Fall 2008

Water Resources Review - Fall 2008, Vol 21, No. 1

Annis Water Resource Institute

Grand Valley State University
ANNIS WATER RESOURCES INSTITUTE
Lake Michigan Center

Water Resources Review

Grand Valley State University | R.B. Annis Water Resource Institute | Fall 2008 | Volume 21, Number 1

In this issue...

Rein In The Runoff: Storm Water Management In Spring Lake

The Spring Lake storm water management project is moving into its second year this summer. Led by AWRI, the project team works with a diverse group of stakeholders to identify the causes, consequences and corrective actions required to minimize the adverse impacts of storm water discharges to Spring Lake and its tributary streams, the Grand River and ultimately Lake Michigan.

Our project team gave a total of 19 presentations to all of the municipalities in Ottawa and Muskegon counties that make up the Spring Lake watershed, including the communities downstream toward Lake Michigan. In addition, the newly-created Stakeholder Steering Committee will assist the project team with data input and project publicity.

The Stakeholder Steering Committee is helping to identify specific locations within the Spring Lake watershed where:

- storm water pollutants contribute to the local water bodies
- new development should be limited or restricted, and
- storm water best management practices (BMPs) should be applied

The project team is using this information to run population growth and pollutant loading models to identify where the biggest contributions of storm water pollution to Spring Lake are occurring. Alternative BMPs will then be selected and recommended to local municipalities for application to these storm water "hot spots" in an effort to reduce the pollutants coming into the lake.

For more information, please visit www.gvsu.edu/wri/reinintherunoff, or contact Elaine Sterrett Isely (iselyel@gvsu.edu) or Alan Steinman (steinmaa@gvsu.edu) at AWRI. Funding for this project is provided by Michigan Sea Grant College Program.

Stakeholders discuss sources of storm water in the Spring Lake watershed

AWRI-Authored (in bold) Peer-Reviewed Publications 2008 (to date):

Biddanda, B. A., A. Steinman, L. Nemeth, Y. Hong and **S. Kendall**. 2008. Nutrient bioassays of plankton biomass and metabolism in an urbanized drowned river-mouth lake (Mona Lake, Michigan). Journal of Freshwater Ecology 23: 41-53.

Biddanda, B. A. May 2008. Greening of lakes: nutrient control of algal blooms in lakes. InterChange Newsletter of the Regional Math and Science Center, GVSU.

Chu, X. and **A. Steinman**. In press. Event and continuous hydrologic modeling with HEC-HMS. ASCE Journal of Irrigation and Drainage Engineering.

Chu, X. and **A. Steinman**. 2008. Continuous hydrologic modeling improved by intensive event data, p. 1-11. In: Proceedings of the World Environmental and Water Resources Congress 2008 Ahupua'a, edited by R. W. Bakcock, Jr. and R. Walton. American Society of Civil Engineers.

Cymbola, J., M. Ogdahl, and **A.D. Steinman**. In press. Phytoplankton response to light and internal phosphorus loading from sediment release. Freshwater Biology.

Kerfoot, C. R., J. W. Budd, S. Green, J. B. Cotner, **B. A. Biddanda**, and D. J. Schwab. 2008. Doughnut in the desert: late-winter production in southern Lake Michigan. Limnology and Oceanography 53: 589-604.

Steinman, A.D., M. Ogdahl, and **M. Luttenton**. In press. An analysis of internal phosphorus loading in White Lake, Michigan. In: Lake Pollution Research Progress. Nova Science Publishers.

Steinman, A.D., X. Chu, and **M. Ogdahl**. In press. Spatial and temporal variability of internal and external phosphorus loads in an urbanizing watershed. Aquatic Ecology.

Steinman, A.D. and **M. Ogdahl**. 2008. Ecological effects following an alum treatment in Spring Lake, Michigan. Journal of Environmental Quality 37: 22-29.

Steinman, A.D., M. Ogdahl, R. Rediske, C. Ruetz, B. Biddanda, and **L. Nemeth**. 2008. Status and trends in Muskegon Lake, Michigan. Journal of Great Lakes Research 34(1): 169-188.

Thum, R. and R.G. Harrison. In press. Deep genetic divergences among morphologically similar and parapatric Skistodiaptomus (Copepoda: Calanoida: Diaptomidae) challenge the hypothesis of Pleistocene speciation. Biological Journal of the Linnean Society.

Thum, R.A. and A.M. Derry. In press. Taxonomic implications for diaptomid copepods based on contrasting patterns of mitochondrial DNA sequence divergences in four morphospecies. Hydrobiologia.

Dispersal and Gene Flow of Round Gobies in Lake Michigan

A round goby

GVSU undergraduate student M. Ben Stacey is working with Dr. Ryan Thum and Dr. Carl Ruetz to better understand the population structure of round gobies along the eastern shore of Lake Michigan. Round gobies are an invasive fish species in North America, and there is considerable interest in their dispersal and movements. This study uses population genetic analyses to test the hypothesis that pier heads represent discrete populations with low gene flow, that is, limited breeding of individuals from different populations. Pier heads offer this research opportunity because large adult round gobies likely have high site fidelity, and juveniles are unlikely to outcompete adults already occupying these sites. Understanding dispersal and gene flow of round gobies among pier heads is important for better understanding their population dynamics, which is necessary for sound fisheries management.

GVSU undergraduate student M. Ben Stacey conducting research at Frankfort Pier

Funded by the Student Summer Scholars program at GVSU, Stacey's project entails sampling round gobies from nine sites spanning from St. Joseph to Charlevoix. DNA is then extracted from fish tissue in the laboratory, and 10 microsatellite markers are genotyped for each fish. For more information on this research, contact Dr. Ryan Thum at thumr@gvsu.edu or (616) 331-3989, or Dr. Carl Ruetz at (616) 331-3946 or ruetzc@gvsu.edu

Lake Sturgeon Research in the Muskegon River and Muskegon Lake

Each spring, lake sturgeon migrate up Great Lakes tributaries to spawn. Lake sturgeon are large, bottom-dwelling fish that were once abundant throughout their range in North America. Yet today, lake sturgeon are designated a threatened species in Michigan. The dramatic declines in lake sturgeon populations throughout much of their range have been attributed to overfishing and loss and degradation of spawning habitats.

Dr. Carl Ruetz and graduate student Matt Altenritter are collaborating with Kregg Smith of the Michigan Department of Natural Resources to assess the status of lake sturgeon in the Muskegon River. This study was initiated in the spring of 2008 and will continue for at least two years. To date, research has focused on three objectives:

1) to estimate the abundance of spawning adults in the system
2) to locate spawning sites in the Muskegon River
3) to assess spawning success of lake sturgeon by sampling larval drift in the river

In the fall, juvenile lake sturgeon will have ultrasonic transmitters surgically implanted in their body cavity so that they can be tracked to determine residence in Muskegon Lake and preferred habitats.

Although this study has just begun, spawning adults and a spawning site in the river have already been documented. As the project continues, researchers hope to shed more light on the biology and ecology of lake sturgeon in the Muskegon system. For more information on this project, contact Dr. Carl Ruetz at ruetzc@gvsu.edu or (616) 331-3946.

Graduate student Matt Altenritter with a lake sturgeon

Getting The Pulse Of The Lakes: Ecosystem Level Process Studies In Lakes Michigan And Huron

Extending over two Great Lakes, ongoing studies in Dr. Bopi Biddanda's laboratory of Aquatic Microbial Ecology and Carbon Biogeochemistry focus on examining pelagic carbon metabolism in Lake Michigan and adjoining Muskegon Lake, and on exploring submerged sinkhole ecosystems in Lake Huron. Collectively, it is anticipated that these two studies will provide a working picture of the cycling of carbon in key sub-ecosystems of the Laurentian Great Lakes.

Lakes are intimately connected to the terrestrial ecosystem through their air and watersheds. Because carbon is a central element of life, tracing its flow in aquatic ecosystems can give us insights into how these systems function. Consequently, these two studies focus on understanding the carbon balance in these natural waters.

Our research indicates that these coastal ecosystems receive substantial inputs of carbon and nutrients from river loading, which may explain enhanced production of microbes and fishes in these receiving basins. We collected the related data through the simultaneous measurement of both production and respiration processes made by measuring changes in dissolved oxygen in light and dark enclosures.

Students Tom Holcomb and Maggie Weinert study the metabolism of Muskegon Lake, a drowned-mouth river tributary of Lake Michigan

One question of great interest is how ecosystem metabolism will respond over the long term to ongoing climate change, especially the ongoing warming of surface waters. Future studies are also aimed at determining whether these water bodies serve as net producers or exporters of carbon, an issue that may be of significance to the global carbon cycle. The recent use of multiparameter sondes that can be moored *in situ* in the lake gives us the capability to continuously monitor carbon fluxes and appreciate the role of episodic events such as storms on lake dynamics.

In Lake Huron, we are exploring karst submerged sinkholes discharging groundwater onto the Lake Huron floor through Paleozoic bedrock. These sinkholes create unique habitats characterized by steep environmental gradients and conspicuous benthic mats. Due to prevailing low dissolved oxygen and high dissolved sulfate conditions in the ground water emerging at these sites, the sinkhole ecosystems are microrganism-dominated. With high microbial biomass and activity, they are biogeochemical "hot spots" where nutrients recycle rapidly.

Currently, student-led projects are examining the link between microbial production at sinkholes and the food web of surrounding Lake Huron using stable isotopic tracers. Preliminary results using radioisotopic tracers suggest that photosynthesis-dominated communities in shallow sunlit sinkholes give way to chemosynthesis-dominated sinkhole communities in deep dark water. These findings are similar to previous observations from deep-sea seep and vent ecosystems. In May 2008, these exciting results were presented at the International Association for Great Lakes Research. Suitable for elementary and middle school students and the general public, educational CDs on this National Science Foundation-funded project are available for distribution. For more information, please contact Dr. Biddanda at (616) 331-3978 or biddandb@gvsu.edu.

Progress on the White River Watershed Planning Project

Staff at AWRI are now more than halfway through a two-year project aimed at reducing the negative impact of pollutants on the White River watershed. Funded by the Michigan Department of Environmental Quality, the project will accomplish this goal through the development and initial implementation of a stakeholder-driven watershed management plan.

A management plan is a tool that provides a broad understanding of watershed function and status, and recommends actions for resource management. A dedicated group of local people involved in the creation of a watershed management plan helps ensure long-term success.

Currently, a team is working to create a watershed management plan for the White River Watershed. This team includes individuals from the White River Watershed Partnership, the White Lake Association, the White Lake Public Advisory Council, the Muskegon Conservation District, the Michigan Department of Environmental Quality, the Michigan Department of Natural Resources, the Natural Resources Conservation Service and the US Forest Service.

The finished plan will include information on watershed characteristics, such as historical uses, geology and land use, and watershed conditions, including a summary of past and current research and monitoring data collected in the watershed. It will also cover watershed challenges such as pollutants affecting the watershed, and a watershed action plan featuring recommendations to control pollutants. The White River Watershed Plan will be completed by December 2008.

If you would like to be involved in this project, please contact Nichol De Mol at demoln@gvsu.edu or (616) 331-3092. For more information about the watershed, please visit the White River Watershed Partnership Web site at www.wrwp.org.

Kayaking on the White River

Invasive Plants "CSI:" Looking for the Links

Invasive aquatic plants have extensive negative effects on both native plant biodiversity and ecosystem services such as recreation and property values. Invasive aquatic plants are very difficult to eradicate once they are well established in lakes and ponds. Unfortunately, it may be hard to detect their initial presence. This is because they can be very similar in shape and appearance to native species. Invasive species also may hybridize with native species, which can create unique genome combinations that are more invasive than the originally-introduced exotic lineages.

The Molecular Ecology laboratory at AWRI, run by Dr. Ryan Thum and current students Tyler Armstrong, Elliot Jagniecki, Carson Prichard, Michael Stacey, Dustin Wcisel and Matthew Zuellig, conducts molecular genetic studies of aquatic plant invasions. Focusing predominantly on invasions by water milfoils in the genus *Myriophyllum* (e.g., Eurasian water milfoil), Thum's lab develops DNA-based identification methods to distinguish between native and invasive species that are difficult to identify using morphological characters alone. They also use DNA fingerprinting methods to determine the degree of genetic admixture or hybridization among native and non-native lineages. Finally, Thum and his students integrate the molecular genetic data with geographic information to reconstruct the geographic origins of different species or lineages, a study known as phylogeography.

The genetic information collected in the lab is then integrated with ecological studies and management practices. For example, the DNA identifications of aquatic plant species are used by several state government agencies to make decisions regarding whether or not a population of putative invasive species will be managed. Similarly, these agencies use the phylogeographic data to identify the ecological factors that limit the distribution and abundance of an invasive species in its native range. For more information on work in the Molecular Ecology Lab, contact Dr. Ryan Thum at thumr@gvsu.edu.

AWRI Helps to Organize Sustainability Coalition

Sustainability is defined as meeting the needs of the present without compromising the ability of future generations to meet their own needs. In early 2007, AWRI joined a group of human service, business, government and environmental representatives to form the Muskegon Area Sustainability Coalition (MASC) out of a belief that a sustainable future is possible through collaboration and planning.

The Coalition is committed to utilizing sustainable practices as a means to control urban sprawl, advance the revitalization of urban centers, educate the Muskegon County population about the principles of sustainability, and to strengthen population centers in an inclusive and equitable manner throughout the entire Muskegon region. The Coalition further commits itself to fostering collaboration among units of government, institutional participants, educational entities and non-profit organizations, as well as business and industry.

Since its creation, the MASC has promoted sustainability in a variety of ways. In October 2007, the MASC developed a Prosperity Index for Muskegon County, a first major step for promoting sustainability. The Index tracks progress and guides actions to assure that Muskegon County is a thriving, desirable community enjoyed by current and future generations. Essentially, the Index is a snapshot of the community, measuring its sustainability and allowing comparisons with other communities. The MASC is currently working on updating the Prosperity Index so it better reflects Muskegon County's state of sustainability.

Two products currently under development are the Sustainability Principles and Sustainability Standards.

AWRI staff plant seedlings in the rain garden, which was built to treat storm water runoff from the cement parking lot

Plants for the green roof on AWRI's new boat storage building are delivered

Much like the Prosperity Index, these will be created with all of Muskegon County residents in mind. The Principles include basic assumptions and ethical rules used in guiding the development of the Standards. The Standards, in turn, will identify specific actions steps needed to attain both short term and long term goals.

The Coalition is also involved with the organization of two sustainability events. Tentatively scheduled for late fall, the first is a local event that will share what the MASC has accomplished thus far and set the stage for implementing the Sustainability Standards. The second is a regional event planned for early next year. For this event, the MASC is partnering with the West Michigan Strategic Alliance, Holland/Zeeland 3e Initiative, West Michigan Environmental Action Council, Northwest Ottawa Sustainability Initiative and the Grand Rapids Sustainability Partnership to further promote sustainable practices and to showcase what sustainability organizations are doing in their community.

For more information about the MASC, contact John Koches at kochesj@gvsu.edu or visit their web site at www.sustainablemuskegon.wikispaces.com.

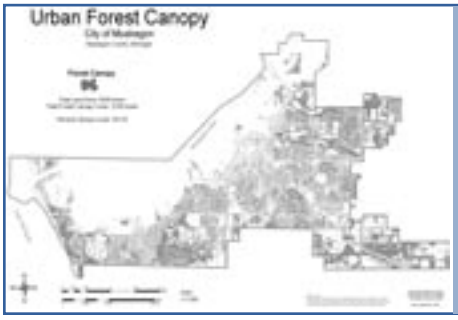
Calculating the Value of our Urban Forests

Since they surround us and provide their services with little notice, we tend to take trees for granted. Yet tree cover, especially in urban areas, is directly related to our environmental quality. Our urban tree cover provides many benefits to society, including wildlife habitat, improved water quality, energy savings, air pollution reduction and enhanced property values.

Just as our road network and utilities act as our grey infrastructure, the urban tree canopy functions as green infrastructure, reducing the need and expense of building structures or machines to mitigate air and water pollution. This summer, AWRI has worked to determine the extent of the urban forest canopy in the cities of Muskegon and Grand Rapids and to calculate the environmental and economic value of the ecosystem services the trees provide.

To map the forest canopy, we used orthophotography along with geographic information system (GIS) and remote sensing technologies. Although mapping the location of the urban forest canopy was challenging, we were able to complete the task in a timely manner and with a high degree of accuracy by using feature extraction tools. We then used this information as an input into the CITYgreen software developed by American Forests®. The software allows us to quantify and value the forest canopy's ability to reduce air pollution and storm water runoff, improve water quality and store carbon.

We determined that the urban forest canopy covers 30 percent of the land area within the city of Muskegon. This forest canopy provides nearly $89 million worth of ecological services that help protect our environment. For example, if the forest canopy were not in place, approximately 16 million cubic feet of additional storm water would be generated during a 2.3-inch rainfall event. The vast majority of the $89 million would be needed for additional infrastructure to manage this storm water runoff. We will conduct this same type of analysis for the city of Grand Rapids, with work expected to be completed by the end of the summer.
For more information on this specific project, please contact Rod Denning at (616) 331-3793 or denningr@gvsu.edu.



A map of the Urban Forest Canopy in the city of Muskegon

Storm Water Effects on Fish in Little Black Creek

Graduate student Bill Keiper measures a mud minnow

This summer, AWRI graduate student Billy Keiper began the first year of his master's thesis research working under Dr. Carl Ruetz. Keiper's research focuses on the ecological effects of storm water on fish in Little Black Creek, a highly degraded stream in Muskegon County. (See related storm water story on p. 13.)

Storm water runoff from urban areas can carry many toxins, which can negatively affect organisms in the receiving streams. Since few experiments have documented the direct impacts of storm water on fish, Keiper designed two experiments to assess these impacts on fish in Little Black Creek. The first experiment compares the growth, mortality and feeding behavior of fish over a gradient of storm water concentrations. The second experiment examines the impacts of storm water runoff on a simplified aquatic community consisting of fish, snails and algae. While Keiper will focus on the fish and snails in this experiment, fellow AWRI graduate student Kelli Johnson will study the effects on algae. Results from initial experiments are forthcoming, and the experiments will be repeated to examine whether the effects of runoff vary seasonally; for example, there may be higher salt content of runoff during winter thaws.

This study is part of a more comprehensive project led by Dr. Alan Steinman to examine the extent of environmental impairment caused by road-induced runoff to Little Black Creek. The goal of this study is to identify and implement the appropriate restoration and remediation activities. Funding for this project is provided by the US Department of Transportation. For more information on Keiper's research, contact Dr. Carl Ruetz at (616) 331-3946 or ruetzc@gvsu.edu.

AWRI Director Completes First Year on Committee Studying Water Levels of the Great Lakes

Last summer, AWRI Director Alan Steinman was nominated and selected to serve on the Public Interest Advisory Group (PIAG) of the International Joint Commission's Upper Great Lakes Study. The International Joint Commission (IJC) launched the International Upper Great Lakes Study in 2007 to examine whether the regulation of Lake Superior outflows can be improved to take into account changing interests and changing climate. Recently, the scope of the five-year Study was revised to focus on possible erosion in the St. Clair River channel and whether an increase in St. Clair River flow might be a cause of lower water levels in lakes Michigan and Huron.

Through bi-national, joint fact-finding and sound science, the Study will provide the IJC, and ultimately the public, with credible, peer-reviewed findings regarding the causes of low water levels and recommendations on management of lake levels and flows. The Study will examine possible factors such as water diversions, changes in precipitation, dredging, evaporation and runoff.

With 10 members each from the US and Canada, the PIAG's 20 members hail from a wide variety of backgrounds, including environmental organizations, tourism, recreational boating, municipal and industrial water users, hydropower facilities, shoreline property owners and the shipping industry. The PIAG provides an avenue for informing the public, as well as a conduit through which public input is delivered to study researchers, helping them formulate future regulation plans. The PIAG holds public meetings throughout the upper Great Lakes basin; at a meeting held in May 2008 at the Lake Michigan Center, home of AWRI, over 75 people attended to express their concerns over water levels and to provide constructive input on the Study. Although involvement in the PIAG is a major time commitment, Steinman is honored to be part of this important process and looks forward to evaluating and disseminating the Study results as they are generated. For more information on the IUGLS, visit www.iugls.org or contact Dr. Steinman at steinmaa@gvsu.edu.

Dr. Eugene Stakhiv, US Army Corps of Engineers, discusses the International Upper Great Lakes Study at a public meeting held at the Lake Michigan Center on May 3, 2008

A New Look at AWRI

New construction at the Annis Water Resources Institute is continuing. Thanks to two grants from the US Department of Housing and Urban Development, obtained with the assistance of Congressman Pete Hoekstra, we are busy with a number of building and renovation projects.

With the first grant, which runs from 2005 through 2008, AWRI:

1) constructed a davit and small boat haul-out facility, enabling us to deploy small boats directly from our site;

2) upgraded the field station, including the installation of a new outer shell to the building and patches on its roof; and

3) constructed a fence and electronic gate structure, providing us with greater site security.

The second grant, running 2006 to 2009, is dedicated to the construction of a new boat storage building. This eight-bay garage allows us to move our vehicles and trailered boats out of the field station and into this new building. In addition, green design is being incorporated into construction, including a green roof, natural lighting, and a rain garden to handle storm water runoff from the site. Ultimately, our goal is to renovate the newly available space in the field station, and turn it into new labs and offices.

This construction is part of our long-term facilities plan at AWRI. We are very grateful to Congressman Hoekstra for his assistance in procurement of funding, AWRI's fleet captain Tony Fiore for his on-site help, and Karen Ingle from GVSU Facilities Planning for her project management.

A temporary "home base" in the water

Taking the Pulse of Great Lakes Coastal Wetlands

To carry out metabolism and survive, all organisms must utilize an energy source. Green plants and algae make use of the sun's energy to produce their own food. Other types of organisms, including all animals and most bacteria, consume food items containing large carbon-based molecules that provide energy for metabolism. We can measure the rates of these two processes in the natural world by measuring changes in either oxygen, which is given off when plants conduct photosynthesis, or carbon dioxide, given off when organisms break down organic molecules. These measurements are collectively referred to as "community metabolism" and provide us with information on how an ecosystem functions.

We can use community metabolism estimates to determine if an ecosystem is producing more organic matter than it is consuming, or whether an ecosystem is a source of organic matter for adjacent habitats. These questions are especially important in Great Lakes coastal wetlands where both primary production (i.e., photosynthesis) and respiration are quite high relative to other Great Lake habitats.

In partnership with a team from Central Michigan University, a team from AWRI including Matt Cooper, Alex Wieten, Steve Asiala and Karen Ickes has been measuring community metabolism in coastal wetlands of Lakes Huron and Michigan seasonally since the spring of 2007. This summer, the team also sampled fish and invertebrate communities to determine if a relationship exists between these organisms and metabolism. The study will provide the first detailed measurements of community metabolism in coastal fringing wetlands of the Great Lakes. Funding for the project has been provided by the US Environmental Protection Agency, the Michigan Department of Environmental Quality, the National Oceanic and Atmospheric Administration and Grand Valley State University. For more information, contact Matt Cooper at coopmat@gvsu.edu.

Matt Cooper taking community metabolism readings in coastal wetlands

Weather Predication: 100 Percent Chance of Rain

It's raining inside AWRI's field station … just the way the researchers planned it. By developing multi-scale methods, including creating indoor rain showers, AWRI researchers in the Overland Flow Laboratory are seeking to improve understanding of overland flow generation and infiltration processes. As part of a five-year project funded by a National Science Foundation CAREER grant, they are also developing a Windows-based modeling system, 3-D visualization tools, and state-of-the-art interactive educational software.

In May, GVSU undergraduate researchers James Barr and Paul Bourdon joined principal investigator Dr. Michael (Xuefeng) Chu and GVSU graduate student Jessica Higgins in puddle research. Since then, this research team has been busy calibrating equipment and preparing and running experiments.

Two major types of experiments came into play: tracer and soil type. The tracer experiments investigated water movement using a bromide tracer on smooth, sloping surface versus a sloping rough surface with puddles. The soil type experiments aim to improve the understanding of how water flows over and into soil, focusing on puddle filling to puddle merging processes. Joining the Overland Flow Project is Dr. Jianli Zhang from China's Institute of Water Resource and Hydropower Research, who is working on the computer software aspect of the overland flow research. This fall, the overland flow lab will be packed up and moved to Fargo, ND, as Dr. Chu begins a new position at North Dakota State University. While we are very sorry to see Michael go, we wish him all the best in his new job.

Undergraduate student Paul Bourbon measures the rainfall amount

Outside view of Overland Flow Laboratory

Dr. Zhang, James Barr, and Dr. Chu (l-r) measure the wetted soil and clean the soil box

Investigation of *E. coli*, *Cladophora* and Microcystin in Saginaw, Grand Traverse and Little Traverse Bays

A nuisance in some areas of the Great Lakes, *Cladophora* is a filamentous green alga that forms thick mats that wash on shore and foul beaches. The proliferation of *Cladophora* along the shores of the Great Lakes is thought to be a result of invasive zebra and quagga muscles altering the nearshore cycling of nutrients. In order to assess the role of *Cladophora* mats in sequestering *E. coli* and the cyanobacteria toxin microcystin in the nearshore waters of Grand Traverse Bay, Little Traverse Bay and Saginaw Bay, the AWRI Environmental Chemistry Laboratory recently started work on a $59,860 grant from the Michigan Department of Environmental Quality (MDEQ).

The Environmental Chemistry Laboratory has been involved with the beach monitoring program in Muskegon, Oceana, Mason and Manistee counties since 2001. Recently, our laboratory completed research projects funded by the National Oceanic and Atmospheric Administration and MDEQ that involved cyanobacteria (i.e., blue-green algae) and microcystin production.

In June 2008, the Environmental Chemistry Laboratory initiated sample collection from 16 beaches within the Grand Traverse, Little Traverse and Saginaw Bays. These samples will be analyzed for *E. coli* and microcystins, which both pose human health risks when present in high concentrations. Building on the former studies, this grant allows for the examination of the role of *Cladophora* mats in the sequestration of *E. coli* and microcystins in important recreational areas in Michigan.

AWRI is collaborating with the Great Lakes Water Studies Institute at Northwestern Michigan College in Traverse City, where a laboratory processes samples and analyzes *Cladophora* mats for *E. coli*. The Water Studies Institute also will coordinate outreach activities with support from Watershed Center Grand Traverse Bay and the Tip of the Mitt Watershed Council. In addition, sampling schedules have been coordinated in Saginaw and Grand Traverse Bays with the local health departments to provide nearshore and swimming depth results on the same days. Finally, AWRI will coordinate sampling schedules with Michigan State University and Watershed Center Grand Traverse Bay in order to track the source of *E. coli* in Saginaw and Grand Traverse Bays. For more information on these projects, contact Dr. Rick Rediske at redisker@gvsu.edu.

Thick mats of Cladophora wash on shore and foul Great Lakes beaches

Distribution of *Dreissena* Mussels in Great Lakes Coastal Ecosystems: Are Wetlands Resistant to Invasion?

AWRI graduate student Kristin Nelson is in the final stages of completing her master's thesis research, focusing on invasive *Dreissena* mussels — zebra and quagga mussels. Although these mussels have become widespread throughout the Great Lakes basin, Great Lakes coastal wetlands appear to demonstrate varying levels of resistance to this invasion. To determine whether some Great Lakes coastal wetlands are resistant to invasion, artificial substrates were placed in adjacent lake and wetland habitats. During summer 2007, these substrates were incubated for 12 weeks at 15 sites in the Great Lakes, consisting of seven drowned river mouth wetlands and eight fringing wetlands. Concurrently, an experiment was performed to determine whether *Dreissena* mussels can survive in each type of wetland.

Graduate student Kristin Nelson setting substrates in Lake Macatawa

Nelson's research suggests that resistance to *Dreissena* mussel colonization varies based on wetland type. Fringing wetlands do not display a resistance. In addition, hardening of shoreline in fringing wetland systems may provide additional habitat for *Dreissena* mussels, thus facilitating colonization.

However, drowned river mouth wetlands appear to be resistant to *Dreissena* mussel invasion, and are not suitable habitat for adult *Dreissena* mussels. All adult *Dreissena* mussels transplanted in drowned river mouth wetlands from adjacent lake habitats died within two weeks of transplantation.

One possible mechanism for this resistance currently being explored is organic sediment depth. In contrast to adjacent lake areas, drowned river mouth wetlands have significantly more organic sediment, which can create a harsh environment due to overnight declines in dissolved oxygen. The resistance of drowned river mouth wetlands to *Dreissena* mussel colonization highlights the importance of preserving these systems. For further information about this work, contact Nelson's advisor Dr. Carl Ruetz at ruetzc@gvsu.edu or (616) 331-3946.

Graduate student Kristin Nelson measures water quality

AWRI Researchers Collaborate to Study Storm Water Effects

The US Department of Transportation recently awarded AWRI with a three-year, $347,000 grant to study the environmental effects of storm water on Little Black Creek in Muskegon. A major tributary to Mona Lake, Little Black Creek is highly urbanized and is impacted by a history of harmful industrial activity.

The concern over storm water entering Little Black Creek stems from both its physical and chemical properties. Because the Little Black Creek watershed has a high concentration of hardened (i.e., impervious) surfaces, precipitation tends to quickly run off and into the creek instead of infiltrating into soils. The "flashy" nature of this storm water runoff causes contaminated sediment in the creek to move downstream, posing a risk to human and environmental health. Storm water that washes off of roads also carries with it a suite of contaminants, including nutrients, oil, grease, hydrocarbons and sediment, which have the potential to impact stream organisms.

The second year of the project is currently underway, with a major focus on data collection. Field crews keep an attentive eye on the weather to capture road runoff from their two study locations on Little Black Creek. During storm events, the crews collect runoff water, determine the flow of storm water and measure the amount of sediment in transport. In the laboratory, the crews analyze storm water samples for chemical properties and potential toxicity.

Two AWRI graduate students are conducting their thesis research on how biota respond to the effects of storm water in Little Black Creek. Kelli Johnson, a student of Dr. Alan Steinman, is investigating the effects of storm water on algal biomass, metabolism and community composition. Billy Keiper, a student of Dr. Carl Ruetz, is evaluating how storm water affects fish growth and feeding behavior; see the related storm water story on page 7.

Our goal is to determine the extent of environmental impairment caused by road-induced runoff in order to identify and implement the appropriate restoration and remediation activities. In addition to field and laboratory data collection, an engineering assessment of storm water retrofits to identify treatment options and minimize the erosive potential associated with increased runoff will be conducted by Prein & Newhof, a local consulting firm.

Dr. Alan Steinman is the principal investigator for the project, in collaboration with co-principal investigators Dr. Rick Rediske, Dr. Carl Ruetz and Dr. Michael Chu. AWRI technicians Brian Scull and Mary Ogdahl lead the field sampling and laboratory analyses. To learn more about this project, contact Dr. Steinman at steinmaa@gvsu.edu.

Graduate student Kelli Johnson measures incubation conditions for algae that will later be exposed to storm water

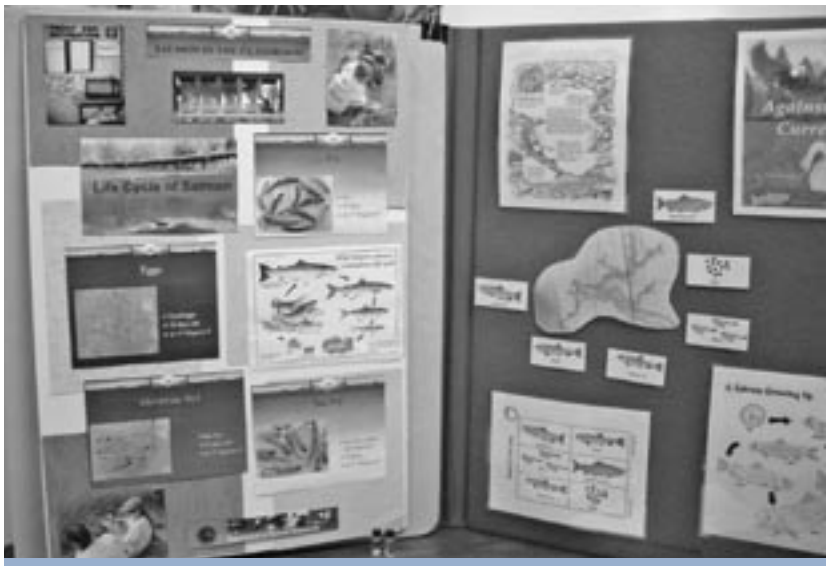
The *W.G. Jackson* On Tour

Did you know that the GVSU-AWRI research and education vessel has been to over 30 ports of call in Lake Michigan? This summer, we celebrated the 31st port of call with a trip of the *W.G. Jackson* to Michigan City, Indiana as part of the Making Lake Michigan Great tour. Our host in Indiana was the Indiana Department of Environmental Management. Later in the summer, the *Jackson* was at the events in Grand Haven for the *Earth Voyager* sailing ship visit; cruises in Muskegon may also be added to the schedule.

Making Lake Michigan Great is an environmental education and outreach effort for the Lake Michigan Forum of the US Environmental Protection Agency (EPA). From onboard the *Jackson*, one of AWRI's two research and education vessels, these tours provide both the general public and teachers with a variety of educational opportunities focusing on local waters and Lake Michigan issues. Since 1997, the US EPA has provided funding for Making Lake Michigan Great tours each summer. The purpose of these tours is to spread the word about the Lake Michigan Lakewide Management Plan (LaMP), foster stewardship in Lake Michigan communities, and establish lakewide partnerships. The tour is specifically mentioned as a priority in the 2008 Update of the Lake Michigan LaMP.

At selected ports of call in Lake Michigan, participants in the tour actively engage in water quality sampling and analysis, and local experts highlight stewardship efforts. Professional development opportunities for teachers provide tools to educate students about Lake Michigan and its issues. Pending funding, we hope to continue Making Lake Michigan Great in 2009 and 2010.

Salmon in the Classroom at AWRI



Salmon in the Classroom makes science fun and accessible for students

It was a picture-perfect day in May when about 125 Chinook salmon were released as part of AWRI's Salmon in the Classroom project. Mrs. Paulla VanOeveren's students from Theodore Roosevelt Elementary in Muskegon Heights were on hand for this event. Katie Gordon, an AWRI intern from Reeths-Puffer High School, and GVSU education assistant Amanda Callaghan supervised the transfer of the fish from the new aquarium in the Annis Educational Foundation Classroom to their new habitat. As part of her internship, Katie Gordon took care of the salmon, which were raised from eggs.

Mrs. VanOeveren trained with AWRI and the Regional Math & Science Center in the Global Learning and Observations to Benefit the Environment (GLOBE) program, so she appreciated the opportunity to take her class outside to learn about their environment. The Muskegon Heights students seemed at home on the waterfront as they explored the shore, picking up shells and speculating on what the salmon would eat. "Mrs. V., look at this" was frequently heard; the excitement was contagious.

Theodore Roosevelt Elementary students observe the small salmon that are soon to be released

Salmon in the Classroom is a program of the Michigan Department of Natural Resources. A gift from the R.B. Annis Educational Foundation allowed AWRI to participate in this program for the first time, purchasing the necessary 55-gallon tank and chiller to keep the water at optimum temperature for the salmon. During the 40th annual visit of the Scientech group from Indiana, Mrs. Elmira Annis viewed this set up, along with Dr. William G. Jackson, Kay Jackson, Dr. Ron Ward and Dr. Bill Schroeder.

Classes and visitors to the Lake Michigan Center saw the salmon project in action. We hosted over 600 students for classroom activities. "It was great to have such a diverse set of groups in the classroom," reflected education assistant Amanda Callaghan. "We had the opportunity to develop and use new curriculum, and according to a teacher survey, we met the learning goals of all of the groups that visited." A component of the new curriculum was production of a CD on Dr. Bopi Biddanda's research on sink holes in Lake Huron.

We hope to continue the salmon project again next year, and to serve as a resource for area schools who are engaged in Salmon in the Classroom. For classroom opportunities at GVSU-AWRI, contact Dr. Janet Vail at vailj@gvsu.edu or (616) 331-3048.

AWRI Summer Student Interns

This summer, we welcomed 16 new and returning students to AWRI. Four interns were funded through long-time AWRI student internship sponsor D.J. Angus-Scientech Educational Foundation. Ben Sanborn worked with John Koches in the Information Services Center, Autumn Trombka worked with Rick Rediske on the MDOT-funded storm water project, Maggie Weinert worked with Bopi Biddanda on the Carbon Cycle in Muskegon Lake and Alex Wieten worked with both Mark Luttenton on community metabolism in headwater streams and a population ecology study of Asiatic clams in the Grand River, and with Matt Cooper on wetlands studies.

Carson Prichard worked with Carl Ruetz conducting fieldwork in Muskegon Lake and River. He also worked with Ryan Thum on collecting data from water milfoil populations.

In addition, several students worked as research assistants for the summer:

- Matt Altenritter worked with Carl Ruetz to assess lake sturgeon spawning success in Muskegon Lake and River.
- Tyler Armstrong worked on ecological niche modeling of invasive milfoil species.
- James Barr and Paul Bourdon worked with Michael Chu for the NSF CAREER project.
- Amanda Callaghan worked with Janet Vail in the classroom and on the vessels.
- Catharina Cramer worked with Rick Rediske in the analytical lab.
- Jordan Fischer returned to Al Steinman's lab, processing invertebrate samples and assisting in the field.
- Tom Holcomb worked with Bopi Biddanda studying Lake Huron sinkhole cyanobacterial mats.
- Karen Ickes worked with Matt Cooper sampling and then processing coastal wetland invertebrates and fish.
- Elliot Jagniecki worked for Ryan Thum on a microsatellite genotyping project and on developing molecular markers for water milfoil species differentiation.
- Michael (Ben) Stacey worked with Ryan Thum and Carl Ruetz studying populations of invasive round gobies.

A special thanks to all of these bright, young researchers for their hard work and dedication!

"Hot Topics" for Teachers

The Lake Michigan Center offered two graduate level education courses for teachers this summer, Introduction to Environmental Education and Human Population. Taught by Dr. Janet Vail with the assistance of education assistant Amanda Callaghan, these courses are part of the GVSU Continuing Education Hot Topics for Educators Series. Educators use these courses to earn academic credit to maintain their teaching certificates or to apply to a master degree. According to one of the participants, "this was a great way to gain new knowledge and ideas for activities, plus it was held close to home."

The education staff participated in other opportunities for teachers, including hosting the kick-off meeting for the Great Lakes Stewardship Initiative (GLSI). The GLSI is a unique model that connects schools with their communities to create learning experiences for students that have lasting impact on the environment. Through regional hubs, teachers receive professional development to better facilitate inquiry-based learning and problem solving. Teachers in the GLSI will be on the *W.G. Jackson* for some of their activities.

In preparation for the new generation of Global Learning and Observations to Benefit the Environment (GLOBE), Janet Vail is working with GVSU Regional Math and Science Center director Karen Meyers to develop a workshop model. GLOBE is a student environmental monitoring program that links scientists with classrooms. Dr. Vail was invited to participate in a week-long GLOBE workshop in Boulder, Colorado.

As state coordinator of Project Water Education for Teachers (WET), GVSU-AWRI presented WET training at the Michigan Department of Natural Resources 2008 Academy of Natural Resources. In cooperation with Ducks Unlimited, we presented the first Project Webfoot workshop to be held in Michigan.

Dr. Vail was invited to facilitate training in the Michigan Environmental Education Curriculum Support (MEECS) Air Quality Unit at the Michigan Science Teachers Association annual conference in Lansing. She is the author of this unit for grades 7-9. Another Air Quality training was given at the Global Change Teacher Institute at Michigan Technological University.

Through a grant from the Michigan Department of Environmental Quality, GVSU-AWRI will be offering training in Chemical Management in Schools. The training can be customized for a school or district and offered as an in-service opportunity. Contact Dr. Janet Vail at vailj@gvsu.edu or (616) 331-3048 for more details.

AWRI's undergraduate summer interns; from l-r, Tyler Armstrong, Paul Bourdon, Autumn Trombka, James Barr, Karen Ickes, Tom Holcomb, Maggie Weinert, Alex Wieten, and Ben Sanborn

WATER RESOURCES REVIEW

Dr. Alan Steinman, Director

Water Resources Review is a publication of the R.B. Annis Water Resources Institute, Grand Valley State University. For further information write:

WATER RESOURCES REVIEW
R.B. Annis Water Resources Institute
Lake Michigan Center
740 West Shoreline Drive
Muskegon, MI 49441

Phone: (616) 331-3749
or (231) 728-3601
Fax: (616) 331-3864
Website: http://www.gvsu.edu/wri

Printed on recycled paper with soy ink

GRAND VALLEY STATE UNIVERSITY

R.B. Annis Water Resources Institute
Lake Michigan Center
740 West Shoreline Drive
Muskegon, MI 49441

ADDRESS SERVICE REQUESTED

**Non Profit Org.
U.S. Postage
PAID
Grand Valley
State University**