North Dakota Water Resources Research Institute

North Dakota State University
University of North Dakota

Website: www.ce.ndsu.nodak.edu/wrri

January 2004

NEWSLETTER

From the Director

Welcome to the 2004-issue of the North Dakota Water Resources Research Institute newsletter. The 2003 fellowship research and activities of the Institute are highlighted. I encourage you to visit the Institute website, www.ce.ndsu.nodak.edu/wrri, for details. As in the past few years, again this year, the Institute continued to meet its mission by dedicating most of the Federal allotment funds toward competitive graduate student research fellowships. The faculty advisors provide matching or co-funding for the research through the university, or grants from local, county, state or federal agencies, foundations, or industry. In recent years, Delta Waterfowl Foundation, MN DNR - both the Wildlife and Fisheries Divisions, MN Pollution Control Agency, MN Agriculture Department, Institute for Wetland and Waterfowl Research, USDA Forest Service – North Central Research Station, ND Health Department, ND State Water Commission, ND Rural Water Systems Association, ND EPSCoR, Fargo and Moorhead Water and Waste water treatment plants, and the USGS have supported the Fellowship projects either through co-funding or in-kind support. The Institute advisory committee consisting of representation from the three water agencies – the State Health Department, the State Water Commission, and the U.S. Geological Survey – provided valuable help in setting Institute's research priorities and reviewing Fellowship applications. Also this year, the Institute co-sponsored an international conference on water with the Red River Basin Institute, Fargo, ND and a biotic resources seminar program with the Department of Biological Sciences, North Dakota State University. The Institute-affiliated faculty and students working in water-related research were encouraged to participate in these events.

The Institute found a new home this year in Engr.108, NDSU College of Engineering and Architecture. We can be reached at NDWRRI, Box 5285, Fargo, North Dakota 58105-5285 or at (701) 231-8342 or via e-mail at g.padmanabhan@ndsu.nodak.edu.

G. Padmanabhan, Director
North Dakota Water Resources Research Institute

Highlights of 2003 Institute Fellowship Research

Chris Laveau is working toward a M.S. degree in Geology with an emphasis in the area of hydrogeology at University of North Dakota. His advisor is Phil Gerla, Professor of Geological Engineering. Funding from the Water Resource Research Institute was used to support his thesis work on modeling the spatial and temporal distribution of prairie wetlands. His work experience included a student appointment to the Water Resource Division of the United States Geological Survey in Grand Forks.

Direct precipitation and spring runoff from snowmelt are the major sources of water supply for prairie potholes, while evapotranspiration is the major cause of water loss. With more water leaving than entering from the atmosphere the persistence of a prairie pothole in the landscape is directly related to its groundwater budget. An understanding of groundwater dynamics has important applications in predicting the spatial and temporal distribution of wetlands. Chris uses spatial datasets and groundwater modeling to explain the distribution and persistence of wetlands within the upper Turtle River drainage basin in Grand Forks and Nelson counties, North Dakota. Gerla had used an estimation technique combining the use of digital elevation models with numerical modeling. Chris is carrying this initial research forward. The model has been redesigned to incorporate the heterogeneity of hydraulic conductivity. The model output on groundwater conditions is being quantitatively compared to field data. He hopes to develop a groundwater model with input parameters derived from readily available spatial datasets.

Trent Museus is working on his M.S. degree in environmental engineering at NDSU. His thesis research is on microbial regrowth potential in Fargo,ND and Moorhead, MN treated water. His advisor is Eakalak Khan, Assistant Professor in Civil Engineering. Trent monitors the biodegradable dissolved organic carbon (BDOC) and assimilable organic carbon (AOC) in the Fargo and Moorhead water treatment plants and the distribution systems. The plants are sampled once every other week for one year. The samples are taken from all of the processes of each plant from raw water to finished water and three points along the distribution system. The points along the distribution system are selected based upon the estimated amount of hydraulic residence time that the water is in the system. BDOC and AOC are important because they represent the amount of natural organic matter (NOM) that can be utilized for microbial growth. The growth of microorganisms in the water supply system can have many negative effects, such as taste and odor problems, reduced hydraulic capacity, pipe corrosion, and adverse human health impact. In his research, effect of seasonal variations on the parameters is investigated for the type of climate that the cities of Fargo and Moorhead experience.

Jennifer Newbrey is a Ph.D student working under the guidance of Wendy Reed, Assistant Professor of Zoology, NDSU. Her research focuses on the effects of female age and infection with West Nile Virus on yellow-headed blackbird reproduction. Recent high water levels in the Missouri Coteau region of North Dakota have resulted in increased aquatic habitats for wetland breeding birds and mosquitoes. Because birds often serve as intermediate hosts for the mosquito borne West Nile virus (WNV), increased populations of birds and mosquitoes could impact the ecology, rate of emergence, and persistence of the disease in humans and wildlife. The recent arrival of WNV into the state necessitates a study of the prevalence and immunological impact of WNV on native North Dakota wetland species. 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 birds to determine the non-lethal effects of the virus. Failure of biologists to adequately address disease emergence in free-ranging wildlife may lead to diminished geographic distributions and population declines. The Missouri Coteau region of central North Dakota has many small prairie wetlands, which provide essential foraging and breeding habitat for many species of birds. Yellow-headed blackbirds (*Xanthocephalus xanthocephalus*) are an ideal species to study WNV infection because they breed in high-density wetland colonies throughout the Coteau. Establishing rates of WNV infection in yellow-headed blackbirds is necessary to determine the vulnerability of this wetland dwelling species and to predict potential impacts of the virus on other species of wetland birds.

Michael Newbrey is a Ph.D student in the department of Biological Sciences working under the guidance of Allan Ashworth, Professor of Geology, NDSU. The objectives of his study include: 1) examine the age and growth patterns of fossil freshwater amiids, hiodontids, esocids, and the percid, *Perca flavescens* from all fossil localities known to produce these taxa in North America; 2) investigate evolutionary and geographic patterns occurring in the geologic record to understand the effects of climate change on fish; 3) quantify patterns of growth of extant amiids, hiodontids, esocids, and the percid, *Perca flavescens* from a range of latitudes and mean annual air temperatures (MAT); 4) estimate MAT for selected parts of the geologic record from the Cretaceous to Recent; and 5) examine the relationship between plate tectonics and global climatic cooling on the interpretation of paleoclimatic indices. Ultimately, this research will help to understand how contemporary species respond to climate change. In addition and prior to this research, there has been only one paleoclimatic curve available for the continental record (non-marine), which is based on leaf margin analysis. Growth of fish in the fossil record will provide an alternative method and a means to check the accuracy of the leaf margin curve.

Kasi Murthy is a Ph.D student in the Civil Engineering department, NDSU. His advisor is Wei Lin, Associate Professor of Civil Engineering. Murthy continues his research on phosphorus transport through a wetland ecosystem. Preliminary field data collected in the summers of 2001 and 2002, suggested that phosphorus levels in water column in all wetlands and Lake Bisson are quite high. Water sample analysis revealed high levels of calcium and magnesium and that a previous study in Lake Bisson indicated the soils as calcareous. The pH of soil in Bisson Lake ranged between 7.5 and 8.0. Under high pH conditions apatite ($Ca_5(PO_4)_3OH$) is the solid phase that controls phosphate solubility. But apatite formation is hindered if high amounts of carbonates and magnesium are present. The other metal ions that control phosphorus availability in wetland water are iron and manganese. Results thus far indicate that phosphate solubility in Bisson Lake and Hass wetlands appear to be controlled by metal (calcium, iron, and manganese) ions' solid phases. Equilibrium equations for the metal ions' solid phases will be included in the model to identify the availability of orthophosphate under varying pH and redox conditions. Further sorption processes and biological uptake-release mechanisms need to be studied yet and a sampling procedure and a mass balance need to be developed.

Anthony Pothoff completed his M.S. degree in Zoology at NDSU in August 2003. His advisor was Malcolm Butler, Professor of Zoology. Anthony's research focused on the evaluation of walleye to suppress fathead minnow populations in type IV & V wetlands. The greater depth of many prairie wetlands resulting from consolidation of smaller, more ephemeral wetlands has caused a decrease in the frequency and extent of summer and winter anoxia. As a result, fathead minnows now persist on a more permanent basis, often reaching high population densities**,** which reduce zooplankton and macroinvertebrate diversity and abundance. Reductions in zooplankton in turn lead to increased phytoplankton**,** decreased water clarity**,** reduced macrophyte abundance, and ultimately decreased waterfowl use. Effective ways to control fathead minnow populations in Prairie Pothole Region wetlands are needed by wetland managers. A two-year study to assess walleye stocking as a tool to suppress fathead minnow populations and improve water quality was designed. Treatments consisted of 6 wetlands stocked with age-0 walleyes, 6 wetlands stocked with adult walleyes, and 6 wetlands that were left unmanipulated (contained only fathead minnows). The biomanipulation was ineffective in the advanced walleye treatment, as these wetlands did not differ significantly from the control wetlands. In both 2001 and 2002, the walleye fry treatment had significantly lower densities of fathead minnows and significantly higher densities of cladocerans. Macroinvertebrate populations in 2001 did not differ significantly but in 2002 some macroinvertebrate groups were significantly higher in the walleye fry treatment sites. Chlorophyll a and turbidity decreased significantly in 2002 in the walleye fry treatment. These results indicated the biomanipulation was successful in suppressing fathead minnow populations, creating a trophic cascade which improved water quality in the walleye fry treatment wetlands.

Tedros Tesfay is working toward his Ph.D under the guidance of Scott Korom, Professor of Geology, UND. His research focus is to understand the hydrogeochemical environment that governs denitrification and other associated aquifer reactions, particularly with respect to the involvement of ferrous iron and to develop computer models of denitrification in aquifers. In total, over half a million dollars in funding and in-kind matches has been provided thus far for this research involving nine sites in North Dakota and Minnesota. Preliminary interpretation of all the completed tracer tests has been done. Aquifer sediment samples of all the sites and much of the physical and geochemical analyses of the sediment samples are done. Of particular note are the preliminary results of the analyses of the iron coating the surface of the sediments. The surface component is the most reactive fraction of the total ferrous iron in the sediments. Organic carbon appears to be the major electron donor for denitrification at the Perham2 site. The denitrification at the Akeley and Robinson sites could not be explained by either organic carbon or sulfide; the hypothesis is that ferrous iron is the electron donor. Preliminary analyses indicate that both of these sites have relatively high concentrations of reactive ferrous iron (3.5 times that of the Perham2 site), which supports the hypothesis. The Larimore site has even more ferrous iron, but it also has higher concentrations of organic carbon and sulfides, which may be used preferentially before the ferrous iron as an electron donor for denitrification. In this project PHREEQC computer model will be used to couple the regulating geochemical factors involved in the denitrification at the various in situ mesocosms (ISM) sites.

2004 Institute Fellows Announced

- **Brajesh Gautam** (M.S program, Civil Engineering, NDSU). **Analysis and Model Simulation of Stormwater Runoff**; advisor, Wei Lin, Civil Engineering, NDSU.
- **Brent Hanson** (M.S program, Civil Engineering, NDSU). **Reliable and Continuous Measurement of Flow Rate in the Red River of the North by means of an Acoustic Doppler Velocity Meter**; advisor, Wei Lin, Civil Engineering, NDSU.
- **Trent Museus** (M.S program, Civil Engineering, NDSU). **A Study of Microbial Regrowth Potential of Water in Fargo, North Dakota and Moorhead, Minnesota**; advisor, Eakalak Khan, Civil Engineering, NDSU. (Renewal)
- **Jennifer Newbrey** (Ph.D. program, Zoology, NDSU). **Effects of West Nile Virus Infection, Immune Function, and Age on Female Yellow-headed Blackbird**; advisor, Wendy Reed, Biology, NDSU. (Renewal)
- **Michael Newbrey** (Ph.D. program, Geology, NDSU). **Comparative Study of Fossil and Extant Fish Growth: Including Analyses of Mean Annual Temperature in the Geologic Record**; advisor, Allan Ashworth, Geology, NDSU. (Renewal)
- **Lynne Seth** (M.S program, Civil Engineering, NDSU). **Sample Analysis, Kinetic Studies, and Modeling of a Full-Scale Moving Bed Biofilm Reactor for Ammonia Removal**; advisor, Wei Lin, Civil Engineering, NDSU.
- **James Spencer** (M.S program, Geology, UND). **Study of Denitrification in the Karlsruhe Aquifer Using Stable Isotopes of N and O in Nitrate**; advisor, Scott Korom, Geology, UND.
- **Tedros Tesfay** (Ph.D. program, Geology, UND). **Modeling Groundwater Denitrification by Ferrous Iron Using PHREEQC**; advisor, Scott Korom, Geology, UND. (Renewal)

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Conferences and Seminars

First Red River Basin International Conference on Water (April 23-24, 2003, Fargo, ND)

NDWRRI co-sponsored this conference with the main sponsor, the Red River Basin Institute, Fargo, ND. More than sixty papers were presented from Canada and the United States on the Red River basin water issues. About 350 participants from Minnesota and North Dakota; and from Manitoba, Canada attended the conference. Next conference is scheduled for January 2005.

NDSU Biotic Resources Seminar Program

NDWRRI continues to help support the NDSU Biotic Resources Seminar program. Under this multi-disciplinary program, visiting scientists are invited and hosted by faculty and graduate students from several departments in the Colleges of Agriculture and Science and Mathematics. Seminar topics range widely. Examples include the genetics and conservation of rare and endangered fish and aquatic invertebrates, human impacts on the biota of lakes, and wetland ecology. NDWRRI seed money had helped to leverage other support for this program from the NDSU Cooperative Sponsorship Committee, ND EPSCoR, and the colleges and departments of the hosts.

National Competitive Grant Program

The Request for Proposals for the FY 2004 National Competitive Grants Program authorized by section 104G of the Water Resources Research Act of 1984 has been released. The RFP may be obtained either by going to https://niwr.org/ and clicking on "View the RFP" under "National Competitive Grants Program" or by going directly to https://niwr.org/2004_104G_RFP. An abstract of the RFP has also been posted at http://water.usgs.gov/wrri/news.html. Funds have not been appropriated for this program. If an appropriation is received, the RFP will be revised accordingly. The closing date for proposals to be filed on the web site by principal investigators is 5:00 PM, Eastern Standard Time, March 1, 2004. The closing date for approvals of the applications by Institute Directors is 5:00 PM, Eastern Standard Time, March 12, 2004. It is highly competitive and the research should be of regional or national significance. As you know the proposals for this program need to be approved by the state Water Resources Research Institute. If you plan to submit one, please consult the director of the Institute.

North Dakota Water Resources Research Institute (NDWRRI)

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 NDWRRI 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. The NDWRRI continues to meet its mission by dedicating most of the Federal allotment funds toward competitive graduate student research fellowships. Each of the Fellowship is also a research project that will result in a master's thesis or doctoral dissertation. The faculty advisors find matching or co-funding for the research through the university, or grants from local, county, state or federal agencies, foundations, or industry. Also, the Institute co-sponsors seminars and conferences on water themes.