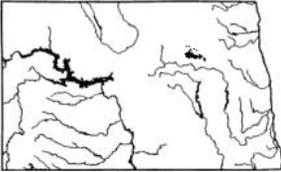


August 2006

**North Dakota Water Resources Research Institute
North Dakota State University
Fargo, ND 58105**



Newsletter



<http://www.ndsu.edu/wrri>

From the Director

Welcome to the 2006 issue of NDWRRI newsletter. In this issue, we feature five of the institute researchers. Also highlighted are the 2005 institute research projects. I encourage you to visit the Institute website, www.ndsu.edu/wrri.

The Institute continued to meet its mission by dedicating most of the Federal allotment funds toward competitive graduate student research fellowships. The Institute Advisory Committee consisting of representatives from the three major water agencies—the State Water Commission, the State Health Department, and the U.S. Geological Survey—provided valuable help in setting Institute's research priorities and reviewing Fellowship applications.

Again this year, North Dakota State Water Commission continued its support to the Fellowship program of the Institute by appropriating fifteen percent of the USGS base grant.

For the second consecutive year, a ND WRRI affiliate faculty received a grant award from the National Competitive Program of the USGS and National Institute of Water Resources. ND WRRI proposal is one of eight that were successful nationally out of 64 proposals submitted to the competition.

G. Padmanabhan, Director

Seminars sponsored by the Institute

- John J. Magnuson, professor emeritus at the University of Wisconsin-Madison, presented a seminar "Everything is Connected To Everything Else, Or Is It? An Analysis of Coherent Dynamics of Lakes" on April 19. Magnuson contrasted variations in lake-to-lake characteristics due to unique local factors, with global changes that affect lakes similarly over time. The former director of the University of Wisconsin's Center for Limnology, Magnuson is an expert in freshwater and marine fisheries, and ecosystem-level ecological studies. The event was sponsored by the NDSU Biotic Resources Program with support from the Cooperative Sponsorship Committee, the College of Science and Mathematics, and the North Dakota Water Resources Research Institute.

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- North Dakota Water Resources Research Institute and Civil Engineering Department of North Dakota State University cosponsored a seminar on "Dam-Break Flood in Natural Channels" by Dr. Arup K. Sarma, Associate Professor of Civil Engineering at Indian Institute of Technology (IIT)-Guwahati, India. Dr. Sarma has worked on dam-break flood wave propagation modeling of some of Himalayan rivers in the state of Assam located in the northeast part of India. Computation of dam-break flood has been a topic of interest for more than hundred years. However, numerical simulation of dam-break flow in channels with relatively higher complexities poses difficulties. Natural channels with steep slopes and wide flood plains offer numerous complexities and make the computation very challenging. These channels are highly non-prismatic and have significant variations in bed slope and roughness characteristics. Selection of proper and suitable governing equation(s) and use of efficient numerical scheme are the important issues in dam-break flood modeling. Numerical simulation using complex high-resolution scheme can bring finer computational accuracy. However, such accuracy comes at the cost of computational time and space, and implementation efforts. Dr. Sarma presented a simple but robust numerical scheme to efficiently simulate dam-break flood in complex rivers. Dr. Sarma also visited with the Energy and Environmental Research Center at the University of North Dakota, Grand Forks and made a presentation on dam-break modeling. Dr. Sarma was here in the USA to participate in the Environmental and Water Resources Institute of the American Society of Civil Engineers conference in Omaha, Nebraska.

NDWRRI Proposal funded by the USGS/NIWR National Competitive Program

Three proposals were submitted through NDWRRI for the 2006 National Institutes for Water Resources and U.S. Geological Survey National Competitive Grants Program, out of which one (highlighted below) was successful receiving funding. Listed below are the eight proposals selected for funding nationally out of a total of 61 proposals. North Dakota proposal is highlighted.

Title: Evaluating Alternatives for Watershed-Scale Design of BMPs. By: John W. Nicklow, Southern Illinois University at Carbondale Institute: Illinois Water Resources Center, University of Illinois (2 years)

Title: Application of Wireless and Sensor Technologies for Urban Water Quality Management. By: William A. Arnold, Miki Hondzo, Raymond Hozalski, and Paige Novak, University of Minnesota Collaborator: Paul Capel, USGS Minnesota Water Science Center Institute: Water Resources Center, University of Minnesota (2 years)

Title: Validation, Calibration, and Improvement of Remote Sensing ET Algorithms in Mountainous Regions. By: Jan Hendrickx and Jan Kleissl, New Mexico Institute of Mining and Technology Collaborators: David Stannard, Branch of Regional Research, Water Resources Discipline, Central Region, U.S. Geological Survey, and Alan Flint, USGS California Water Science Center Institute: Water Resources Research Institute, New Mexico State University (2 years)

Title: Collaborative Research on In Situ Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit By: Scott Korom, University of North Dakota Collaborator: Paul Capel, USGS Minnesota Water Science Center Institute: North Dakota Water Resources Research Institute, North Dakota State University (3 years)

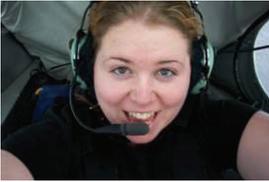
Title: An Econometric Investigation of Urban Water Demand in the U.S. By: Ronald C. Griffin, The Texas A&M University Institute: Texas Water Resources Institute, The Texas A&M University (2 years)

Title: Microtopography Effects on Vegetative and Biogeochemical Patterns in Created Wetlands: A Comparative Study to Provide Guidance for Wetland Creation and Restoration By: Changwoo Ahn, George Mason University Collaborator: Gregory Noe, Branch of Regional Research, Water Resources Discipline, Eastern, Region, U.S. Geological Survey Institute: Virginia Water Resources Research Center, Virginia Polytechnic Institute and State University (2 years)

Title: West-Wide Drought Forecasting System: A Scientific Foundation for NIDIS By: Anne Steinemann, Dennis Lettenmaier, and Andrew Wood, University of Washington Collaborators: Michael Dettinger, Branch of Regional Research, Water Resources Discipline, Western Region, U.S. Geological Survey, and Randall Hanson, USGS California Water Science Center Institute: State of Washington Water Research Center, Washington State University (3 years)

Title: Identifying High-Infiltration and Groundwater Recharge Areas By: Stephen J. Ventura and John M. Norman, The University of Wisconsin-Madison Collaborator: Randall Hunt, USGS Wisconsin Water Science Center Institute: Water Resources Institute, The University of Wisconsin-Madison (2 years)

The Institute awarded twelve Graduate Fellowships for the year 2006-2007



Fellow: Ali Tackett
 Adviser: Craig Stockwell, Biological Sciences, North Dakota State University
 Title: "Molecular phylogeography of *Etheostoma nigrum* (Rafinesque) in the upper Midwest"



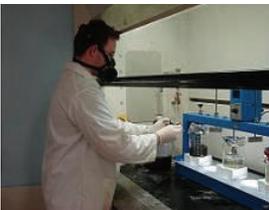
Fellow: Dan McEwen
 Adviser: Malcolm Butler, Biological, North Dakota State University
 Title: "Stoichiometry and the transfer of mercury from benthic macroinvertebrates into game fish "



Fellow: Ara Anderson
 Adviser: Malcolm Butler, Biological Sciences, North Dakota State University
 Title: "The life history of *Hexagenia limbata* (Serville) (Ephemeroptera:Ephemeridae) in North Dakota and Minnesota streams



Fellow: Kendall Goltz
 Adviser: Jay Leitch, Agricultural Economics, North Dakota State University
 Title: "The Impact of Wetlands and Wetland Easements on North Dakota Land Values"



Fellow: Christopher Hill
 Adviser: Eakalak Khan, Civil Engineering, North Dakota State University
 Title: "Using Entrapped Cell Systems for Treating Supernatant from Anaerobic Digester of the Moorhead Wastewater Treatment Plant"



Fellow: Mary Schuh
 Adviser: Frank Casey, Soil Physics, North Dakota State University
 Title: "Farm-scale reconnaissance of estrogens in subsurface waters"



Fellow: Ryan Klapperich,
 Adviser: Scott Korom, Geology and Geological Engineering, University of North Dakota
 Title: "Analysis of Associated Bedrock-Aquifer System Sediments: Origins of Electron Donor-Rich Aquifers in Eastern North Dakota"



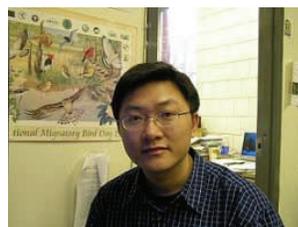
Fellow: Yuhui Jin
 Adviser: Julia Zhao, Chemistry, University of North Dakota, Title: "Rapid and Sensitive Determination of Bacteria in Water Using Nanoparticles"



Fellow: William Lenarz
 Adviser: Phil Gerla, Geology and Geological Engineering, University of North Dakota
 Title: "Effect of flow path processes on the geochemistry and quality of water discharged along the seepage face at Pigeon Point, Sheyenne delta aquifer, Ransom County, North"



Fellow: Michael Newbrey
 Adviser: Allan Ashworth, Geology, North Dakota State University
 Title: "Comparative Study of fossil and extant fish growth: Including analyses of Mean annual temperature in the geologic record"



Fellow: Wei Zheng
 Adviser: Malcom Butler, Biological Sciences, North Dakota State University
 Title: "Classification of Macroinvertebrate Communities across Red River Drainage Basin"



Fellow: Tedros Tesfay
 Adviser: Scott Korom, Geology and Geological Engineering, University of North Dakota
 Title: "Modeling Groundwater Dentrification by Ferrous Iron using PHRE-EOC"

2005-06 NDWRI Fellowship Research Highlights

Fellow Michael Newbrey



It is important to consider the implications of climatic change on surface water resources in light of potential consequences of global warming. North Dakota boasts some of the best long-term data sets in the form of a fossil record to measure the effect of climatic warming on a single population of fish. Very little is known about growth and the life history characteristics of fish in the fossil record. Fossils can provide valuable information about growth of extinct forms of fish, thereby providing insight into their life histories and ecology. In this study Michael examines the relationships between age, growth, longevity of extinct forms of fish, and climate on a geologic scale using data from all fossil localities known to produce these taxa in North America. Ultimately, this research will document the changes in evolution of growth of extinct species during the past climate changes and help to understand how contemporary species respond to climate change. Michael's advisor is Dr. Allan Ashworth.

Fellow Tedros Tesfay

Nitrate is one of the most common groundwater contaminants. Denitrification converts nitrate irreversibly into harmless nitrogen gas. It is a natural process that requires an anaerobic environment, denitrifying bacteria, and sufficient and reactive electron donating species. Numerous researchers show that the availability of electron donors within aquifer sediments limits the denitrification are organic carbon, sulfide (usually as pyrite), and ferrous iron. Reduced manganese may also contribute to denitrification, but it has never been shown to be a significant electron donor for denitrification in an aquifer. Tedros and his adviser, Dr. Scott Korom use the PHREEQC model to gain a more comprehensive understanding of the hydrogeochemical environment that governs denitrification by ferrous iron and associated aquifer reactions.

Fellow Jennifer Newbrey



The recent spread of West Nile Virus into the state has produced a need for research to study the influence of the virus on wetland wildlife in North Dakota. Because stagnant water in wetlands is ideal breeding habitat for mosquitoes, wildlife associated with these habitats may suffer high rates of WNV infection. Most research on the virus has focused on using carcasses of birds as a surveillance system for detecting the spread of WNV across North America. No published research has been conducted on a living population of free-ranging wildlife may lead to diminished geographic distributions and population declines. The specific objectives Jennifer's project are to identify the prevalence of WNV in a free-living population of yellow-headed blackbirds, to quantify variation in immune function of female blackbirds, and to measure the relationship between female immune function and age on carotenoid allocation to eggs. Dr. Wendy Reed is Jennifer's adviser. This study will provide essential information on the prevalence of WNV in a North American avian species.

Fellow Brajesh Gautam



A 2002 study to estimate the Total Maximum Daily Load (TMDL) for the Fargo-Moorhead reach of the Red River identified fecal coliform is mainly being discharged from the urban area. The stormwater sampling and initial data showed a high BOD, fecal coliform and turbidity in storm runoff. The objective of Brajesh's study was to get a better understanding of urban runoff pollution to assist the source assessment and linkage analysis elements of the Red River TMDL development project. The approach adopted was a combination of stormwater runoff sampling and computer modeling. A calibrated SWMM model was used for simulation and for calculation of total volume and total load of fecal coliform and TSS from all the Fargo-Moorhead drainage areas. In addition, the SWMM model was also used as a tool to analyze the impact of Sanitary Sewer Bypass on the Red River fecal coliform concentration and to calculate the critical conditions for high fecal coliform concentration in the Red River. Brajesh's adviser is Dr. Wei Lin.

Fellow Dan McEwen



Successful implementation of management programs call for an understanding of the kinds of environmental characteristics that are amenable to the production of desired fish species. While many environmental factors contribute to the structuring of fish communities, the role of food quality in terms of benthic invertebrate stoichiometric constraints is not known but may be significant. In this research, Dan addresses questions relating to benthic invertebrate food quality that affect fisheries community structuring by determining stoichiometric values for common North Dakota and Minnesota benthic invertebrates at a fine taxonomic resolution. Dan and his adviser, Dr. Malcolm Butler, explore how the structure of different macrobenthic communities may constrain fish communities or growth rates by relating their data to lake surveys of fishes. Results could have significant management implications for determining how much effort needs to be put into the management of lakes for particular fish communities. For example, stocking or habitat creation in lakes where nutrient regimes are not supportive of particular fish communities could be avoided, and resources could be directed toward more suitable environments.

Fellow Christina Melaas (Hargiss)

Since the implementation of the Clean Water Act in 1972 (Public Law 92-500) there has been increased effort to restore and maintain our nation's wetlands. Legislation since this Act, accompanied with a wide range of land uses within the Prairie Pothole Region (PPR), has resulted in the EPA and other government agencies trying to answer the question of how to assess the health of a wetland. Efforts were made by the Natural Resources Conservation Service (NRCS) and the US Army Corps of Engineers (COE) to answer this question when they created the Hydrogeomorphic (HGM) Model for wetland functional assessment. Another attempt to answer this question was through the creation of the Index of Biological Integrity (IBI) for biological assessment. This was a joint venture of the EPA and several state agencies. In this study, Christina investigates the applicability of an IBI that was developed in an earlier study for other ecoregions of the PPR and whether it is reliable through major climatic disturbances such as droughts. Christina found this IBI, termed the Index of Plant Community Integrity (IPCI), an effective tool for evaluating the health of wetland plant communities in the NGP and NWGP of North Dakota, South Dakota, and Montana. The IPCI can be used to provide baseline data by private landowners, agencies, and land managers. Also, the IPCI can be used in restoration efforts to monitor change year to year. The IPCI can also be used in reclaimed areas and for mitigation purposes. Dr. Donald Kirby is Christina's adviser.

Fellow Ali Tackett

The geologic history and abundant potential study sites of the upper Midwest provide a unique opportunity for the assessment of spatial genetic diversity. Ali's study of this problem on the Johnny Darter, *Etheostoma nigrum* (Rafinesque), with its large range and abundant populations, will answer phylogeographic questions about North Dakota and Minnesota. In this study, the genetic diversity of *E. nigrum* will be examined by using microsatellite PCR primers designed initially for other species of *Etheostoma* and recently optimized for *E. nigrum*. The results of this study will provide not only the inferred gene flow among the darters but will also provide a baseline against which to evaluate gene flow for other fish species located in the same water bodies. For instance, many game fish are stocked and transferred within and among watersheds with no genetic monitoring. By studying a benthic fish with a small home range, it will be possible to uncover the phylogeographic structure among the various watersheds of the upper Midwest. In turn, such information can be used by managers for conserving genetic diversity within and among watersheds. Dr. Craig Stockwell is Ali's adviser.

Fellow Kendall Goltz

To ensure programs such as Small Wetland Acquisition Program of the United States Fish and Wildlife Service (USFWS) and the Wetlands Reserve Program (WRP), and the Natural Resource Conservation Service (NRCS) are effective in encouraging landowners to place wetlands under easement while minimizing the expenditure of public funds, it is necessary that the impact of both wetlands and wetland easements on land values be fully understood. Kendall will develop a methodology for agricultural land appraisals upon which the value of easement to offer a landowner and the ranking of potential wetland sites for restoration, conservation, or acquisition can be based. It is important to understand the implicit prices of wetlands and wetland easements to landowners so that a better prediction can be made of landowner willingness to restore, conserve, or degrade specific wetlands; and fair market levels of compensation to landowners can be calculated. Kendall's adviser is Dr. Jay Leitch.

Fellow William Lenarz

Bill's research traces the evolution of groundwater geochemistry back to its source from the large seepage face at Pigeon Point, Ransom County, North Dakota where infiltrating precipitation discharges. Previous work delineated pathlines and the capture zone in the groundwater flow system, which extends several kilometers upgradient. The contrasting land cover within the spring and seep capture zone consists of dunes, native grass pasture, wetland, irrigated cropland that lie above the phreatic Sheyenne delta aquifer. Previous work revealed that the seepage face shows a wide variation in mineralization and oxidation-reduction conditions, with strikingly more reduced and mineralized water discharging from higher areas indicating a shorter groundwater pathline. In this study Bill hypothesizes that the groundwater quality relates to vadose and shallow phreatic geochemical processes, which are largely controlled by differences in soils and land cover, and that water composition remains generally unchanged along deeper path lines. Results will provide a conceptual model on how groundwater composition evolves within this shallow aquifer flow system. The model will be used to explain the unusual variation of water quality at the seepage face and help predict changes in water quality following alteration of land cover. Dr. Phil Gerla is Bill's adviser.

USGS/NIWR National Competitive Program Projects

2005-08

Title: Assessing the Effectiveness of Local Water Institutions in Water Management

PI: Robert Hearne



A variety of formal and informal local institutions are involved with water resources management in rural areas. These include governmental institutions such as county water resources boards, watershed districts, soil and water conservation districts, and nongovernmental environmental and recreational interest groups. These institutions have different objectives, legal status, and affiliations with state and local governments. Research is needed to assess the roles and effectiveness of local water institutions. The research will contribute to a better understanding of the processes of public participation in natural resource management by identifying the types of institutions that are truly representative of local constituencies, well-funded, and have low institutional costs. In this research, Dr. Robert Hearne will study and assess the effectiveness of local water institutions to improve local management of water resources by providing policy makers and agencies with an improved understanding of the characteristics of

successful local institutions. This research will focus on the Red River of the North basin in Minnesota and North Dakota although some assessment of Manitobas institutions will be included. By identifying the attributes of local institutions that effectively achieve their own goals and/or further goals of water quality maintenance, this research will: 1) ascertain whether existing institutional frameworks should be adapted to meet evolving needs or new institutions should be developed to address emerging issues such as water quality monitoring and enforcement; 2) support local institutions by identifying key characteristics that facilitate effectiveness; 3) assess the benefits and costs associated with having water resource institutions defined along county lines as opposed to watershed lines; 4) support the development of extension and education programs that strengthen local institutions by specifically addressing key characteristics of effectiveness; and 5) help policy makers in the design strategies to monitor and enforce nonpoint source pollution abatement initiatives. Based upon this research and subsequent reviews and comments, recommendations will be made to political leaders and lawmakers, agency officials, and local stakeholders.

In the first year of the project, a review of water management organizations and institutions has been completed and a population of watershed and water districts and conservation districts identified. Current activities are focused on developing a set of criteria and indicators for effective public water management organizations. These criteria and indicators will be used to develop a survey instrument. Surveys of organization managers, local informed stakeholders, and board members will be conducted in August 2006. Craig Kritsky, an MS student in NDSU's Agribusiness and Applied Economics program, is assisting Dr. Hearne on the project.

2006-09

Title: Collaborative Research on *In Situ* Denitrification and Glyphosate Transformation in Ground Water: NAWQA Eastern Iowa Basins Study Unit

PI: Scott Korom



Contamination of ground water by nitrate and pesticides is widespread in some areas of the country and can threaten drinking water supplies. It is well known that the most important removal mechanism of nitrate and most pesticides from ground water is biodegradation, but the *in situ* transformation rates are largely unknown. In this study, two 180-L stainless steel chambers forming *in situ* mesocosms (ISMs) of aquifer sediments will be installed below the water table at the NAWQA agricultural chemicals study sites in the glaciated part of Iowa. This work will extend the use of this technique to examine denitrification in an area characterized by high dissolved iron concentrations and to measure the transformation rate of the extensively-used herbicide, glyphosate. The objectives for the research are:

1. Measure the denitrification and glyphosate transformation rates in the two ISMs.
2. Determine whether the denitrification is better fit by zero-order or first-order reaction rates.
3. Determine what donors are contributing electrons for the denitrification and their relative amounts.
4. Incorporate the results of the two ISMs into the existing databank of nine other ISM sites in glacial outwash aquifers in the Upper Midwest.
5. Update the available data of the apparent isotopic enrichment factor for ^{15}N in nitrate versus denitrification rate among of ISM sites.
6. Update the nitrate vulnerability index and extrapolate the findings to similar, unmonitored agricultural and environmental settings.

(Continued from page 6)

Aquifer sediment samples will be collected from the Iowa site and analyzed for grain-size distributions, mineralogy, and major e^- donors (organic carbon, sulfide, and ferrous iron) to determine optimum locations for installation of the ISMs, provide insights on the types and heterogeneity of e^- donors at the site, and provide the e^- donor supply data at the Iowa site that can be compared to previous ISM studies in the Upper Midwest. After the ISM chambers are installed, they will be purged and then amended with nitrate and bromide, which serves as a tracer for nitrate. Any loss of nitrate beyond that explained by dilution of the bromide tracer is attributed to denitrification. The ISMs will be sampled over time (months) and the decreases in nitrate concentrations will be used to calculate rates of denitrification. Modeling of the evolution of the geochemistry in the ISMs will provide insights into what donors contributed electrons to the denitrification and their relative amounts. The field experiment will be repeated a second time; however, in addition to nitrate and bromide, glyphosate will be added. Denitrification information from the second test will provide insights into the variability of the results from the first test. More importantly, the attenuation and transformation of glyphosate (with the dominant metabolite, AMPA) will be studied in both the presence and absence of nitrate to determine the fate of glyphosate in oxidizing and reducing conditions. The results of this study will provide site-specific transformation rates for nitrate and glyphosate and extend the aquifer nitrate vulnerability index that was developed in earlier studies. This information is vital for the development of tools and quantitative methods to characterize the transport and fate of agricultural chemicals in the Eastern Iowa Basins Study Unit, the Upper Midwest, and beyond.

Featured Institute Researchers

Jay Leitch



Dr. Jay A. Leitch is a professor in the School of Natural Resources and Emeritus Dean in the College of Business at North Dakota University. Jay received a BA with honors from Minnesota State University-Moorhead, with a double major in political science and geography. He was the first MS degree recipient in natural resources management at North Dakota State University. He received a PhD in applied economics from the University of Minnesota-St. Paul. His formal education was geared toward both the socioeconomic and the natural resources management, with an emphasis on policy. Jay is a certified Professional Wetland Scientist, having spent about 1/3 of the past three decades working on some aspect of wetlands or water management. Another 1/3 of his effort has been in the area of outdoor recreation and economic development. The final 1/3 of his effort has been in public finance. Much of his work in each of these three broad areas has centered around human interactions with water, from wetland mitigation, to water-based recreation, to financing large-scale public works projects.

Dr. Leitch started his NDSU career in the Department of Agricultural Economics, where he was instrumental in initiating and growing academic programs in natural resources management. He later shifted to administration and spent eight years as dean of the College of Business. He has returned to a half-time faculty position in the School of Natural Resources where he teaches NRM courses and advises BS, MS, and PhD students. His graduate students are currently working on the effects of public policy on rural land values, understanding recreational uses of the Red River of the North, and the role of communications in natural resources management policymaking.

Dr. Leitch has augmented his campus experiences with time spent working as a scientific advisor in Washington, DC, for the Secretaries of the Army, Interior, and Navy. He has traveled extensively, working on natural resources management issues from titanium mining in South Africa, to reverse draining in Hungary, to management of Alaska's North Slope, to water management in central America, to the Three Gorges Dam in China.

Jay is a retired Naval Intelligence Officer, a current Coast Guard license holder to captain watercraft up to 50 tons, and the author of a regionally popular book on ice fishing. He and his wife, Becky, who teaches economics at NDSU, and their two children, Forrest and Rachel, live along the Red River north of Moorhead, Minnesota.



Scott Korom



Dr. Scott F. Korom is an Associate Professor in the Department of Geology and Geological Engineering at the University of North Dakota. He came to UND in 1994 after a two-year postdoctoral research position in groundwater contaminant transport with the Department of Energy at the Savannah River Site in Aiken, South Carolina. He received B.S. and M.S. degrees in Civil Engineering from the University of Akron and a Ph.D. in Civil & Environmental Engineering from Utah State University in 1992.

Korom teaches classes in hydrogeology, groundwater remediation, groundwater modeling, contaminant hydrogeology, and water sampling and analysis. His research interests include water resources, hydraulics of wells, contaminant transport, and groundwater remediation. Remediation of nitrate via aquifer denitrification has been the focus of his and his students' involvement with the North Dakota Water Resources Research Institute (NDWRRRI). The following students of Dr. Korom have been NDWRRRI fellows:

1. Allen J. Schlag (M.S., 1999, Geology) studied in-situ denitrification at the Larimore site in the Elk Valley aquifer.
2. Paul A. Skubinna (M.S., 2004, Geology) modeled the geochemistry of the denitrification at the Larimore site in the Elk Valley aquifer.
3. Eben J. Spencer (M.S., 2005, Environmental Engineering) studied denitrification in the Karlsruhe aquifer.
4. Tedros Tesfay (Ph.D., in progress, Geology) is studying the importance of ferrous iron as an electron donor for denitrification in regional aquifers.
5. Ryan Klapperich (M.S., in progress, Geology) is studying the supply of electron donors in bedrock formations and members underlying aquifers in eastern North Dakota.

As a result of the retreat of the last Wisconsinan icesheet about 12,000 years ago, the aquifers in our region are among the youngest in the U.S. Furthermore, some aquifer sediments are derived from bedrock members of the Pierre shale that are rich in electron donors – reactive substances such as organic carbon, inorganic sulfide (mainly as FeS_2), and ferrous iron that bacteria use to reduce nitrate to nitrogen gas. The goal of the UND denitrification research group is to develop an aquifer nitrate vulnerability index based on the supply and types of electron donors in the aquifer sediments. Based on our research to date, the index has been initiated, but developing it to further refine its predictive capabilities is an on-going process. The index is for aquifer denitrification in North Dakota and the surrounding region, but our insights into aquifer denitrification should be applicable world-wide.

Korom and his students work closely with the ND Department of Health (NDDH) and the ND State Water Commission (NDSWC). Support from NDDH, NDSWC, and USGS through the NDWRRRI is gratefully acknowledged.

Malcolm (Mac) Butler

Dr. Malcolm (Mac) Butler is a professor in the Department of Biological Sciences at NDSU, where he teaches classes in invertebrate



zoology, aquatic community ecology, and limnology. Limnology is a synthetic discipline integrating the physics, chemistry, and biology of inland waters; its biological aspects many involve microbes, protists, plants, and animals. Historically, the field of limnology developed in zoology departments as zoologists interested in a specific group of aquatic animals sought to understand relationships between their favorite animals and physical, chemical, and biological features of aquatic habitats. Butler's predecessor in the former Zoology Department at NDSU was Dr. Gabe Comita, a limnologist who taught invertebrate zoology and limnology for over 30 years, while conducting research on the taxonomy of freshwater copepods and the role played by these planktonic crustaceans in lake ecosystems.

Mac Butler has continued this zoological/limnological tradition at NDSU since 1981. However, instead of copepods, Mac focused on the aquatic larvae of flies in the family Chironomidae. Mac became familiar with this important group of aquatic animals while working in the Laurentian Great Lakes during his first years of graduate school at the University of Michigan. In 1975, Mac joined a team of limnologists working in northern Alaska, where chironomids are the predominant macroinvertebrates in ponds and lakes. Coincidentally, Butler's predecessor Comita had studied copepods at the same arctic laboratory near Barrow, Alaska in the early 1950s.

Chironomids are ubiquitous aquatic organisms, occurring in virtually all freshwaters and even a few marine habitats, from the tropics to the polar regions. Larvae of some species are adapted to very low oxygen levels, and can live in organic-rich sediments of eutrophic lakes, while other species have much stricter ecological indicators of environmental conditions in streams and waterbodies— if one can distinguish the many species and genera within this fly family. Chironomids are also major players in aquatic food webs, transferring energy and nutrients from plants and detritus to consumers like fish and birds. Chironomids could be seen as the “ants” of the aquatic

(Continued from page 8)

world, in terms of their ubiquity, abundance, and functional importance.

During his arctic studies, Mac recognized the need for better taxonomic knowledge of chironomids in the Nearctic, where this insect family was poorly studied relative to Europe and Russia. In 1980, Butler received a NATO Postdoctoral Fellowship to study with leading chironomid systematists in Germany. Mac continues to collaborate on systematic studies of the genus *Chironomus*, with colleagues he met during and since that postdoctoral year.

Butler's research has expanded across a wide range of aquatic habitats since he arrived at NDSU 25 years ago. New opportunities for regional aquatic research have driven some of this diversification, and much has resulted from the interests of graduate students. Several projects have focused on the benthic community of deeper lakes, where chironomids and other benthic invertebrates are important ecological players and useful biological indicators of eutrophication and other lake characteristics. In the most recent biomonitoring study, benthic communities of three large lakes in Voyageurs National Park were sampled for two years to assess recent changes in water-level management. Other studies have focused on broader ecosystem dynamics in shallow lakes and wetlands. In these studies, chironomids, although virtually always present, have played minor roles in the research. One long-term study has involved monitoring a large but shallow Minnesota lake (Lk Christina) that is managed as waterfowl habitat. Collaboration with state and federal agencies has produced a 21-year data set on the limnological dynamics of this lake, which has been subjected to three large-scale fish eradications in the past half-century.

Several of Butler's former students continue to collaborate with NDSU, and help provide opportunities for new graduate students. Mark Hanson received his Ph.D from NDSU in 1990 after working on Lake Christina, and has been a research biologist with the MN DNR for 15 years. Mac and Mark have co-advised a series of students studying aquatic ecology in regional wetlands, both on the prairie and in forested areas of northern Minnesota. Another doctoral student, Kyle Zimmer, documented strong effects of minnow populations on diverse characteristics of prairie pothole wetlands. Zimmer now teaches at the University of St Thomas in St. Paul, and has joined with Butler and Hanson in advising a current NDSU graduate student participating in a 75 basin, landscape-scale study organized by the MN DNR to look more closely at fish effects on prairie wetlands. Nicky Hansel-Welch, another student who worked on Lk Christina in the mid 1990s is now the leader of the Minnesota DNR's Shallow Lakes Program. Nicky organized the 2003 biomanipulation treatment of Lake Christina, in the latest effort to restore water clarity and macrophyte beds to this waterfowl lake.

Recently Mac's research interests have spilled over into flowing waters. One current student is studying mayflies in the Straight River, a trout stream 80 miles east of Fargo. This summer, Mac and a new doctoral student will begin an exploratory study of macroinvertebrate communities in the Red River. Little is known about the nature and ecological roles of invertebrates in this river, despite growing interest at state, national and international levels in developing biological criteria for monitoring water quality. Mac is also contemplating a return to the northern Alaskan tundra, to look into opportunities for studying effects of climate change on the arctic chironomids he began to study 31 years ago this June.



Phil Gerla



Dr. Philip J. Gerla is an associate professor of geology and geological engineering at the University of North Dakota, where he teaches courses in hydrology and environmental geology. After receiving a Ph.D. degree in hydrogeology at the University of Arizona, Phil held teaching positions in Ohio and Wisconsin, and worked as an environmental consultant in Milwaukee before coming to UND in 1988. He has published peer-reviewed research papers, book reviews, and various reports that cover a diversity of hydrological topics such as the effects of land use on stream flow, changes in water quality following fire, groundwater-surface water modeling, fish ecology, and stream-hyporheic zone interaction. During the last four years, Phil has worked as a contractor and now a part-time prairie hydrologist for The Nature Conservancy. As a collaborator with The Nature Conservancy, he recently helped to complete the Northern Tallgrass Prairie Eco-

region Stream and River Conservation Portfolio and the Glacial Ridge Restoration Master Plan. These reports will guide future conservation efforts by The Nature Conservancy to protect aquatic biodiversity in the Red River region and enhance wetland and prairie restoration within the 25,000-acre Glacial Ridge National Wildlife Refuge, the nation's newest federal wildlife sanctuary. His current research activities include assessing the effect that conversion of cropland to native prairie has on peak runoff, impact of climate change on regional hydrology, and the relationship of vadose infiltration on groundwater geochemistry.

Eakalak Khan



Dr. Eakalak Khan is an Associate Professor of Civil Engineering at North Dakota State University. He received his Bachelor degree in Environmental Engineering from Chiang Mai University, Thailand in 1990. His M.S. degrees are in Agricultural Engineering and Civil Engineering from University of Hawaii in 1993 and University of California, Los Angeles (UCLA) in 1994, respectively. He obtained his Ph.D. in Civil Engineering from UCLA in 1997. In 1998, he was a Postdoctoral Research Associate at the Institute of Environment, UCLA. Prior to joining North Dakota State University, from January 1999 to May 2002, he was an Assistant Professor in the Department of Civil Engineering, Polytechnic University, Brooklyn, New York.

Dr. Khan has three areas of research interests: 1) Biological process development for water and wastewater treatment, 2) Removal of hazardous chemicals from water and wastewater, and 3) Stormwater and non-point source pollution control. He is currently working on a project funded by National Science Foundation on fundamentals of cell entrapment for water pollution control. The goal of this research is to advance a foundational understanding on the use of cell entrapment in wastewater treatment. The effects of cell entrapment on growth rate, metabolic activity, cell morphology, cell surface properties, genetic material quantity and stress of bacteria cultures encountered in activated sludge are investigated. Techniques in molecular biology and nanotechnology are used to determine what lies beneath the performance of entrapped cells.

Dr. Khan has two on-going projects on the applications of cell entrapment and/or bioaugmentation for water pollution control. One of the two projects is funded by the North Dakota Water Resources Research Institute. It involves the use of cell entrapment process for removing high-level nitrogen in supernatant from anaerobic digesters. Applications of cell entrapment for water pollution control have been mostly on low strength wastewater. The high cell density property of entrapped cell systems has not been taken an advantage of; Entrapped cell systems should be effective for high strength wastewater due to high number of cells available to biologically transform target contaminants. The other project funded by the Thai Commission of Higher Education investigates the use of entrapped cells for bioaugmentation, in particular for removing a herbicide, atrazine, from agricultural infiltrate. The benefit of bioaugmentation with entrapped cells is the ability to retrieve the augmented cells for reactivation.

Another current research project of Dr. Khan deals with filamentous growth in entrapped cell system treating domestic wastewater. Filamentous growth in activated sludge process treating municipal wastewater is a common problem that has been thoroughly studied. However, the susceptibility of entrapped cell systems, which can also be used effectively for wastewater treatment, is unknown. This research investigates the characteristics of filamentous growth in the entrapped cell system. Dominant filamentous types and severity in the system and their effective control method are examined.

Dr. Khan is affiliated with American Society of Civil Engineers, American Water Work Association, Association of Environmental Engineering and Science Professors, International Water Association, and Water Environment Federation. He has served on several professional organization committees and panels. Some of his honors and awards include 1) Researcher of the Year, 2005, College of Engineering and Architecture, North Dakota State University, 2) CAREER Award, National Science Foundation, 2005, 3) Journal of Environmental Engineering Editor's Award for outstanding reviews, 2002, and 4) Outstanding Teaching Award, Polytechnic Student Chapters of American Society of Civil Engineers and National Society of Professional Engineers, 1999.

Recent Publications by the Institute, Fellows and Faculty

Phillips, R.L., O. Beeri, and **E.S. DeKeyser**. 2005. Remote wetland assessment for Missouri Coteau prairie glacial basins. *Wetlands*. Vol. 25(2) pp. 335-349.

J. R. Williams, W. L. Harman, M. Magre, **U. Kizil**, J. A. Lindley, **G. Padmanabhan**, and E. Wang. 2006. APEX Feedlot Water Quality Simulation, *Transactions of American Society of Agricultural and Biological Engineers*, Vol. 49(1): 69-73.

U. Kizil, **J. A. Lindley**, and **G. Padmanabhan**. 2006. Verification of Nutrient Transport Modelling of a Bison Feedlot, *Biosystems Engineering*, Vol. 94 (3): 453-460.

Newbrey, M. G., M.V.H. Wilson, and **A.C. Ashworth**. 2005. Growth characteristics of Cretaceous and Cenozoic North American Esociformes: Implications for systematics. In *Fourth International Meeting on Mesozoic Fishes - Systematics, Homology, and Nomenclature, Extended Abstracts*; edited by F.J. Poyato-Ariza; Madrid, Servicio de Publicaciones de la Universidad Autónoma de Madrid / UAM Ediciones. pp. 201-204.

Trent A. Museus, **Eakalak Khan**. A Study of Microbial Regrowth Potential of Water In Fargo, North Dakota and Moorhead, Minnesota. Technical Report No: ND06-01, **North Dakota Water Resources Research Institute**, 2006

Christina L. M. Hargiss, **Edward S. DeKeyser**, **Donald R. Kirby**. Evaluation of an Index of Plant Community Integrity for Assessing Wetland Plant Communities In the Prairie Pothole Region. Technical Report No: ND06-02, **North Dakota Water Resources Research Institute**, 2006

Up Coming Conference

The North Dakota Water Resources Research Institute (NDWRRI) works closely with the International Water Institute located in Fargo, North Dakota and provides a forum for research, public education, training, and information dissemination relating to flood damage reduction and natural resource protection and enhancement in the Red River Basin. The IWI draws on the experience and talents of resource professionals throughout the Red River Basin and assemble a basin-wide network of professionals at education institutions in Minnesota, North Dakota, South Dakota, and Manitoba. The Institute established an International Management Board in 2001 that was charged with the provision of oversight to the Red River Center for Watershed Education and the Center for Flood Damage and Natural Resource. The Institute has an administrative framework with Tri-College University, a collaborative effort between North Dakota State University, Concordia College and University of Minnesota Moorhead that preserves the Institute's International mandate and basin wide scope. The IWI, in partnership with NDSU, hosts an internet-based decision support system, Red River Basin Decision Information Network (RRBDIN) which provides a one-stop portal to information about water management within the basin including databases, references, technical tools, communication tools and GIS data. The IWI holds biennial conferences on watershed related themes and has issued a call for proposal for the 2007 conference. NDWRRI has traditionally participated in these conferences and intends to do so in the 2007 conference as well. Find below a call for papers for the conference.

CALL FOR PAPERS

Third International Water Conference

"Research and Education in an international Watershed: Implications for Decision-Making"
&
Red River Basin River Watch Forum "Youth Perspective on Local Water Quality"

MARCH 13-15, 2007 GRAND FORKS, ND

Abstract Deadline: November 1, 2006

Abstract Submission

The international Water Institute invites submission for podium and poster presentations that fall under the major conference theme. Both types of presentations require an abstract. For details, please visit WWW.INTERNATIONALWATERINSTITUTE.ORG . Please meet the abstract deadline to allow pre-publication of abstracts. An abstract form may be downloaded from Mail a copy of the abstract and a resume on CD to the following address:

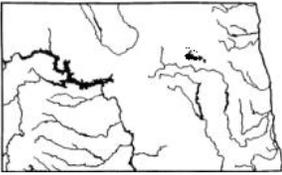
International Water Institute
1805 Research Park Drive 2
Fargo, ND 58102

Authors are expected to supply a CD copy of their final presentation version no later then March 1st, 2007 for inclusion in the conference.

Conference Topics

- Methods of flood damage reduction/mitigation
- The role of wetlands in water management
- Flooding impacts on communities
- Assessing flooding costs
- Land use impacts on water management and natural resources
- Socio-economic impact and sustainability
- Science in policy-making
- Water quality
- Watershed education and research initiatives
- Community & K-12 watershed resources
- Ecological restoration and management
- Ecosystem services provided by rivers
- Sources and ecological effects of nutrients, sediments, and agricultural chemicals
- Invasive species
- Recreational use of rivers
- Climate change and water management

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Site Sampled by Ali Tackett on Fish
Hook River, Minnesota



E. nigrum taken from Lake Ida,
Minnesota Spring 2005



Ali Tackett and Dr. Craig Stockwell
on Mississippi River

North Dakota Water Resources Research Institute (NDWRI)

The Institute was founded in 1965 by authority of Congress as one of the 54 Institutes throughout the nation and is administered through the United States Geological Survey. The NDWRI receives funding through section 104 of the *Water Resources Research Act of 1984* and it applies its Federal allotment funds to research that fosters: A) the entry of new research scientists into the water resources field, B) training and education of future water resources scientists, engineers, and technicians; C) the preliminary exploration of new ideas that address water problems or expand understanding of water and water-related phenomena; and D) the dissemination of research results to water managers and the public.
