North Dakota Water Resources Research Institute

Annual Technical Report

FY 1998

Introduction

Research Program

INTRODUCTION

The North Dakota Water Resources Research Institute is one of 54 entities known collective-ly as the *National Institutes for Water Resources*. The Institutes were established by Congress (Water Resources Research Acts of 1964, 1972, 1984 and 1990) at the Land Grant University in each state, the District of Columbia, the Virgin Islands, Puerto Rico, and Guam/Federated States of Micronesia, and are administered by the United States Geological Survey. Each Institute conducts research, information transfer, and education on water resources. The bulk of the North Dakota Institute's resources are allocated to the research and education functions. Information transfer is done primarily through presentations and publications by grant and fellowship recipients, and an annual news-letter initiated in 1992.

Through actions of Congress during 1995, the federal core support for the Institute was reduced to $20,000 per year during FY 1996, 1997 and 1998. Remaining appropriated funds were placed in four regional competitive grant pools of $805,000 each. North Dakota was one of 13 states in the North Central Region. During 1996-1998, North Dakota had one regional project funded.

During FY 1996-1998, the North Dakota Institute dedicated more than half of the $20,000 federal allocation to continue its Graduate Student Summer Research Fellowships. The remaining funds were used to support the administrative activities required to conduct this program as well as the region-al competitive grants program, to support information transfer activities from past research projects, and to prepare an annual newsletter. In 1998-99, matching funds were provided by in-kind contributions from North Dakota State University (NDSU) and the Univer-sity of North Dakota. (UND), and by the Minnesota Department of Natural Resources specifically for project ND96-02. This report describes the activities of the ND WRRI during the period March 1998 to February 1999, including summaries of each graduate fellowship research project.

State Advisory Committee The State Advisory Committee has participated in the periodic formulation of water resources research priorities for the Institute and state of North Dakota, and in the evaluation of research proposals and projects. The committee membership is as follows.

- Gregg Wicke, U.S. Geological Survey, Water Resources Division, Bismarck, North Dakota
- Milton Lindvig, Director, Water Appropriation Division, ND State Water Commission, Bismarck, North Dakota
- Francis J. Schwindt, Chief, Environmental Health Section, ND State Health Department, Bismarck, North Dakota

In the absence of a federal appropriation to co-fund cooperative research on water resources problems of importance to the state, the State Advisory Committee was not active during FY 1996-1998. The USGS District Chief was specifically precluded (by USGS policy) from participat-ing in activities relating to the regional competitive grants program. However, with the reinstatement of the former state-based program, the State Advisory Committee was instrumental in formulating the FY 1999 Institute program (see below).

FY 1999 Graduate Student Research Fellows

Late in FY 1998, the current (March 1999-February 2000) Institute program was developed. For FY 1999, Congress removed the regional competition requirement and provided sufficient funding to restore the federal allotment to $68,178. Faculty at the University of North Dakota and North Dakota State University, as well as three senior state agency members of the State Advisory Committee, were asked for recommendations on the optimum use of the increased funding. The choices were to reinstate a small grants program or continue with an expanded fellowship program, with minimum administrative expenses. The responses strongly favored the fellowship option. For the current (FY 1999) program, student support constitutes $56,560 or 83% of federal funds.

- Edward Shawn DeKeyser, PhD Program, Department of Animal and Range Sciences, NDSU, *A Vegetative Classification of Seasonal and Temporary Wetlands Across a Disturbance Gradient Using a Multimetric Approach,* Advisor: Dr. Donald Kirby
- Melani Lynn Tescher, MS Program, Department of Biology, UND, *Bioaccumulation of Methylmercury in Waterfowl at Kelly's Slough Wildlife Reserve in Grand Forks, North Dakota,* Advisor: Dr. Sally Pyle
- Rochelle Nustad, MS Program, Department of Civil Engineering, NDSU, *Determination of the Factor Causing Elevated Phosphorus Levels in a Natural Wetland and Methods for Remediation,*Advisor: Dr. Wei Lin
- Paul Skubinna, MS Program, Department of Geology and Geological Engineering, UND, *Modeling the Hydrogeochemistry of Denitrification in In-Situ Microcosms in the Elk Valley Aquifer,* Advisor: Dr. Scott Korom
- Megan Jaskowiak, MS Program, Department of Botany, NDSU, *Sheyenne River Periphyton Study,* Advisor: Dr. Marvin Fawley
- Andrea Arruda, M.S. PhD Program, Department of Chemistry, NDSU, *Analysis of Organic Pollutants in Water Samples by SLE-RTP,* Advisor: Dr. Andres D. Campiglia
- Kyle D. Zimmer, PhD Program, Department of Zoology, NDSU, *Effects of Fish on Wetlands Ecosystems,* Advisor: Dr. Malcolm Butler

In four of the projects federal and state agencies, and a local watershed board, are providing co-funding or in-kind services such as water analyses:

- Army Corps of Engineering: Jaskowiak/Fawley, *Sheyenne River Periphyton Study.*
- North Dakota State Department of Health: DeKeyser/Kirby, *A Vegetative Classification of Seasonal and Temporary Wetlands Across a Disturbance Gradient Using a Multimetric Approach.*
- ND State Department of Health and ND Water Commission: Skubinna/Korom, *Modeling the Hydrogeochemistry of Denitrification in In-Situ Microcosms in the Elk Valley Aquifer.*
- Pelican River (MN) Watershed District: Nustad/Lin, *Determination of the Factor Causing Elevated Phosphorus Levels in a Natural Wetland and Methods for Remediation.*

Basic Project Information

Basic Project Information	
Category	**Data**
Title	Graduate Student Summer Fellowships
Project Number	B 98-01
Start Date	03/01/1998
End Date	02/28/1999
Research Category	Water Quality
Focus Category #1	Education
Focus Category #2	Acid Deposition
Focus Category #3	Acid Deposition
Lead Institution	North Dakota State University

Principal Investigators

Principal Investigators			
Name	**Title During Project Period**	**Affiliated Organization**	**Order**
Kyle D. Zimmer	Student	North Dakota State University	01
Gregory J. McCarthy	Professor	North Dakota State University	01
Jon Paul Jones	Student	University of North Dakota	01
Andrew T. Bradshaw	Student	North Dakota State University	01
Lee Beauvais	Student	North Dakota State University	01

Problem and Research Objectives

One objective of the Section 104b Program is to ensure the future availability of water resources research professionals. Graduate student training is currently the major activity of the ND WRRI through competitive fellowships for summer research in a degree program on a topic directly related to water resources. This fellowship program addresses an important gap in support for graduate student research. It is often the case that graduate students hold teaching assistantships during the academic year, but have no summer support for their thesis research in water resources research.

During FY 1998, the Graduate Student Summer Research Fellowships was allocated more than half of the $20,000 in federal funding. Applications were solicited from both the University of North Dakota and North Dakota State University. A panel made up of the ND WRRI director, the former assistant director, and two senior faculty made the selections. From seven applications, four $3,000 awards were made, one at the University of North Dakota (UND) and three at North Dakota State University (NDSU).

Summaries of progress from the four research fellows follow.

Determining Capture Zones for Three-Dimensional, Heterogeneous, Anisotropic Aquifers by

Monte Carlo Analysis, ***Jon Paul Jones*** , Department of Geology and Geological Engineering, Box 8358, University of North Dakota, Grand Forks, ND 58202-8358. [Advisor: Dr. Philip J. Gerla, Department of Geology and Geological Engineering] M.S. December 1998, .

Most methods of delineating capture zones for pump-and-treat remedial design and wellhead protection assume a two-dimensional, homogeneous aquifer. Real aquifers, however, are three-dimensional and heterogeneous, thereby introducing uncertainty in capture zone analysis. This study used a Monte Carlo analysis of three sets of statistical parameters defining aquifer heterogeneity. Each set had a difference variance for the mean ln(K), which varied among the sets by a factor of four. The ensemble means of the capture zones for each set were estimated from 120 realizations. Realizations of the hydraulic conductivity fields were generated using the method of fast Fourier transforms and incorporated into a confined, 128 m long by 64 m wide grid that included sufficient vertical layers to maintain the vertical correlation length. The U.S. Geological Survey MODFLOW code coupled with MODPATH was used to simulate the capture zones surrounding a pumping well within a simple flow system defined by constant head boundaries on the narrow edges of the grid. Mapping the capture zones for many aquifer realizations with similar stochastic properties provided the data required to construct 1%, 80%, and 90% quantile intervals. These figures begin to show how heterogeneity reduces the size of the capture zones estimated for statistically homogeneous aquifers.

Effects of Bait Fish on Prairie Wetland Ecosystems, ***Kyle D. Zimmer*** , Department of Zoology, North Dakota State University, Fargo, ND 58105. [Advisor: Malcolm Butler, Department of Zoology] Ph.D. expected May 2001.

Fish populations affect biotic and abiotic components of aquatic systems, and may influence aquatic ecosystem structure. Fathead minnows are naturally found in some prairie wetlands, but intentional stocking and landscape alterations have likely increased the number of wetlands supporting a minnow population. My objectives are to quantify effects of fathead minnows on restored and natural wetlands, and to determine if restored wetlands are more susceptible to fish influences. To reach these objectives I am studying 20 wetlands equally partitioned among four groups of wetlands: natural without fish, natural with fish, restored without fish, and restored with fish. I am testing effects of fish (presence/absence), wetland history (restored/natural), and fish-history interactions on ecological characteristics of wetlands. Characteristics measured include abundance of aquatic invertebrates, amphibians, and submerged macrophytes, as well as water-column levels of chlorophyll a, turbidity, nitrogen, and phosphorus. Results indicate that fathead minnows have dramatic impacts on the biota and water quality of wetlands. Wetlands with fathead minnows have fewer aquatic insects, large cladocerans, ostracods, calanoid copepods, and larval and adult tiger salamanders, as well as higher levels of chlorophyll a, total phosphorus, and turbidity compared to fishless sites. In contrast, wetland history had much less of an influence, with no consistent differences observed between restored and natural wetlands, and no consistent fish-history interactions. These results indicate that fathead minnows affect the species assemblage and abiotic components of both restored and natural wetlands, and restored and natural wetlands respond similarly to fish influences. Finally, similarities of measured variables in restored and natural wetlands indicate that wetland restorations are biologically successful.

Investigation of Ammonia Removal by Nitrification in Biological Treatment Systems Relevant to Moorhead Minnesota, ***Andrew T. Bradshaw*** , Department of Civil Engineering, North Dakota State University, Fargo, ND 58105. [Advisor: Wei Lin, Department of Civil Engineering] M.S. expected May 2000.

The project is focused on nitrification of ammonia to nitrate by bacteria in biological or secondary

wastewater treatment process. A literature review has been conducted as well as necessary background research pertaining to the history of flow characteristics and state of ammonia removal at the Moorhead Minnesota Waste Water Treatment Plant. This WWTP has occasional problems with the levels of ammonia discharges to the Red River of the North. The sequencing batch reactors have been constructed and set up; including necessary pumps, tubing, monitoring equipment, and operating scheme. The City of Moorhead has contributed toward purchasing necessary reagents, and much of the lab analysis are being performed at the wastewater plant. Initial start-up of the experiment occurred in the late summer of 1998. Four SBRs are being operated at a 3, 6, 9, and 12 day mean cell residence time. The time required for stabilization is being monitored.

Effects of Wind Mixers on Wastewater Stabilization Lagoon Systems. ***Lee Beauvais*** , Department of Civil Engineering, North Dakota State University, Fargo, ND 58105. [Advisor: Wei Lin, Department of Civil Engineering] M.S. expected May 2000.

The City of West Fargo uses a system of lagoons to treat its wastewater before the effluent is ultimately discharged into the Sheyenne River. Because of springtime odor problems associated with anaerobic conditions that develop under winter ice, wind generated mixers have been installed in the smaller of two primary lagoons to prevent septic conditions from occurring during winter. In addition to being able to keep the lagoons from going septic during winter, these wind mixers may be beneficial in the removal of BOD, nutrients, and suspended solids throughout the year. The purpose of this research is to determine the potential for additional treatment resulting from the mixing caused by the wind mixers. The objectives of this thesis project include the determination of the potential to increase the loading rate into the primary lagoon and a quantification of the affect of wind mixers on the removal rates of BOD and ammonia within primary lagoons. The primary lagoon containing the wind mixers has been monitored beginning after the first spring discharge, through subsequent filling and treatment, and ending at the time of the next discharge. Following this discharge, the mixers will be pinned to prevent mixing, and the lagoon will be monitored for the next cycle. The concentration and variation within the lagoon of such parameters as the BOD5, suspended solids, dissolved oxygen, fecal coliforms, and ammonia are being monitored throughout the two treatment cycles. From this data and climatic data, comparison of the wastewater stabilization rates can be made in order to determine the extent of the effects, if any, the wind mixers have on overall wastewater stabilization within the lagoon.

Methodology

Principal Findings and Significance

Descriptors

ammonia, denitrification, ecosystems, ground-water quality, lakes, nitrification, nutrients, waste water treatment, wetlands

Articles in Refereed Scientific Journals

Zimmer, K.D., M.A. Hanson, and M.G. Butler. (In press). Factors Influencing Invertebrate Communities in Prairie Wetlands: A Multivariate Approach. Canadian Journal of Fisheries and Aquatic Science.

Noraker, T., K.D. Zimmer, M.G. Butler, and M.A. Hanson. (In press), Dispersion And Distribution Of Marked Fathead Minnows (*Pimephales promelas*), in Prairie Wetlands. Journal of Freshwater Ecology,

Vol. 14.

Book Chapters

Dissertations

Jones, Jon Paul, Determining Capture Zones for Three-Dimensional, Heterogeneous, Anisotropic Aquifers by Monte Carlo Analysis, Department of Geology and Geological Engineering, "M.S. Thesis," Department of Geology and Geological Engineering, University of North Dakota, Grand Forks, ND.

Water Resources Research Institute Reports

Butler, M.D., K.D. Zimmer, M.A. Hanson and W.G. Duffy, 1998, Influences of Fathead Minnows on Nutrient Partitioning, Water Clarity, and Ecosystem Structure in Prairie Wetlands, Rept. No. ND96-02, North Dakota Water Resources Research Institute, North Dakota State University, Fargo, North Dakota, 72 pages.

Conference Proceedings

Jones, J.P., P.J. Gerla, and S.F. Korom. 1998. Stochastic Analysis of Three-dimensional, Heterogeneous Capture Zones, in Proceedings of MODFLOW '98, E. Poeter, C. Zheng, and M. Hill, eds., Colorado School of Mines, Golden CO, vol. 2, pp. 751-758.

Other Publications

Information Transfer Program

USGS Internship Program

Student Support

Student Support					
Category	**Section 104 Base Grant**	**Section 104 RCGP Award**	**NIWR-USGS Internship**	**Supplemental Awards**	**Total**
Undergraduate	0	0	0	0	0
Masters	3	0	0	0	3
Ph.D.	1	0	0	0	1
Post-Doc.	0	0	0	0	0
Total	4	0	0	0	4

Awards & Achievements

Publications from Prior Projects

Articles in Refereed Scientific Journals

Book Chapters

Dissertations

Water Resources Research Institute Reports

Conference Proceedings

Other Publications