

September 1997, Minnegram

Downstream suffocation: University researchers explore Minnesota links to Gulf hypoxia

by Shandor Szalay

If you talked with some of the fish in the northern Gulf of Mexico, they might be a little short of breath. A growing zone of hypoxia (low oxygen) in the region is the subject of a new six-part investigation coordinated by the White House Council on the Environment and Natural Resources. The purpose of study is to assess causes of and explore management strategies for the extensive zone of hypoxic waters in the northern Gulf.

The hypoxic zone has doubled in the last few years, prompting concern that the low levels of oxygen will permanently damage the region's lucrative fish and shrimp industries. Several previous studies conducted by the Gulf of Mexico Program, a federally-funded five-state research consortium, identify nitrate loading from the Mississippi and Atchafalaya Rivers as the primary cause of the hypoxia.

Minnesota's Water Resources Center director and University of Minnesota professor, Pat Brezonik, is heading one portion of the new inquiry. Brezonik's study, which involves water quality experts from several universities and governmental agencies, will focus on evaluating effects of nutrient source reductions in the Upper Mississippi Basin on nutrient concentrations and water quality of the Mississippi River. Existing data will feed several empirical and deterministic models to predict aquatic responses to nutrient load reductions.

These results will be synthesized with those from another investigation evaluating the effects of reduced nutrient inputs from the Mississippi/ Atchafalaya river system on the hypoxic conditions in the Gulf.

Other portions of the full study include investigations of the extent of the hypoxia, the ecological and economic consequences of hypoxia, sources of nitrate in the Mississippi River system, and the effects of reducing nutrient loads on hypoxic waters.

Hypoxia history

As early as 1972, oil prospectors identified a zone of low oxygen in the waters of the Louisiana-Texas continental shelf. Researchers now believe this low-oxygen area is the result of high rates of algal productivity, which stimulate oxygen-using decomposers. Since it was first detected, the hypoxic zone has increased in size, reaching an estimated 18,000 km² during the summer of 1995.

Researchers from the Gulf of Mexico Program have been studying the hypoxia problem for several years. Their studies were summarized in a 1995 publication, "Hypoxia in the northern

Gulf of Mexico: past, present, and future.” The evidence in support of nutrient loading from the Mississippi River system as the primary instigator of hypoxia in the Gulf is compelling. Several studies using sediment cores from the Gulf of Mexico have found close positive correlation between the production of organic matter in the Gulf and the increase in nitrate loading from the Mississippi watershed.

The flooding of summer 1993 provided other strong evidence linking Mississippi River nutrients to the problems in the Gulf. During the flood, nutrient inputs increased dramatically over their already elevated levels. A corresponding order of magnitude increase in phytoplankton production was recorded, and the region of hypoxia expanded to more than double the size that had been observed previously.

But while the proximal causes of low oxygen levels in the gulf are relatively clear, linking the nitrate loading to upstream land use and municipal activities has been the source of increasing controversy.

Who gets the blame?

Studies done by the USGS in 1992 suggest that the Upper Mississippi Watershed, which drains intensively farmed regions of Minnesota, Iowa, Illinois, Indiana, and Ohio, is the principal contributor of nitrate to the Mississippi River system. A concurrent USGS study identified commercial fertilizer as the leading source of nitrogen in the basin, accounting for more the half of the total annual nitrogen input. According to Greg Gross, unit supervisor for the Minnesota Pollution Control Agency’s Watershed Assistance Program, at a 1996 conference on hypoxia, EPA officials did not explicitly blame any one region for the hypoxia problem, but felt that the evidence pointed to the Upper Mississippi Basin as the major contributor.

But some Midwestern farmers and scientists are slow to welcome any of the blame. Iowa State professor John Downing said much of the early data “can be circumstantial.”

“New liabilities aren’t welcomed in the Midwest. We need to recognize exactly what the problem is and try to do something about it.”

Bryan Seivers, a farmer from West Liberty, Minnesota, questions the ability of nutrient reduction programs to solve the problem. “If we reduced nutrient loading in the Gulf, would it eliminate hypoxia?” Because the hypoxia was discovered in 1972, only indirect evidence exists to verify the existence or absence of the hypoxic zone prior to human settlement and development.

Federal officials hope that the new study will provide a clearer view of the geographical sources of the problem and the potential effectiveness of various management scenarios. Brezonik’s work will be summarized in a final report in May 1998 and will contribute to a synthesis document that will provide direction for future federal efforts on the hypoxia issue.

Implications for Minnesota River management

The hypoxia issue may change the way nutrient management in the Minnesota River basin occurs, says Brezonik. “Traditionally management has focused on phosphorus and suspended solid; now nitrate could be a major concern.”

University professor Dave Mulla described the nitrate situation in the Minnesota Basin at a recent conference on hypoxia in St. Louis. Mulla says the situation in the Minnesota River isn't as bad as it could be. Nitrate levels are consistently below drinking water standards, and per area, the Illinois and Iowa Rivers contribute twice as much nitrate as the Minnesota.

Further, Mulla feels the prospects for reducing nitrate loading in the Minnesota are quite good. “Two-thirds of the nitrate comes from 15% of the watershed. We need to focus our efforts there,” said Mulla. Down in the Gulf, the fish are breathing easier already.

Around the state: water resources updates

Freshwater mussels studied

Drs. Drew Miller and Barry S. Payne, of the U.S. Army Engineer Waterways Experiment Station (WES), have been conducting a series of experiments to evaluate the effects of commercial navigation traffic on the Upper Mississippi River on the behavior and ecology of native mussels.

Laboratory studies were used to assess the effects of increased water velocities and suspended sediment on the physiology and general condition of several types of mussels. Preliminary analysis indicates that increased traffic levels associated with navigational improvements will not significantly affect mussels.

Field studies were conducted to monitor the effect of barge traffic on feeding habits. Early results indicate that mussels briefly stop feeding when small recreational boats pass overhead. Analysis of tow boat data has not been completed.

Excerpted from UMR-IWW System Navigation Study Newsletter, April 1997.

Minnesota drafts wetlands plan

A new statewide plan for protecting and restoring Minnesota's wetland resources has been drafted. The plan was developed under sponsorship from several agencies including the Minnesota Department of Natural Resources, Board of Water and Soil Resources, Department of Transportation, Pollution Control Agency, and Department of Agriculture.

The plan arose in response to key issues identified in a series of workshops held in 1994. The plan advocates regionalizing wetland policy to accommodate local needs. The plan also calls for a simplification of the regulatory process through combining multiple agency regulations.

In addition, the new plan gives a high priority to protecting wetlands with the highest ecological value, and also provides a guide for restoring lost wetlands. Finally, the plan explicitly recognizes the strong link between healthy wetlands and healthy communities.

The plan does not establish target dates for implementation. Instead, officials see the plan as an evolving document that will change as it is put into practice.

Excerpted from The River Register, May/June 1997.

New coalition teaches clean water message

A new traveling exhibit is attempting to take aquatic education where it has never gone before - into shopping malls. The interactive exhibit, called WaterShed, is designed to increase public awareness about watershed and water quality in the Twin Cities. The exhibit was expected to reach 100,000 visitors this past spring, and may be seen by over a million by the turn of the century.

WaterShed was designed and built by the Science Museum of Minnesota, and has traveled around the Twin Cities this summer at various events and festivals.

The exhibit is the first product of the WaterShed Partners, a new metropolitan coalition formed to address shared goals pertaining to watershed education. The coalition includes more than 30 organizations around the Twin Cities committed to environmental education, including the University of Minnesota Water Resources Center and Extension Service.

For more information on WaterShed Partners or how to schedule the WaterShed exhibit to appear at an event or neighborhood function, call Pauline Langsdorf at (612) 602-1805.

Excerpted from Council Directions, March 1997.

Zebra mussel find puts St. Croix in peril

The recent discovery of 50 tiny zebra mussels in the St. Croix Falls area of the St. Croix River has created widespread concern about the future of the St. Croix River and nearby waters. In late July, National Park Service personnel reported finding the mussels on a sampler placed in an impoundment above the dam at St. Croix Falls. This marks the first time a population of zebra mussels has been found in the river, and strikes a serious blow to on-going multi-agency initiatives to prevent the infestation of the St. Croix.

“We are definitely concerned, but it’s much too early to make any predictions or statements until we gather more information about flow, water conditions, and such,” said Sue Jennings, a resource management specialist with the National Park Service.

If allowed to spread, the mussels could kill off indigenous mussels, foul beaches and damage objects they attach to, such as engine propellers and drain pipes. The spread of zebra mussels in the St. Croix could also mean large-scale ecological changes due to the zebra mussels' tenacious ability to filter plankton out of the water column.

What is of particular concern is that the find probably is not an isolated situation. "Zebra mussel experts we consulted suggest that since many small mussels were found, it means that reproduction and settlement has likely occurred in the area," said Minnesota Department of Natural Resources aquatic biologist, Gary Montz. "We will be working with agencies to figure out how widespread zebra mussels are in the river."

The discovery of zebra mussels in the St. Croix could mean a radical change in the way the St. Croix is managed. According to Eric MacBeth, technical director for the Minnesota/Wisconsin Boundary Area Commission, efforts by both Wisconsin and Minnesota are underway to declare the St. Croix an infested water with respect to zebra mussels. If that occurs, management would shift from trying to prevent the mussel from infesting the St. Croix, to trying to prevent it from leaving the St. Croix. "They would essentially concede the river," said MacBeth.

Some feel that the Park Service should have adopted stricter measures to protect the St. Croix from invasion by zebra mussels, such as closing the river to incoming boat traffic from the Mississippi River at Prescott, Wisconsin. Many, however, felt that infestation was just a matter of time. This recent find in the upper St. Croix, 80 miles north of Prescott and out of range of any of the larger yachts that enter the St. Croix from the Mississippi, suggests they may be right.

Mercury hunt: tracking mercury through Minnesota's north woods

by Shandor Szalay

It is well known that mercury can be devastating to aquatic systems, and that the major source of mercury pollution is atmospheric deposition. Far less, says University of Minnesota professor Ed Nater, is known about how mercury travels from terrestrial environments, where a majority of deposition occurs, to aquatic systems. This critical link in the mercury cycle could provide insight into which watersheds are most susceptible to mercury build-up, and may allow managers to more effectively control inputs of mercury to at-risk water bodies.

Nater and University professor Dave Grigal are working to understand mercury dynamics in forested watersheds in northern Minnesota as part of a current Water Resources Center (WRC) grant. The work is a continuation of a previous WRC grant and a collaboration with the U.S. Forest Service in Grand Rapids, Minnesota.

Particulate taxis

Nater and Grigal's initial work consisted of a limited mass balance of an experimental watershed at Marcell Experimental Forest. The study verified a well known aspect of terrestrial mercury cycling, namely that its movement is closely tied to the movement of organic particles. What caught Nater's eye, however, was that the data indicated that particulate organic carbon was much more important in facilitating mercury movement than dissolved organic carbon, a phenomenon that had not been observed in previous studies of mercury cycling.

Results from the study indicated that as much as 70% of total mercury transport in the watershed occurred in conjunction with particulate organic matter (POM). What made the finding even more interesting was that POM constitutes only 10-20% of the total organic matter present in the system.

"We were surprised to find that particulates were so important," said Nater. "It is exciting because particulates are much easier to manage."

The new study, which focuses on the same experimental watershed at Marcell, has three major objectives. The first is to monitor more closely the movement of POM (and attached mercury). To do this, automatic soil solution samplers have been installed throughout the study watershed. Samples are being taken during a variety of hydrologic scenarios including spring thaw events, summer rainstorms, and low-flow conditions.

A second objective is to find out more about the nature of the POM. At this point, little is known about the physical nature of the particulate material that binds to mercury atoms. However, Nater's speculation from preliminary data is that, at least for low-flow conditions, a large portion of the particulates involved in mercury transport are microbes.

Will buffers do the trick?

Finally, the study will investigate the effectiveness of forested buffer strips in preventing the input of mercury-rich particulates into aquatic environments. A series of simulated harvest experiments in which soil is subjected to vigorous disturbance will allow Nater and Grigal to measure mercury fluxes under different buffer widths.

Keep it on dry land

Nater contends that if managers can keep the mercury in the forests and out of the water, much of the mercury eventually will volatilize out of the system. According to Nater, mercury is far less toxic while in the forests than in aquatic conditions. "Mercury really isn't a problem for terrestrial organisms the way it is for aquatic biota; in aquatic systems, the biomagnification is just awesome," said Nater. He hopes to study the process of mercury volatilization more closely in the future.

Nater would also like to explore the specifics of how mercury binds onto organic particles. "It has a lot to do with sulfur compounds, but there is much yet to learn," said Nater. He is working with University soils professor, Paul Bloom, to use X-ray absorption fine structure spectroscopy to measure binding energies of various mercury/POM complexes. This work could lead to a

better understanding of the bioavailability of particulate-bound mercury once it reaches a lake or stream.

Nater and Grigal will be collecting data for the project through fall 1998. At that time, in addition to publishing in academic journals, they will use the results of the study as a the basis for a BMP for managing mercury in forested watersheds.

Farming and the flood: hydrologic experts size up drainage effects on flooding

On June 4, a panel of experts met for a technical forum to assess the impacts of artificial drainage on flooding, and to develop a detailed research agenda. The forum was organized by University of Minnesota professors Gyles Randall and Fred Bergsrud. Experts from a variety of agencies and institutions came together to devise an integrated assessment of the effects of artificial drainage not only on extreme events, such as the floods of 1997 (see June Minnegram article, "Receding waters: learning lessons from the floods"), but on less severe events as well.

Climatic dominance

A preliminary report issued by the panel concluded that it was "very unlikely" that agricultural drainage had a significant effect on the major flooding events of 1993 and 1997.

"Nature was so dominant in the volume of precipitation those two years that any land-use practice such as agricultural drainage was relatively insignificant," said Fred Bergsrud, engineer with the University of Minnesota Extension Service.

The panel also concluded that wetland restoration would have had a relatively insignificant impact on very extreme floods. This conclusion was based in part on Army Corps of Engineers' simulations of the 1993 flood on the Minnesota River. These simulations showed that even extensive wetland restoration would have had virtually no effect on peak flows. Historical trend analysis of the Minnesota River conducted by University professor Dave Mulla (see June Minnegram) concurred with the Corps' simulations. According to this analysis, more than 50% of the variation in Minnesota River flows could be explained by climatological factors alone.

gricultural drainage can be a "very significant" factor in localized flooding under less extreme conditions. In general, the impacts of land use on flooding increase as the recurrence interval of a flood event decreases. Still, any conclusions seem to be more a result of expert opinion and theoretical predications than empirical evidence. What data have been collected are often ambiguous, making it difficult to interpret the complex interplay between climate, land use, and inherent watershed characteristics. "When you're talking about watershed-scale flooding it's very difficult to pinpoint what had what effect," said University professor Ken Brooks, a participant in the forum.

Scale issues

Another problem is that many of the empirical data on drainage impacts come from highly controlled field-scale experiments. Extrapolating to the scale of major watersheds is a leap that many scientists, including Brooks, think is questionable. Specifically, it is difficult to predict how effects present at small scales over short time periods will interact at broader temporal and spatial scales.

Brooks advocates a modeling approach to isolate the effects of drainage from the climatological effects at the major watershed level. Currently, Brooks and University professor Bruce Wilson are acting as consultants on an effort funded by the McKnight Foundation to assess the cumulative effects of drain tiles on the hydrology of first- and second-order streams in the Minnesota River basin. The project will use computer models to evaluate hydrologic response under a number of combinations of rainfall intensity, watershed characteristics, and drainage intensity.

Along similar lines, the panel strongly recommended research at the watershed scale, including both empirical and modeling approaches.

The panel included many experts in various aspects of drainage and hydrology, including representatives from the Ohio State University, the University of Minnesota, the National Weather Service, and the U.S. Geological Survey. The panel was brought together not only to make conclusions about current and potential impacts, but to create an open dialogue between experts in otherwise segregated agencies.

For more information on this topic, please call Gyles Randall at (507) 835-3620 or Fred Bergsrud at (612) 625-4756.

Students to research water without getting wet

High school and community college students in Minnesota will soon get the opportunity to conduct water research from the comfort of their computer chairs. The National Science Foundation recently awarded the University of Minnesota's Sea Grant Program, Natural Resources Research Institute (NRRI), and College of Education and Human Resources \$656,000 for a three-year project for students to create their own water monitoring projects using geographic information system (GIS) technology, the internet, and Remote Underwater Sampling Station (RUSS) units developed by the University and industry partners.

"Our hope is that students benefiting from this project will become the highly-skilled environmental professionals of tomorrow," said Bruce Munson, Minnesota's Sea Grant Marine Educator. "In order to succeed as scientists and environmental managers in the future, students need to become familiar with this technology now."

Teams of science and technology specialists will develop a curriculum that teaches basic science concepts. The actual studies will be done with the help of RUSS, a patent-pending water sampling robot that students will program to gather, measure, analyze, chart, and report water quality data. RUSS units will be placed in four diverse Minnesota lakes so students can compare real-time data from differing sites.

Finally, an interactive compact disk and a Web site will report the project's results.

Courtesy of Minnesota Sea Grant.

WRC receives education and outreach grants

by Barb Liukkonen

The University of Minnesota Extension Service will receive four new grants for water resources education and outreach through the Water Resources Center (WRC).

A Clean Water Act Section 319 grant will continue to support, in a joint position established in 1995 between Extension and the MPCA, a coordinator for information and education about nonpoint-source pollution. Joe Schimmel, an extension educator housed at the MPCA, is currently coordinating NPS educational initiatives among state agencies, surveying local efforts and needs, and organizing new NPS information and education projects.

The second 319 grant will expand adoption of BMPs in the Minnesota River to include comprehensive farm planning in an effort to reduce sediment and nutrient loads in the river. The funds will provide technical assistance to farmers, making it easier for them to adopt erosion control and nutrient management practices. Lowell Busman, an extension educator based at the Waseca Experiment Station, will coordinate local teams to help farmers develop and implement comprehensive farm plans.

Funding from the Met Council's Twin Cities Water Quality Initiative (TCWQI) program will support installation of at least two alternative on-site septic systems in residential areas in the metro region. Plans are to replace failing systems in Ramsey and Dakota counties with approved alternatives such as recirculating sand filters or small constructed wetlands. The project will demonstrate the effectiveness and practicality of these new technologies in treating household wastewater.

Concurrently, an educational video will be produced to show construction and installation of these demo systems and highlight successes at other sites. Design and installation will be completed this fall and tours of the demonstration sites will be held next summer. Barb Liukkonen (WRC), Jim Anderson (WRC), and Dave Gustafson, an extension educator from Biosystems and Agricultural Engineering, will lead the effort. The Minnesota On-Site Treatment Contractors Association will provide assistance in construction for the project.

In addition, the TCWQI grant program will provide funds to involve stakeholders in the Lower Minnesota River Basin. Few citizens in the Minnesota Watershed are aware of the collective impact that individuals and communities have on the river. This WRC initiative will use an organizing approach to go beyond individual county water plans. It will bring together representatives from rural, urban, and suburban communities; elected officials; educators and other key decision makers to identify and prioritize how to most wisely invest the limited resources available to clean up the Minnesota River.

For more information about these projects, call Barb Liukkonen at the WRC, (612) 625-9798.

Minnesota Water Community News

Appointments

Carol Johnston (Nat. Res. Research Inst.) has been appointed to a three-year term as vice-chair of the National Research Council's Water Science and Technology Board (WSTB). This is Johnston's second term on the Board.

Awards

Jim Anderson (Dept. of Soil, Wat., and Clim.) was part of a multi-state group that received the USDA Secretary's Honor Award for its multi-state project including soil research in the Anoka Sand Plains.

Anne Kapuscinski (Dept. of Fish. and Wild.) received the USDA's highest individual award this June for leading development of the first environmental safety guidelines for aquatic biotechnology research in the United States.

Dave Mulla (Dept. of Soil, Wat., and Clim.) was elected Fellow of the Soil Science Society of America.

Mike Russelle (Dept. Soil, Wat., and Clim.) was elected Fellow of the American Society of Agronomy.

New Grants

Patrick Brezonik (Dept. of Civ. Eng., Wat. Res. Center), **Marvin Bauer** (Dept. of For. Res.), and **Dwight Brown** (Dept. of Geog.) received a grant from the Metropolitan Council to develop a lake quality assessment protocol for lakes in the metro region using remote sensing technology.

Ken Davis (Dept. of Soil, Wat., and Clim.) received \$53,000 from NASA to study mesoscale variability in convective boundary area development.

Tom Johnson (Large Lakes Obs.) received a \$385,000 grant from the National Science Foundation (NSF) for a high resolution paleoclimate study of Lake Malawi, Africa.

John Moncreif (Dept. of Soil, Wat., and Clim.) received \$250,000 from the Minnesota Department of Agriculture and the Legislative Commission on Minnesota Resources to study reducing Minnesota River pollution from lacustrine sediment.

Dave Mulla (Dept. of Soil, Wat., and Clim.) received \$33,000 to study stream sediment in the Blue Earth River Basin in Minnesota.

Elise Ralph and Erik Brown (Large Lakes Obs.) will start a 5-year NSF-funded effort on the Keweenaw Current of Lake Superior.

Nigel Wattrus and Elise Ralph (Large Lakes Obs.) received a two-year grant to explore using acoustic remote sensing systems in the Great Lakes.

Personnel

Terry Brown (Nat. Res. Research Inst.) was hired as a post-doctoral associate to work with **Carol Johnston** and **John Pastor** on modelling of wet beaver meadows at Voyageurs National Park. Terry received his Ph.D. in biological systems simulation from Lincoln University, New Zealand.

Efi Foufoula - Georgiou (Dept. of Civ. Eng.) has been named Director of Graduate Studies effective September, 1997.

Jeffery Gunderson is the new part-time associate director for outreach for the Minnesota Sea Grant. He will be responsible for developing, coordinating, implementing, and evaluating the Minnesota Sea Grant Outreach Program.

Ray Holzowsky and **Paige Novak** are new assistant professors in the environmental engineering program within the Department of Civil Engineering. Holzowsky received his Ph.D. from Johns Hopkins University and specializes in drinking water treatment processes; Novak received her Ph.D. from the University of Iowa and specializes in bioremediation of organic contaminants.

Howard Mooers (Dept. of Geol.) has been named the Director of Graduate Studies for the Water Resources Science Program in Duluth.

Ty Wilson is the new network administrator for the Department of Soil, Water, and Climate.

Meng Zhou is a new assistant professor of limnology at the Large Lakes Observatory in Duluth. His research will focus on turbulent flow and the swarming behavior of zooplankton. He will begin his work in February, 1998.

Travel

Ken Brooks (Dept. of For. Res.) is spending a sabbatical year in Taiwan on a Fullbright Award.

Barb Liukkonen (Wat. Res. Center) is an invited participant at a conference on the future of rural water supplies conference at the University of Iowa, Sept 21-22.

Carol Johnston (Nat. Res. Research Inst.) was an invited speaker at BIOGEOMON, the Third International Symposium on Ecosystem Behavior, held in Villanova, PA. Her presentation was entitled "Geographic information systems for wetlands and watersheds: a U.S. - Russian collaboration."

Bob Sterner (Dept. of Ecol., Evol., and Behav.) is spending a fall quarter leave conducting research at the Max Plank Institute for Limnology at Plon, Germany.

Upcoming Events

Sept 20-24. **Technical Conference: 1997 Ground Water Protection Council Annual Forum. Cleveland, OH.** A technical conference on ground water, watershed, wellhead protection and underground injection control. GWPC is accepting abstracts for technical papers as well as oral and poster presentations. Contact: GWPC at (405) 848-0690 or E-mail: ben@gwpc.site.net. Register online at gwpc.site.net.

Sept 27-30. **Ninth International Conference on Cold Regions Engineering.** Reston, VA. Contact: American Society of Civil Engineering at (703) 295-6144.

Oct 1-3. **Minnesota GIS/LIS Consortium.** St. Cloud, MN. Contact: Minnesota Land Management Information Center at (612) 296-1211.

Oct 1-3. **Annual Meeting of the Great Lakes Commission.** Chicago, IL. Invited speakers include U.S. Department of Commerce Secretary William Daley, Illinois Governor Jim Edgar, and Chicago Mayor Richard Daley. Special sessions will highlight sustainable development in the Great Lakes region, land-use planning and the Chicago waterfront, and obligations and opportunities of Great Lakes Commission membership. Contact: Mike Donahue at (313) 665-9135 or E-mail: mdonahue@glc.org.

Oct 10-12. **What's GREEN and WET: An Introduction to Watershed Education.** Shreveport, LA. Hands-on workshop providing information and training on sources of water pollution and their effects on human health, identification of water pollution problems, gathering data on possible sources, and methods of data analysis Contact: Carolyn Henne at (313) 761-8142 or E-Mail: chenne@green.org.

Oct. 17-19. **River of Words: Exploring Watersheds Through Poetry, Art and Ecology.** Berkeley, CA. Explores a river and its watershed through maps, drawings, walks and photos,

interviews with local experts, and reflections using writing, drawing and poetry. Contact: Carolyn Henne at (313) 761-8142 or E-Mail: chenne@green.org.

Oct 18-27. **WEFTEC '97: The Water Environment Federation's 70th Annual Conference and Convention.** Chicago, IL. Attracting more than 14,000 water professionals and 650 exhibiting companies for technical education, information exchange and networking opportunities. More than 75 technical sessions. Contact: WEFTEC '97, Water Environment Federation at (800) 666-0206 or E-mail: confinfo@wef.org; URL: www.wef.org.

Oct 23-24. **Great Lakes Information Network 1997 Conference.** Chicago, IL. Focuses on the use of internet technology to enhance information transfer in the management of the Great Lakes region. Contact: Carol Ratza, Great Lakes Commission, at (313) 665-9135.

Oct 27. **Thirtieth Annual Water Resources Conference.** St. Paul, MN. Contact: Bev Ringsak at (612) 625-6689.

Oct 30-31. **Karst-Water Environment Symposium and Workshop.** Roanoke, VA. Features papers on water resources management, source water pollution, monitoring, modeling, risk assessment, and use of alternative technologies in karst investigations. Contact: Judy Poff at (540) 231-8030, or E-mail: water@vt.edu.

Nov 3-4. **The Practice of Restoring Native Ecosystems National Conference.** Nebraska City, NE. Will examine the principles behind restoration as well as important issues, approaches, and techniques. Contact: The National Arbor Day Foundation at (402) 474-5655.

Dec 3-6. **Seventeenth International Symposium of the North American Lake Management Society.** Houston, TX. Theme: Managing for healthy aquatic system: water quality and quantity. Contact: Dr. Robert Doyle, Lewisville Aquatic Ecosystem Research Facility, at (972) 436-2215 or E-Mail: rddoyle@gte.net.

Nov 5-6. **Erosion and Sediment Control Workshop.** Columbus, OH. Practical techniques for preventing soil and water quality damage caused by land development. Contact: Jen Pemble, Soil and Water Conservation Society, at (515) 289-2331 or E-mail: jenp@swcs.org; URL: www.swcs.org

Dec 7-10. **59th Midwest Fish and Wildlife Conference.** Milwaukee, WI. Theme: Managing Natural Resources: Integrating Ecology and Society. Practical information and techniques for applying the principles of ecosystem management. Topics of interest: landscape-scale management, effects of alternative agricultural practices on wildlife, applied statistics and modeling, and effects of riparian land use on aquatic ecosystems. Contact: Robert Dumke, Wisconsin Department of Natural Resources, at (608) 266-8170, or E-mail: dumker@dnr.state.wi.us.

New Publications

Hydrogeologic and water-quality data used to evaluate the effects of focused recharge on groundwater quality near Princeton, MN 1991-95. 1997. G.N. Delin, M.K. Landon, K.J. Nelson, R.B. Wanty, R.W. Healy, H.W. Olsen, J.K. Bohlke, B.R. Schroyer, and P.D. Capel. USGS Open-File Report 97-21. Available from the USGS, Mounds View, MN, call: (612) 783-3100.

Water-quality and hydrogeologic data used to evaluate the effects of farming systems on groundwater quality at the management systems evaluation area near Princeton, MN, 1991-95. 1997. M.K. Landon, G.N. Delin, K.J. Nelson, C.P. Regan, J.A. Lamb, S.J. Larson, P.D. Capel, J.L. Anderson, and R.H. Dowdy. USGS Open-File Report 97-22. Available from the USGS, Mounds View, MN, call: (612) 783-3100.

Great Lakes Research Review - Great Lakes Exotic Species. 1997. H.M. Domske - ed. Available from the Great Lakes Program, call: (716) 645-2088.

Nitrate and pesticides in surficial aquifers and trophic state and phosphorus sources for selected lakes, Eastern Otter Tail County, West-Central Minnesota, 1993-1996. 1997. James F. Ruel. USGS Water Resources Investigations Report 97-4085. Available from the USGS, Mounds View, MN, call: (612) 783-3100.

Mississippi National River and Recreation Area, Minneapolis/St. Paul, MN - Map and Guide. 1997. Available from the National Park Service at: (612) 290-2901. URL: <http://www.nps.gov/miss>.