

MINNEGRAM

March 2006

Water experts converse on the future of water quality

Lakes and rivers do not observe international boundaries. Issues of water quality and quantity in Canada and the U.S. are therefore continental, a point that became clear on February 28 as leading Canadian freshwater expert David Schindler and WRC co-director Deborah Swackhamer engaged in a free-flowing discussion entitled, "Protecting Water Quality for Future Generations," the first in this year's series of Great Conversations sponsored by the College of Continuing Education. Ensnared in comfortable chairs on a stage resembling a living room in the University's Ted Mann Concert Hall, the two scientists spent an hour exploring water-related challenges in North America, from global warming to toxic contaminants to exotic species.

Ninety percent of Canadians live within 60 kilometers of the U.S. border, said Schindler, a region that is quite arid, while the population in the western U.S. is growing rapidly. We may feel water rich, but the U.S. and Canada comprise only 12 percent of the world's land surface area and receive only 12 percent of its precipitation. At the same time, the two countries rank first (U.S.) and second in

per capita water consumption. Add to this the pressure of climate change, which has increased evaporation rates without increasing precipitation, resulting in a net loss of water in regions fed by glacial melt. This is especially evident, said Schindler, on the eastern slopes of the Rocky Mountains, a region he knows well. "There is a stream that used to support riverboat traffic, and now my friends are complaining that they have to carry their kayaks."

Schindler's research helped introduce a ban of phosphorus in laundry detergents and the widespread use of water treatment plants to remove excess nutrients from surface waters. Unfortunately, water treatment plants do not remove the emerging contaminants that researchers now find accumulating in fish and other aquatic organisms. "In Europe, they use the precautionary principle—chemicals with toxic "relatives" are

assumed to be harmful until proved safe. [In the U.S.,] we wait until damage appears and try to mitigate it after the fact,"



Deborah Swackhamer (l) and David Schindler (r) participated in the first installment of the 2006 Great Conversations series.

said Swackhamer, "while the scientists shake their heads and say, 'So how can we get ahead of the curve?'" Invasive species such as zebra mussels and spiny water flea further degrade water quality and threaten to disrupt the delicate ecology of

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Call for abstracts issued by Minnesota Water 2006 and Annual Water Resources Conference

The Minnesota Water 2006 and Annual Water Resources Joint Conference, which will take place on October 24–25, 2006, at the Earle Brown Heritage Center in Brooklyn Center, Minnesota, has issued a call for presentation abstracts and posters. The call can be accessed on the WRC's Web site at <http://wrc.coafes.umn.edu/>. Abstracts are due by April 21, 2006.

After a successful first year as a joint conference in 2005, the event will once again present innovative and practical water resource management techniques

and highlight research about Minnesota's water resources. The conference will provide an opportunity to address emerging issues and present lessons learned and best practices discovered. It will facilitate interactions among resource managers, researchers, state and local agency staff, and other water resources professionals, including consultants and practicing engineers.

As more information about the conference becomes available, it will be featured in upcoming issues of the *Minnegram* and on the WRC Web site.

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A new diatom species is discovered in our backyard

by Mark Edlund, St. Croix Watershed Research Station and Department of Geology and Geophysics

Most scientists dream of discovering something new, but when the discovery happens in samples taken right under our feet, it always comes as a surprise. Lake Superior, specifically the harbor in Grand Marais, is home to the newest species described from Minnesota, a diatom called *Hannaea superioensis*. Back in 1992, I stopped in Grand Marais on the way home from a Boundary Waters canoe trip and collected a bit of periphyton coating the rocks along the Coast Guard breakwall. Among the hundred or so diatom species in the collection was a long, boomerang-shaped critter growing in pin cushion-like colonies. It obviously belonged to the genus *Hannaea*, but was much bigger than any *Hannaea* species I had ever seen.

A few years later, my colleague, Dr. Rebecca Bixby, currently at the University of Georgia, joined the lab and took on a systematic study of the genus *Hannaea*. I passed along the samples that I had been taking from Lake Superior over the years and in the

November issue of the journal *Diatom Research*, we formally described *Hannaea superioensis* in a paper co-authored by Bixby, me, and Dr. E.F. Stoermer from the University of Michigan. *Hannaea superioensis* is easily separated from other members of this genus by size alone; it is nearly twice the size of other *Hannaea* species. Other lines of evidence supporting this new species include its shape, ultrastructure, and ecological preferences.

While new species are often rare in number, *Hannaea superioensis* is not. The thick coating of periphyton that covers the rocks in the wave zone of Lake Superior is covered with billions of specimens of *Hannaea superioensis*. Healthy populations of *Hannaea superioensis* are found on

the North Shore, around Isle Royale, the Keweenaw Peninsula, along northern and eastern Lake Superior, and in Canada's Lake Nipigon. We studied historical collections made in Lake Superior

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Minnesota's newest species, *Hannaea superioensis*, as seen through a microscope, is about 0.125 mm long and gently curved.

From the Director's Desk

What have I been doing lately?

I had a call the other day from a person I had not talked with for awhile. They asked a question something like "What have you been doing lately?" It set me back because I did not have a ready answer even though my sense is that I have never been busier in my life! I also thought it was pretty ridiculous that I didn't have an answer.

So here is a sampling of what we have been doing lately. We have continued to work closely with the Minnesota Pollution Control Agency on the science issues surrounding the development of a TMDL for Lake Pepin, and with the Minnesota River Sediment Reduction Panel, which in the early stages of a turbidity TMDL for the Minnesota River.

Work has progressed on the Assessment of Stormwater Management Practices on Water Quality. Protocols to be used for monitoring and assessment of stormwater management practices are being prepared. In the summer and early fall these will be taken to local communities around the state for their review prior to release.

The Mississippi-Mekong Partnership continues to develop. During the month of March, we have a visitor, Lilao Bouapao, who hopefully will be working on a Ph. D. project with faculty here at the University of Minnesota. A delegation will be traveling to Laos in May to attend an annual flood forum to address ways to establish flood forecasts for the lower portions of the Mekong River Basin.

Both Deb and I have been to national meetings reporting on research, education, and outreach efforts to the U.S. Depart-

ment of Agriculture, U.S. Geological Survey, and U.S. Environmental Protection Agency (EPA). In addition, a number of WRC staff and faculty associated with the WRS Graduate Program have made reports on their projects at these meetings and conferences. This is increasingly important as funding cutbacks and changes continue to occur on a regular basis.

The Great Lakes Regional Water Quality team has published the second progress and impact report covering regional activities involving Minnesota, Wisconsin, Illinois, Indiana, Michigan, and Ohio. Those projects have leveraged on a 5:1 basis funds for research and outreach on water quality issues across the region. The team continues to work with the state 319 coordinators and EPA to develop social indicators for non-point source pollution watershed projects.

On top of this, we continue to take part in numerous task forces and committees working on strategic efforts to integrate the College of Natural Resources and College of Agricultural, Food, and Environmental Sciences into a new college. All these significant efforts take time but are well worth doing. It just shouldn't be so hard to tell people what we do.



A handwritten signature in black ink, appearing to read "Jim".

Jim Anderson, WRC Co-Director

WRC awards three grants in 2006 competition

The WRC is pleased to announce the selection of three research projects for funding in the 2006 WRC grant competition. The projects include a study on the factors affecting lakeshore revegetation success, the ecological stoichiometry and microbial biodiversity effects on water quality, and the development of a DNA marker to track source *E. coli* in watersheds. Funding for the projects is provided by the Water Resources Research Institute program of the U.S. Geological Survey, and the Minnesota Agricultural Experiment Station through the WRC.

northern freshwater lakes, they will identify five lakes in the Twin Cities metropolitan area where experimental plantings will be conducted in summer 2006, with subsequent observation of the plantings in the first summer and also in summer 2007. They hope to answer such questions as “Is bulrush survival and establishment affected by time or depth of transplanting?” and “Is there an optimal combination of factors including time, water depth, and root development for establishment of bulrush?”

With everyone from the Department

gal decomposition and hypoxic or anoxic conditions can themselves be a solution to the problem of eutrophication.

From their past research, Jim Cotner (Ecology, Evolution, and Behavior) and Tim LaPara (Civil Engineering) have shown that the biomass stoichiometry of microbial communities can play a key role in carbon decomposition and P cycling in surface waters. In this project, the pair proposes to apply principles of ecological stoichiometry to understand the importance of microbial diversity to the elemental composition of microbial communities and surface water quality.

One unique aspect of this project is the emphasis on involvement of undergraduate students, who will aid in sampling seven kettle lakes of the Twin Cities and Itasca State Park.

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This successful lakeshore restoration at Thompson Lake, using several species of bulrush and bur reed, will protect the shoreline from erosion and provide habitat for fish.

Factors affecting revegetation success in lakeshore restorations

Aquatic vegetation in the near-shore environment provides habitat and refuge for fish and also protects the shoreline from wave impact, reducing erosion. Because of this, successful revegetation of the near-shore environment is critical to the overall success of lakeshore restoration projects. However, little is known about how or why some lakeshore revegetation efforts succeed while others fail.

Sue Galatowitsch (Horticultural Science) and Dana Vanderbosch (Water Resources Science) are leading a project to investigate the factors that affect the success of lakeshore revegetation. Focusing on soft-stem bulrush, a species common to

of Natural Resources to private landowners interested in lakeshore restoration, the results of this study will have widespread use, and may lead to the increased success of future lakeshore revegetation and restoration efforts.

Ecological stoichiometry and microbial biodiversity effects on water quality

A lake or stream that receives excess nutrients, such as phosphorus (P), can experience excessive algae growth. When these algae die, their decomposition consumes dissolved oxygen in the water, adversely affecting other aquatic organisms and the entire ecosystem. This process is called eutrophication, and is a serious problem in Minnesota today. Interestingly, the bacteria that are responsible for the al-

WRS Ph.D. students receive dissertation fellowships

Water Resources Science (WRS) students Stanley Asah and Meghan Brown were awarded University of Minnesota Doctoral Dissertation Fellowships for the 2005–2006 academic year. The fellowships are given to outstanding final-year Ph.D. candidates making timely progress toward their degrees, and provide an opportunity to devote full-time effort for the upcoming academic year.

Asah's dissertation is titled “Individuals as Complex Adaptive Systems: Operationalizing Social-Ecological Resilience Analysis of Indigenous Agriculture within the Lake Chad Basin.” He is advised by James Perry (Fisheries, Wildlife, and Conservation Biology). The title of Brown's dissertation is “The Distribution and Emergence of *Bythotrephes* Diapausing Eggs: Defining the Role of Cumulative Environmental Stressors in Dormancy.” She is advised by Donn Branstrator (Biology-UMD).

NRRI expertise flows from Great Lakes to Great Rivers

As scientists at UMD's Natural Resources Research Institute (NRRI) begin to wrap up the successful Great Lakes Environmental Indicators (GLEI) project, the great rivers of the United States beg for the same attention. The Environmental Protection Agency (EPA) awarded NRRI \$840,000 over the next five years to use some of their proven research techniques on river systems.

The Great Rivers Project will cover the Upper Mississippi, the Ohio, and the Missouri rivers and their watersheds. As part of the Project, NRRI hopes to answer questions such as "What areas are still pristine? What areas need pollution remediation? How are human activities in the watersheds impacting water quality? Just how healthy are these 'great rivers'?"

NRRI's specialists in algae research at the Ely Field Station will tackle a large portion of this comprehensive project. Algae—microbiotic and environmentally

sensitive organisms—are remarkable "tools" for monitoring disturbances in river systems. Developing these tools will be the first major task of this project.



NRRI will identify indicator algae that can be used to rank the health of river reaches, such as this reach of the Mississippi River above the Upper St. Anthony Falls Lock and Dam in Minneapolis.

Other indicators of environmental health, like water chemistry, macroinvertebrates, fish, sediment, and vegetation, are currently being developed by collaborating agencies.

Euan Reavie is the lead scientist at the

Ely Field Station charged with execution of NRRI's portion of the Great Rivers Project, in close collaboration with scientists at the EPA's Health & Environmental

Effects Research Laboratory in Duluth.

"The samples have already been gathered," Reavie explained. "Now, we'll spend the first two years of the project looking at more than a thousand samples under the microscope. It is excruciatingly detailed work, but it's important. In the end, we'll have identified hundreds of species and their ecology."

As with the GLEI project, the EPA ultimately wants to be able to rank portions of the rivers from "good" to "highly degraded" based on the various indica-

tors developed by the scientists. With clearly defined environmental quality data in hand, the EPA can understand what is truly attainable for remediating the most degraded areas.

Excerpted from a Natural Resources Research Institute news release.

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since the 1960s and found abundant populations of *Hannaea superiorenensis* from similar locations.

Hannaea superiorenensis prefers the high energy, well-oxygenated, cold waters of Lake Superior's wave zone. "The fact that *Hannaea superiorenensis* is only distributed along the shore of Lake Superior, and doesn't live in rivers, supports the hypothesis that it may have speciated from a close relative, *Hannaea arcus*, which is river-dwelling in western North America," Bixby said. Molecular analysis, analysis of historical samples, and additional river surveys in the region may further support this hypothesis.

What makes *Hannaea superiorenensis*

so special is that it is endemic to Lake Superior; it is not a new exotic or invasive species. Endemic species are often the most vulnerable to pollution, climate change, and human impacts; they are the harbingers of ecological change. We long ago learned our lesson in the Great Lakes when it comes to how vulnerable endemic species are. The blue pike in Lake Erie, the deepwater and shortnose ciscoes in Lakes Michigan and Huron, and even a diatom, *Cyclotella americana*, have gone extinct in the Great Lakes.

Finding a new species that has evolved to thrive in Lake Superior's unique physical and chemical environment has led Bixby and me to search for new *Hannaea* species in other large lakes in the world. Currently we are focusing our work on

this genus in the Asian rift lakes. Lake Baikal, the world's largest lake, and Lake Hövsgöl, Mongolia's largest lake, are both home to undescribed species of *Hannaea* that are similarly adapted to live in the high energy wave zone of these cold lakes. The two Asian taxa are obviously different from the widespread *Hannaea arcus* and do not resemble the Lake Superior species, except for size. The Mongolian species is sometimes as large as our Lake Superior specimens (125 µm long). As reported in the December 2005 *Minnegram*, new regions of Mongolia are being surveyed for new biodiversity discoveries by WRS faculty and students—it's just a little harder than driving up to the North Shore to make our collections!

CoreWall project creates access to digital geologic cores

by Emi Ito, Limnological Research Center, Department of Geology and Geophysics, and National Lacustrine Core Repository and Analysis Laboratory; and Paul Morin, National Center for Earth-surface Dynamics and Department of Geology and Geophysics

Geologic cores are often taken one and two at a time, without the context of other cores taken in the same area. But imagine if you had access to every core taken in a watershed or state, or every core drilled with public money. Access to this scale of data is the goal of CoreWall, a real-time stratigraphic correlation, core description,

environment for stratigraphic correlation, visual core description, and data visualization. Routine acquisition of digital imagery has created an opportunity for new ways to capture, collect, analyze, and distribute scientific measurements to the scientific community. These images provide the basic template for all sediment

is an integrated system with access to numerous community databases, bringing meaning to the oft-used phrase “multi-proxy study.” At present, it takes months to years before any integrative interpretation of multi-proxy data are attempted, often after individual researchers already have published papers based on just their own proxy data.

In 2000, National Lacustrine Core Repository and Analysis Laboratory (LacCore) staff recognized the need for an integrated core data visualization system. Many of the features LacCore wanted were missing from existing systems.

About two years ago, we started to work with the computer scientists at the Electronic Visualization Laboratory (EVL) at the University of Illinois at Chicago and with the Joint Oceanographic Institutions (JOI) to see if an integrated data visualization system that could display data as they were being acquired could be developed. EVL sent Arun Rao to LacCore to learn first-hand how we studied cores, and he produced prototypes of data visualization software. The early results were very promising and they were demonstrated at Geological Society of America and American Geophysical Union meetings and at JOI. Last fall, LacCore, EVL, and others submitted a multi-institution collaborative proposal to the National Science Foundation. The CoreWall proposal was funded, and in two short years, the completed software suite should be installed on the newly refurbished JOIDES Resolution Drill Ship and at LacCore, benefiting all scientists and students who come to us to study their cores. CoreWall will be distributed free of charge.



Doug Schnurrenberger, former curator of LacCore, studies geologic cores using CoreWall software.

and data visualization software (and hardware) system to be used by the marine, terrestrial, and Antarctic science communities. For the Minnesota water resources community, this translates to the ability to take lake sediment core studies to the next level, and the ability to visualize all the well log data for the state and its neighbors in three dimensions.

Scientists who study lake sediment cores have been wishing for an integrated

descriptive work such as annotations about structures, lithologic variation, grain size variation, bioturbation, chemical composition, and fossils. The integration of split core images with discrete data and images of smear slides and thin sections provides a robust approach to the description of sediment cores. These records are permanent, unaffected by drying and shrinkage or subsequent sampling of the core, and accessible outside the core lab. CoreWall

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our lakes. Spiny water flea is so small that fishing line has to be sterilized to remove it, Schindler said.

None of these problems is easy to solve, but scientists have succeeded in the past and continue to make progress protecting our resources, Swackhamer said. Meanwhile, everyone can help. Swack-

hamer mentioned the simple act of turning off the tap while we brush our teeth, which can save a couple of gallons. Schindler suggested avoiding bottled water, which requires vastly more energy to produce and provides no greater safety than tap water, in most cases. “You think because they are plastic the bottles are being recycled,” Swackhamer pointed out, “but according to the statistics, they are not.”

While both scientists agreed that better communication between researchers and decision-makers is needed, they noted that citizens can make a difference by contacting their state and national representatives with their concerns. “Ten phone calls puts it on their radar screens, and 100 calls helps make it law,” said Swackhamer.



U of M Water Community News

The **Water Resources Science (WRS)** graduate program received contributions to the Travel Grant Fund from Bonestroo, Rosene, Anderlik & Associates and Barr Engineering Company. These generous contributions will be given as \$500 awards to WRS students for travel to conferences. For more information on contributing to the Fund, contact Jan Sickbert at (612) 624-3283.

The 2nd **Agricultural Drainage and Water Quality Field Day** was held August 19, 2005, at the Southwest Research and Outreach Center (SWROC). Over 85 people attended the program, which featured the installation of a water table management structure at the Hick's family farm near Tracy, Minnesota, launching a cooperative research and demonstration project. Proceedings of the event are available through the SWROC Web site <http://swroc.coafes.umn.edu/>.

Bill Arnold (Civil Engineering) received an Excellence in Review Award from the journal *Environmental Science and Technology*. He also gave two talks at "Pacifichem 2005: The International Chemical Congress of Pacific Basin Societies."

Rich Axler (Natural Resources Research Institute) presented at the U.S. Department of Agriculture-Cooperative State Research, Education, and Extension Service's Tribal Water Quality Facilitation Grant Summit held October 17–19, 2005, in Polson, Montana. He also presented at the North American Lake Management Society meeting held November 9–11, 2005, in Madison, Wisconsin.

Jay Bell (Soil, Water, and Climate) and his graduate students **Brandy Elf** and **Dan Tersteeg** have partnered with U.S. Department of Agriculture agencies on two research projects. Bell and Elf are working with the Agricultural Research Service to describe the local hydrology,

establish a generalized phosphorus mass balance, and define major factors that control phosphorus loading to a ditch system for Rice Lake Wetland, near Detroit Lakes, Minnesota. Together with the Forest Service, Bell and Tersteeg are testing the effectiveness of buffering seasonal ponds following the harvest of adjacent upland forest.

David Gustafson (Water Resources Center) received the 2006 "Man of the Year" award from the National Association of Wastewater Transporters on February 16, 2006 "in recognition and appreciation for [his] efforts and outstanding ability in the onsite wastewater treatment industry with a unique touch of levity." The award was presented at the 2006 Pumper & Cleaner Expo in Nashville, Tennessee.

Barb Liukkonen (Water Resources Center and Sea Grant) presented a poster at the 23rd Annual Red River Basin Land and Water International Conference in Winnipeg, Manitoba, held January 11–13, 2006. The poster was co-authored by **Vince Crary** (UMN Extension Service), **Melinda Erickson** (MnDOT and WRS alumna), **James Linn** (Animal Science), and **Michael Murphy** (Veterinary Population Medicine). With the same co-authors, she delivered an oral presentation at the USDA-CSREES National Water Quality Conference in San Antonio, Texas, held February 5–9, 2006. Liukkonen and **Eleanor Burkett** (UMN Extension Service) delivered a poster presentation at the USDA-CSREES conference.

The **Natural Resources Research Institute (NRRI)** received \$100,000 from **Ron Weber** (UMD alumnus) to restore degraded streams in Lake Superior watersheds. NRRI also received a \$35,000 grant through the National Fish and Wildlife Foundation, which will complement the Stream Restoration Initiative.

Linda Weavers is a visiting professor in Civil Engineering on sabbatical leave from Ohio State University.

University of Minnesota Water Resources Science Program Degree Recipients

Lindsay Anderson-Powers received her Ph.D. in November 2005. Her thesis was titled "Calibration and Application of a New Paleotemperature Tool in Lacustrine Systems: TEX86 for Continental Paleoclimate Reconstruction." Anderson-Powers was advised by **Tom Johnson** (UMD-Geological Sciences and Large Lakes Observatory).

Jason Ulrich received his M.S. in December 2005. The title of his Plan B paper was "Analysis of Stream Health Indicators for TMDL Assessment in the Minnesota, St. Croix and Upper Mississippi River Basins of Minnesota." Ulrich was advised by **Bruce Wilson** (Biosystems and Agricultural Engineering).

Winfried Ksoll received his M.S. in January 2006. His thesis was titled "Growth and Persistence of Fecal Indicator Bacteria in Lake Superior Epilithic Periphyton." Ksoll was co-advised by **Randall Hicks** (UMD-Biology) and **Michael Sadowsky** (Soil, Water, and Climate).

Michael Donahue received his M.S. in January 2006. The title of his Plan B paper was "Inferred Sulfate Reduction Rate and Associated Sulfur Isotope Fractionation from the Cariaco Basin." Donahue was advised by **Josef Werne** (UMD-Chemistry and Large Lakes Observatory).



Upcoming Events

October 24–25, 2006. **Minnesota Water 2006 and Annual Water Resources Joint Conference.** Earle Brown Heritage Center, Brooklyn Center, Minnesota. Refer to page 1 for additional information. Conference plans will be featured in the June issue of the *Minnegram* and on the WRC Web site at <http://wrc.coafes.umn.edu/> as they become available.

April 4–6, 2006. **Remote Sensing Across the Great Lakes: Observations, Monitoring, and Action.** Clarion Riverside Hotel, Rochester, New York. This conference will provide the opportunity to learn about remote sensing tools, geospatial applications, and observing technologies that are being used to study, monitor, and manage the Great Lakes-St. Lawrence River system. It will facilitate information exchange between policy makers, scientists, and engineers from around the Great Lakes region and beyond. For more information, visit the conference Web site at <http://rdx.glc.org/06/>.

April 19, 2006. **4th Annual William E. Larson and Raymond R. Allamaras Lecture on Emerging Issues in Soil and Water.** 335 Borlaug Hall, University of Minnesota, St. Paul, Minnesota. The overall theme of the program will be “Defining a Future Bioeconomy.” This will be an expanded program with two speakers: (1) Dr. Bruce Dale from

Michigan State University on “Biomass Supply and Biofuels: Some Perspectives” and (2) Dr. Rick Cruse from Iowa State University on the “Future Bioeconomy and its Impacts on Soil and Water Resources.” Before the lectures there will be brief comments from Minnesota State Representative Al Juhnke on the “Importance of Bioenergy to Rural Minnesota.” For more information, contact Dr. Satish Gupta at sgupta@umn.edu, or at (612) 625-1241.

July 25 & 27, 2006. **Strip Tillage Expo: Tillage for Today and Tomorrow.** July 25, University of Minnesota Southwest Research and Outreach Center, Lamberton, Minnesota; July 27, University of Minnesota Southern Research and Outreach Center, Waseca, Minnesota. Manufacturers will gather to demonstrate equipment for strip tillage and associated operations. Speaker topics range from equipment management to the results from two years of on-farm trials across Minnesota comparing tillage systems. Equipment vendors and other organizations with conservation tillage-related information who would like to participate are encouraged to reserve display space, preferable by May 1. More information is available on the WRC Web site, <http://wrc.coafes.umn.edu/>.

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Development of a DNA marker gene system to determine sources of fecal *E. coli* in watersheds

As part of the Clean Water Act and Total Daily Maximum Load determinations, Minnesota’s waters are being surveyed and classified according to their respective uses. One of many reasons for our state’s waters failing to meet the water quality standards of these classifications is contamination from fecal coliform bacteria. These bacteria can come from a variety of sources, such as wildlife, malfunctioning septic systems, discharge from sewage systems, or runoff from urban areas, feedlots, or manure-amended agricultural lands. To address this water quality problem, the sources of the fecal bacteria in a lake or river must be identified.

Michael Sadowsky (Soil, Water, and Climate) has proposed the use of the suppression subtractive hybridization technique to enrich for host-specific DNA markers for *E. coli* originating from cows and humans, which will provide a means to identify the source of fecal bacteria in surface waters. In his past work, Sadowsky has successfully used this approach to identify DNA markers for *E. coli* originating from geese in Lake Superior fecal bacteria. After identifying the fecal coliform DNA markers, he plans to use them to determine sources of *E. coli* in the Minneopa Creek watershed.

Sadowsky believes this will provide a cost-effective and accurate method to determine the sources of *E. coli* bacteria.

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Publications and Resources



The Great Lakes Monitoring Inventory. Binational Executive Committee. 2005. The Binational Executive Committee has established an on-line basin-wide binational monitoring inventory to share information and to improve the coordination of monitoring activities throughout the Great Lakes. The Great Lakes Monitoring Inventory contains information about over 1,000 monitoring programs being conducted by Canadian and U.S. federal, provincial/state, and municipal agencies, academia, and non-governmental organizations. You can access it at www.binational.net and share information about your monitoring program, or find out about programs being conducted by others in the basin. Should you have any questions, please feel free to contact Brad Hill (Environment Canada) at Brad.Hill@ec.gc.ca, or (905) 319-7209.

Handbook for Developing Watershed Plans to Restore and Protect Our Waters. U.S. Environmental Protection Agency (EPA). 2005. A draft guide to watershed management to help various organizations develop and implement watershed plans is now available. The Handbook is aimed toward communities, watershed groups, and local, state, tribal, and federal environmental agencies. This Handbook contains in-depth guidance on quantifying existing pollutant loads, developing estimates of the load reductions required to meet water quality standards, developing effective management measures, and tracking progress once the plan is implemented. EPA will be accepting comments and suggestions on the document in the coming year to incorporate in the final version of the Handbook. The Handbook is available at www.epa.gov/owow/nps/watershed_handbook/.

Minnesota Wetlands Protection Report. Minnesota Center for Environmental Advocacy (MCEA). 2006. The first annual Report identifies some of the regulatory failures that have caused wetland loss and calls for action from legislators, policymakers, and citizens who care about the state's wetlands and natural heritage. The Report features nine on-the-ground case studies that illustrate how current laws and enforcement issues can contribute to wetland destruction and loss. The Report is available through MCEA's Web site at www.mncenter.org/mcea_wetlands_initiative/.

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