampled and temporarily removed from the population. Brandon's results are similar to findings reported for trout and salmon. His results will help fisheries biologists conduct more accurate and scientifically-rigorous monitoring of fish populations.

Brandon Harris holds a mottled sculpin captured during backpack electrofishing.

Brandon recently summarized the results of his research in an oral presentation at the Midwest Fish and Wildlife Conference in Des Moines, Iowa. He also is working with Dr. Ruetz on a manuscript describing their research, which they plan to submit to a peer-reviewed journal for publication. After completing his field sampling this past summer, Brandon continued to work on his research during the fall semester with the generous support of the Bill and Diana Wipperfurth Student Research Scholarship.

David Janetski joined AWRI in September of 2011 as a Postdoctoral Researcher and will finish his Ph.D. from the University of Notre Dame in January 2012. He will work with Dr. Carl Ruetz on the spatial and temporal patterns of fish communities in drowned-river mouth lakes.

AWRI Faculty and Staff

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Roxana Taylor, Secretary
Paula Wicklund, Office Coordinator

Facilities/Maintenance:

Roger Hillstead, Maintenance

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- Rod Denning, Research Associate
- Betty Gajewski, Technical Call-in
- Jon VanderMolen, Technical Call-in

Outreach & Education:

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- Paula Capizzi, Science Instructor
- Paul Carlson, Science Instructor
- Bonnie Cowles, Science Instructor
- Leslie De Vries, Science Instructor
- John Gort, Science Instructor
- Shirley McIntire, Science Instructor
- Michele Smith, Science Instructor
- Amanda Syers, Technical Call-in
- Chuck Vanderlaan, Science Instructor
- Diane Veneklasen, Science Instructor

GVSU Vessels/Field Station Operations:

Anthony Fiore, Jr., Fleet Captain
- Ronald Brown, Captain WGJ
- Dave Fisher, Marine Engineer WGJ
- Robert Marx, Deckhand WGJ
- Brad Nieboer, Marine Electrician
- Robert Pennell, Deckhand DJA
- Jim Rahe, Deckhand WGJ
- George Thibault, Deckhand DJA
- Jim Winks, Captain DJA

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- Liqiang Xie, Post-doctoral Researcher
- Eric Fahnenstiel, Technical Call-in
- Jim O'Keefe, Research Associate
- Brian Scull, Research Assistant

Ecological Research, Environmental Biology:

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- Scott Kendall, Adjunct Research Assistant
- Steve Long, Technical Call-in
- Tom Holcomb, Technical Call-in

Mark Luttenton, Professor of Biology
Jim McNair, Associate Professor
Carl Ruetz III, Associate Professor
- Yakuta Bhagat, Post-doctoral Researcher
- Dave Janetski, Post-doctoral Researcher
- Jessica Comben, Technical Call-in
- Ray Govus, Technical Call-in

Alan Steinman, Professor
- Nadia Gillett, Post-doctoral Researcher
- Geraldine Nogaro, Post-doctoral Researcher
- Sara Damm, Technical Call-in
- Carrie Hause, Technical Call-in
- Mary Ogdahl, Research Assistant
- Kurt Thompson, Research Associate
- Eric Tidquist, Technical Call-in
- Maggie Weinert, Adjunct Research Assistant

Ryan Thum, Assistant Professor
- Dustin Wcisel, Adjunct Research Assistant
- Matt Zuellig, Technical Call-in

Photo credit: Mary Ogdahl

Graduate Students:

Nicholas Albrecht, AWRI Assistantship (major advisor: Mark Luttenton)
Jordan Allison, AWRI Assistantship (major advisor: Carl Ruetz)
Deb Dila, AWRI Assistantship (major advisor: Bopi Biddanda)
Travis Foster (major advisor: Mark Luttenton)
Leon Gereaux, AWRI Assistantship (major advisor: Bopi Biddanda)
Jared Homola, AWRI Assistantship (major advisor: Carl Ruetz)
Nicole Horne, AWRI Assistantship (major advisor: Bopi Biddanda)
Elizabeth LaRue, AWRI Assistantship (major advisor: Ryan Thum)
Whitney Nelson, AWRI Assistantship (major advisor: Al Steinman)
Jeremy Newton (Cell & Molecular Biology intern with Ryan Thum)
Stephanie Sherburn (major advisor: Ryan Thum)
Andrew Sisson, AWRI Assistantship (major advisor: Rick Rediske)
Michael Snider, AWRI Assistantship (major advisor: Bopi Biddanda)
Neal Swanson (major advisor: Mark Luttenton)
Hannah Tavalire, AWRI Assistantship (major advisor: Ryan Thum)
Elizabeth (Hannah) Tromp, AWRI Assistantship (major advisor: Rick Rediske)
Alex Wieten, AWRI Assistantship (major advisor: Carl Ruetz)

Undergraduate Student Assistants:

Michael Bredeweg
Heather Hayward
Allison Kneisel
Amanda Mercer
Patricia Phillips
Latricia Rozeboom
Heather Snyder
Adrienne Gibson
Caleb James
Amanda Maycroft
Elizabeth Mullins
Stacy Provo
Ben Sikkenga
Mikel Vredevoogd

AWRI Science Advisory Board

Harvey Bootsma, Great Lakes WATER Institute, U of Wisconsin - Milwaukee
Carol Johnston, South Dakota State University
Gary Lamberti, University of Notre Dame; Chair
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 2011.

D. J. Angus-Scientech Educational Foundation Interns:

Jessika Blackport
Adrienne Gibson
Allison Kneisel
Anthony Weinke

Herbert VanderMey Intern:

Leah Borns
Heather Hayward

Robert B. Annis Foundation Interns:

Erika Arndt
Travis Bisson
Zachary Madaj

Bill and Diana Wipperfurth Scholarship:

Brandon Harris

Summer Student Scholar:

Brandon Harris

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AWRI Peer Reviewed Publications 2011

(AWRI staff in Bold)

Bhagat, Y. and C.R. Ruetz III. 2011. Temporal and fine-scale spatial variation in fish assemblage structure in a drowned river mouth system of Lake Michigan. Transactions of the American Fisheries Society 140: 1429-1440.

Biddanda, B., S. Nold, G. Dick, **S. Kendall**, **J. Vail**, S. Ruberg, and C. Green. In Press. Rock, water, microbes: Underwater sinkholes in Lake Huron are habitats for ancient microbial life. Nature Education.

CABI, 2010. Datasheet on *Myriophyllum heterophyllum* [text and tables by **R. A. Thum** and **M. Zuellig**]. Invasive Species Compendium (http://www.cabi.org/isc/). CABI, Wallingford, UK.

Gillett, N.D. and **A.D. Steinman**. 2011. An analysis of long-term phytoplankton dynamics in Muskegon Lake, a Great Lakes Area of Concern. Journal of Great Lakes Research 37: 335-342.

Johnson, K.A., **A.D. Steinman**, **W.D. Keiper**, and **C.R. Ruetz III**. 2011. Biotic responses to low concentration urban road runoff. Journal of the North American Benthological Society 30: 710-727.

LaRue, E., **C.R. Ruetz III**, **M.B. Stacey**, **R.A. Thum**. 2011. Population genetic structure of the round goby in Lake Michigan: implications for dispersal of invasive species. Hydrobiologia 663: 71-82. DOI 10.1007/s10750-010-0555-6.

MacDonald, N.W., D.W. Mays, **R.R. Rediske**, and **C.R. Ruetz III**. In press. Environmental variation, fish community composition, and brown trout survival in the Pigeon River, Ottawa County, Michigan. Michigan Academician.

Molecular Ecology Resources Primer Development Consortium (76 authors, including **E. LaRue** and **R.A. Thum**). 2010. Permanent genetic resources added to molecular ecology. Resources database 1 June 2010 – 31 July 2010. Molecular Ecology Resources 10: 1106–1108. DOI: 10.1111/j.1755-0998.2010.02916.x.

Parkos, J.J., III, **C.R. Ruetz III**, and J.C. Trexler. 2011. Disturbance regime and limits on benefits of refuge use for fishes in a fluctuating hydroscape. Oikos 120: 1519-1530.

Sanders, Jr. T.G., **B.A. Biddanda**, C.A. Stricker, and S.C. Nold. 2011. Stable isotope analysis reveals benthic macroinvertebrate and fish communities linked to submerged groundwater vents in Lake Huron. Aquatic Biology 12: 1-11.

Steinman, A.D., **M.E. Ogdahl**, K. Wessell, **B. Biddanda**, S. Kendall, and S. Nold. 2011. Periphyton response to simulated nonpoint source pollution: local over regional control. Aquatic Ecology 45: 439-454. DOI: 10.1007/s10452-011-9366-8.

Steinman, A.D., and **M.E. Ogdahl**. 2011. Does converting agricultural fields to wetlands retain or release P? Journal of the North American Benthological Society 30: 820-830.

Steinman, A.D., J.R. Nicholas, P. Seelbach, J. Allan, and F. Ruswick. 2011. The role of science in developing policy for the use of groundwater in the state of Michigan. Water Policy 13: 69-86. DOI:10.2166/wp.2010.047.

Steinman, A.D., **M.E. Ogdahl**, and **C.R. Ruetz III**. 2011. An environmental assessment of a small, shallow lake threatened by urbanization. Environmental Monitoring and Assessment 173: 193-209. DOI: 10.1007/s10661-010-1381-z.

Steinman, A.D. 2011. Environment. In: Leadership in nonprofit organizations: A reference handbook. Pages 205 – 214. Editor: K.A. Agard. Sage Publ., Los Angeles, CA.

Thum, R.A., **M.P. Zuellig**, R.L. Johnson, M.L. Moody, and C. Vossbrinck. In Press. Molecular markers reconstruct the invasion history of variable leaf watermilfoil (*Myriophyllum heterophyllum*) and distinguish it from closely related species. Biological Invasions. DOI:10-1007/s10530-010-9927-0.

Thum, R.A., A. Mercer, and **D. Wcisel**. In Press. Loopholes in the regulation of invasive species: genetic identification techniques identify the sale of prohibited invasive aquatic plants. Biological Invasions. DOI:10.1007/s10530-011-0130-8.

Voorhies, A., **B. Biddanda**, **S. Kendall**, J. Jain, D. Marcus, S. Nold, N. Sheldon, and G. Dick. In Press. Cyanobacterial life at low O_2: community genomics and function reveal metabolic versatility and extremely low diversity in a Great Lakes sinkhole mat. Geobiology.

Wieten, A.C., M.J. Cooper, A.D. Parker, and D.G. Uzarski. In Press. Great Lakes coastal wetland habitat use by seven turtle species: influences of wetland type, vegetation, and abiotic conditions. Wetlands Ecology and Management.

Xie, L., **J. Hagar**, **R. Rediske**, **J. O'Keefe**, J. Dyble., and **A. Steinman**. 2011. The influence of environmental conditions and hydrologic connectivity on cyanobacteria assemblages in two drowned river mouth lakes. Journal of Great Lakes Research 37: 470-479.

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AWRI Technical Reports/Manuals and Non-Peer Reviewed 2011

(AWRI Staff in Bold)

Biddanda, Bopi. 2011. Isotopes reveal groundwater link to Great Lakes's food web. Interchange, 18(3). www.gvsu.edu/rmsc/interchange/2011-april-science-and-math-update-538.htm

Steinman, A.D. and **M.E. Ogdahl.** 2011. Internal phosphorus loading in Spring Lake 5 years following alum treatment. Final report to Progressive AE.

Steinman, A.D. 2011. Internal phosphorus loading: the unseen source. The MI Corps Monitor, Fall 2011. www.micorps.net/newsletter/2011/fall/article2.html.

Steinman, A.D., **M.E. Ogdahl**, **R.R. Rediske**, and **C.R. Ruetz III**. 2011. A study of surface runoff from U.S. 31 and Seaway Drive to Little Black Creek. Final report to U.S. DOT.

Vail, J. 2011. Research Vessel D. J. Angus Use Report 2010. CR-2011-1.

Vail, J. 2011. Research Vessel W. G. Jackson Use Report 2010. CR-2011-2.

Vail, J. 2011. Instructor's Manual for Scientific Educational Cruises Aboard the D. J. Angus and W. G. Jackson Vessels (revised). TM-2011-1.

More About AWRI

If you would like more information about AWRI's programs, please contact us:

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Giving opportunities to support the operations of the Annis Water Resources Institute are available at the Community Foundation for Muskegon County (www.cffmc.org) or at the GVSU Office of Development (www.gvsu.edu/development).

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