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# Soil Conservation/Water Quality Wetlands and Symposium

8:30 THE ROLE OF ECONOMIC, MANAGEMENT AND PUBLIC POLICY FACTORS ON POST–CONTRACT CONSERVAYION RESERVE PROGRAM LAND USE DECISIONS

*Dr. Larry Janssen, Economics Department, Scobey Hall, South Dakota State University, Brookings, SD 57007*

Most Conservation Reserve Program (CRP) contracts will expire from 1996–2001, which will affect the land use of 36.4 million acres of highly erodible and other environmentally sensitive cropland enrolled in this land retirement program. The major objective of this study is to estimate the role of economic, management, and public policy factors on post–contract CRP land use decisions in South Dakota, a Northern Plains state with 2.1 million acres of enrolled land, 10% of the States cropland base.

One major data source is a 1993 CRP survey sent to a random sample of 8.33% of South Dakota CRP contract holders and completed by 556 of 1133 persons contacted. Management, socio– economic and land use data from the 1993 CRP survey are combined with their CRP contract file data from USDA. Respondents' intend to return 52% of their CRP acres to cropland, retain 29% in grassland, and are uncertain about post contract land use of 19% of their CRP acres.

A logistic regression model is used to determine the relative importance of economic, public policy, and management factors on respondents post– CRP land use intentions. Federal farm program incentives and crop base acres on CRP lands are two key factors favoring a recropping decision. Management practices on other agricultural land owned or leased by CRP contract holders are other important determinants of their post–CRP land use decision.

Projected economic cost and return budgets for CRP lands in three distinct climatic regions of South Dakota will be developed and presented for the major post–CRP land use alternatives. Breakeven and sensitivity analysis will be conducted to determine the role of enterprise profitability and public policy incentives on CRP land use decisions.

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8:50 WATERSHED PLANNING – ECONOMICS OF WATER QUALITY: ANALYSIS OF PROPOSED LAND TREATMENT AND PHOSPHORUS LOADING REDUCTIONS TO BIG STONE LAKE.

*David Buland, Soil Conservation Service, Federal Building, 200 Fourth St. SW, Huron, South Dakota 57350*

Many approaches have been proposed to improve hyper–euthorpic lakes. This paper summarizes a consensus watershed planning effort by an interdisciplinary, interagency team to target phosphorus reduction from the Little Minnesota River Watershed as a key to cleaning up Big Stone Lake. Many Resource Management Systems (RMS) for reducing phosphorus were analyzed and the most cost–effective selected into the final cleanup plan. Several agronomic, engineering, and economic models were used to quantify sources of pollution, including the Erosion/Productivity Impact Calculator (EPIC), Ephemeral Gully Impact Model (EGIM), Cost and Return Estimator (CARE), and Agricultural Non–point Source Pollution (AGNPS). Two hundred and fifty cropping systems were examined through 30 years of simulated weather data using the EPIC model. The sediment and phosphorus were routed through six subwatersheds to estimate delivered phosphorus and sediment from each watershed source. Onsite and offsite economic benefits and costs were calculated to determine the cost effectiveness of RMS and to select the recommended combination of practices to reduce phosphorus delivered to Big Stone Lake.

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9:10 EVALUATION OF AGRICULTURAL NONPOINT SOURCE POLLUTION CONTROLS ON WATER QUALITY IN SOUTHWESTERN NORTH DAKOTA

*J. Yoon and L.A. Disrud, Department of Agricultural Engineering, North Dakota State University, Fargo, ND 58105-5626*

The agricultural nonpoint source pollution control of water quality in a 72,000 acre watershed in southwestern North Dakota and northwestern South Dakota that drains into the Bowman-Haley Federal Reservoir was evaluated by using a distributed parameter hydrologic model, AGNPS (Agricultural Nonpoint Source Pollution Model). Due to the watershed size constraint with the model, a methodology was developed to prepare a database for the each subwatershed and to link them together in cascade routing model formulation to simulate water quality of runoff influxed into the reservoir. Model simulation was used to identify critical areas within the watershed where land treatment should be focused to optimize results. Sensitivity matrix analyses were performed to determine the impact of changing values of various parameters in the model on predicted water quality. These changes in parameter values were related to changing practices on the land to control nonpoint source pollution. Several alternative Best Management Practice (BMP) scenarios were simulated for various changes in land management and treatment and subsequent changes in water quality due to these changes were determined. It was observed that the most effective scenario could reduce sediment and nutrient loading into the Bowman-Haley Federal Reservoir by 48%. Based on the results from simulated scenarios, possible improvements for future water quality management and planning were obtained. Although the study emphasized the application of the methodology to the Bowman-Haley watershed in North Dakota, the methodology is applicable to any watershed in general.

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9:30 INFILTRABILITY AS A CONTROLLING FACTOR OF RUNOFF

*Robert A. Kohl, Box 2207-A, South Dakota State University, Brookings, SD 57007*

The rate at which rainfall can enter the soil determines if and/or how much runoff will occur. Since runoff is the transporting mechanism for inter-rill erosion and the

combined agent and transport for gully erosion, soil infiltrability is the first cause and is strongly influenced by crop and residue cover. This paper will focus on factors influencing infiltrability on cropped and uncropped soils.

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9:50 DEVELOPMENT AND IMPLEMENTATION OF A NONPOINT SOURCE POLLUTION MODEL LINKAGE TO GIS AND RDBMS FOR CRITICAL AREA ASSESSMENT AND BMP GENERATION

*J. Yoon and G. Padmanabhan, Dept. of Agricultural Eng. and Dept. of Civil Engineering, North Dakota St. University, Fargo, ND 58105-5626*

Nonpoint source pollution management is highly dependent on simulation models. Evaluating alternative management strategies through experiments is not feasible, and a modeling study is often the only viable means of providing input to management decisions. Methods were developed for directly linking a distributed nonpoint source pollution parameter model, AGNPS (Agricultural Nonpoint Source model) with a vector-based geographic information system (Geo/SQL) and a relational database management system (ORACLE) for simulating runoff and the transport of sediment and nutrients from a proposed dam site near Winger, the Sand Hill River Watershed District, Minnesota. The AGNPS model operates on a regular Voronoi polygon basis so that the spatial variation in parameters of each cell can be accounted for in the analysis throughout the entire watershed. Distributed parameter models such as AGNPS are often applied to large problem domains. Linking such models to geographic information system (GIS) and database management system (DBMS) will facilitate better data storage, manipulation and analysis within the GIS environment than constructing many input and output files individually and managing them. Rather than manually implementing AGNPS, spatially extracted data are integrated in an automatic fashion through a direct linking between the AGNPS model engine and GIS/RDBMS. This direct linkage results in a powerful, up-to-date tool that would be capable of monitoring and instantaneously visualizing the transport of any pollutant that AGNPS can simulate. Thereby, it reduces the time required to analyze the numerical output from AGNPS, and enables users to perform various "what if" scenarios to develop the optimal Best Management Practice (BMP) for the watershed. Simulated results showed that the final BMP scenario achieved an average reduction of about 26% from current nonpoint source pollutant levels.

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10:10 POSTER: COUNTY LEVEL EDUCATIONAL PROGRAMS IN RESOLVING MANURE RELATED WATER PROBLEMS IN SOUTH-CENTRAL MINNESOTA

*C. M. Hanson and L. M. Gunderson, Brown-Nicollet-Cottonwood, Clean Water Partnership, Room 13, Cottonwood Environmental Office, St. Peter, MN 56082, Brown-Nicollet- Cottonwood, Clean Water Partnership, 301 South Washington, Windom, MN 56101*

The Brown, Nicollet, Cottonwood Clean Water Partnership is a cooperative water quality project involving over 30 co-sponsors located in these three counties in south central Minnesota. The overall mission of the project is to develop a strategy to minimize high nitrate concentrations in surface and ground water.

One of the first initiatives was to conduct a survey of farmers in the three counties to determine their agricultural practices. Forty-one farmers were interviewed. Survey questions keyed in on N management including commercial, manure, and legume sources of N. The purpose of the survey was to:

- learn more about N rates and practices in the area.
- identify opportunities to improve farm profits and water quality
- identify education needs for our Clean Water Partnership efforts.
- develop a base against which to measure the effectiveness of our educational programs.

Analysis of the survey showed two key results:

1. Applications of commercial N to ***unmanured*** corn are on the average approximately equal to the University of Minnesota recommendations.
2. Application of N to ***manured*** corn substantially exceed the University of Minnesota recommendations.

Farmers were employed under the South Central Emergency Employment Program (SCEEP) to collect manure samples for free analysis. These farmers were organized and educated to assist other farmers in manure samples and distributed information on fertilization, manure sampling, safety, crediting nutrients from manure, and manure handling. Analysis results were promptly sent to the farmers along with an invitation to call the project staff with questions.

Future plans include workshops and field demonstrations. Workshop topics will include how to use manure testing results, manure application, spreader calibration, and computer software to assist in making nutrient recommendations. Test plots will include livestock manure and commercial N.

Effectiveness of this country-level program in resolving agricultural water quality problems, specifically due to the over application on N from manure, will be addressed.

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10:10 POSTER: THE ANOKA SAND PLAIN WATER QUALITY DEMONSTRATION PROJECT: GROUNDWATER PROTECTION BEST MANAGEMENT PRACTICES FOR AGRICULTURE

*David Cooper, Jan Jarman, Mike Blaine, Jeff King, Bill Harju, JoAnn Johnson, Anoka Sand Plain Water Quality Demonstration Project Staff, Anoka Sand Plain Project, Minnesota Extension Service, 312 Agricultural Engineering Building, 1390 Eckles Avenue, St. Paul, MN 55108*

The Anoka Sand Plain Project is one of sixteen projects established nationwide by the U.S. Department of Agriculture to demonstrate agricultural production practices that can be voluntarily adopted by producers to protect water quality.

The specific goal of this project is to help agricultural producers residing on the Anoka Sand Plain Aquifer to adopt nutrient, pest control, and irrigation water management practices that will reduce the risk of non–point source contamination to groundwater in the aquifer. The Anoka Sand Plain Aquifer is an important source of water in the region, and it also serves as a source of recharge to several bedrock aquifers and contributes to the base flow of the Mississippi River which together contribute most of the drinking water supply for the Minneapolis – St. Paul Metropolitan Area. The project works with over 40 producers residing in seven counties (Benton, Chisago, Isanti, Mille Lacs, Sherburne, Stearns, and Wright) north of the metropolitan area in the establishment of on–farm demonstrations of nitrogen fertilizer and animal waste applications, integrated pest management, irrigation water scheduling, and related production practices that can contribute to groundwater protection. The results of those on–farm demonstrations will be presented in this poster.

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10:10 EXHIBIT: NORTHERN CORNBELT SAND PLAIN MANAGEMENT SYSTEMS EVALUATION AREA (MSEA)

*Bruce Giebink, John Lamb, Jim Anderson, Minnesota Extension Service, 452 Borlaug Hall, 1991 Upper Buford Circle, University of Minnesota, St. Paul, MN 55108*

Collectively, there are five Management Systems Evaluation Area (MSEA) Projects (involving 10 research sites) located across the Midwest. At these sites researchers are studying how various farming systems impact water quality and farm profitability. The Northern Corn Belt Sand Plain MSEA Project – with research sites located on highly permeable sandy soils overlying shallow aquifers in Minnesota, North Dakota, South Dakota and Wisconsin – focuses on how irrigated farming systems on sandy soils affect ground water quality. The Minnesota site is located on the Anoka Sand Plain Aquifer. This aquifer is an important source of water in the region: it serves as a source of recharge to several bedrock aquifers and also contributes to the base flow of the Mississippi River. Together, these water resources supply most of the drinking water for the Minneapolis – St. Paul Metropolitan Area. We will explain how agricultural production systems at Minnesota's MSEA site have affected crop productivity and ground water quality. Systems at the Princeton, Mn. site include:

- Full–width tillage continuous corn, broadcasted herbicides;
- ridge tillage corn–soybean rotation, banded herbicides;
- a higher input sweet corn– potato rotation.

After four growing seasons:

- No agricultural production systems affected herbicide (atrazine, alachlor(Lasso), metoalachlor (Dual), metribuzin (Sencor) concentrations;
- Nitrate–N concentrations increased under the sweet corn – potato rotation.

Visitors will be able to try out an interactive tutorial about water quality in the Midwest, watch a video or pick up literature (brochures, fact sheets, etc.) that explains in more detail what the project is about and how specific findings can help agricultural producers and practitioners farm more profitably and protect water quality.

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10:40 MODEL ESTIMATION OF BMP IMPACTS ON LONG-TERM GROUND WATER QUALITY IN THE ANOKA SANDPLAINS

*John L. Nieber, Hung Viet Nguyen, John L. Nieber, David Cooper, Michael I. Blaine, Jeffrey S. King, Jeffrey L. St. Ores, Department of Agricultural Engineering, University of Minnesota 1390 Eckles Ave., St. Paul, MN 55108*

The Anoka Sand Plains Water Quality Demonstration Project was established in 1990 as a demonstration of best management practices (BMP's) in agricultural production for protection of ground water quality. Forty producer cooperators, representing the range of agricultural management practices in the Anoka Sand Plain region, are involved in the project. Pretreatment conditions at each cooperator operation were quantified and best management practices were then prescribed. Best management practices involved such practices as crop rotation, tillage, irrigation water management, nutrient crediting for manure, leguminous crops and crop residue, selection of more stable forms of commercial nitrogen, and split application of fertilizers. Crop yields are monitored on each operation, along with the nitrate content in the soil profile at the beginning and end of the growing season. In late 1993 a modeling study was initiated to provide estimates of the potential long–term impact of the adoption of the best management practices on reduction of nutrient contamination of ground water in the shallow sandplain aquifer. Numerical simulation models of water flow and chemical transport are being used for the study. The models included in the study are GLEAMS, LEACHM–N, SWAST, and NLEAP. Field data acquired at several of the more intensively monitored sites are being used to provide baseline tests of the models. The regional weather record for the 1960–1990 period is being used as input to the models, along with the crop and nutrient management practices for both pre– and post–BMP conditions. Results obtained from the application of these models will be summarized and conclusions about management practices derived from the simulations will be given.

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11:00 ESTIMATION OF SELENIUM IN DRAINAGE WATER

*Dr. Darrell W. DeBoer, Dept. of Agricultural Engineering, South Dakota State University, Brookings, SD 57007*

A simulation model, based on the travel paths of water movement through saturated soils to subsurface drain lines, is being used to estimate the concentration of selenium in drainage water. Data sets which describe the soil and water characteristics of the Lake Andes–Wagner/Marty II irrigation project in South Dakota are used as inputs to the model. Chemical and physical properties of the project soils have been determined along about 20 miles of transects within the project boundaries. Irrigation management practices which minimize drainage flows have been identified and are also

used as model inputs. Results of this study will illustrate projected long term trends of selenium concentrations in drainage water as a function of irrigation management practices, drainage design considerations and initial selenium concentrations in the soil.

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11:20 ORGANIC CARBON CONTENT OF SOILS: VARIATIONS IN CROP TYPE AND SOIL TEXTURE

*Mariana Garrettson, Vanessa Bodrie, and Karen Bobbitt, Carleton College, Northfield, Mn. 55057*

We investigated the effect of crop rotation and soil texture on organic carbon content and the subsequent distribution of organic carbon within the A horizon. Soils were collected from nine fields in which no artificial fertilizers had been used on the Bauer farm in Rice County, MN. These fields included a sandier and siltier soil for each of four crops: wheat/oat, alfalfa, corn and soybeans, plus a plot in the Conservation Reserve Program (CRP) which has not been tilled for seven years. In each field, soil samples were collected from depths of 5– 10 cm and 20–25 cm below the surface. Organic carbon content of each sample was determined by the difference in weight before and after incineration at 600°C. Results show that soils planted in corn and soybeans have a lower organic carbon percentage (averaging 4.10% and 4.51% respectively) than soils planted in wheat/oat and alfalfa (averaging 7.01% and 7.92% respectively). The CRP plot had an average organic carbon percentage of 5.76%. When crops were held constant, organic carbon was positively correlated with an increase in clay content. Soils with a high total organic carbon content have it concentrated in the lower part of the A horizon while soils with a low total organic carbon content have it concentrated in the upper part of the A horizon. The trends of increasing carbon content can be attributed to both higher clay content in the soil and differences between specific crops including differing root structures, planting techniques (cover crops vs. row crops), and tillage techniques.

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11:40 TILLAGE METHODS AND LOSSES OF SOIL CARBON DIOXIDE

*D. C. Reicosky, USDA–ARS–MWA, North Central Soil Conservation Research Laboratory, North Iowa Avenue, Morris, MN 56267*

Man's activities in agricultural production associated with tillage can have significant influence on atmospheric composition through the greenhouse effect and potential global climate change. Minimizing agricultural's impact on the global increase in carbon dioxide requires that we sequester or maintain high levels of soil organic matter. The objective was to determine the effect of different fall tillage methods on the short–term carbon dioxide flux from soil. Various methods of tillage that incorporate aspects of conservation tillage were evaluated and the $CO_2$ flux measured with a large portable chamber system, commonly used to measure crop canopy gas exchange. Measurements of $CO_2$ flux were initiated shortly after tillage and continued intermittently for several days. The results showed that moldboard plow had the roughest soil surface and highest initial $CO_2$ flux and maintained the highest flux throughout the study. The differences in the $CO_2$ flux between tillage treatments were small but consistent. Measurements after tillage with a newly developed conservation tillage tool showed the initial $CO_2$ flux was < 10% of that after moldboard plowing. Equipment designed for residue management and conservation tillage can be beneficial in minimizing $CO_2$ lost from the soil. These preliminary results suggest new conservation tillage equipment designed for better residue management may also aid in minimizing soil organic matter loss by decreasing the amount of carbon dioxide lost at tillage time. The results showed tillage methods affected the initial $CO_2$ flux differently and suggest improved soil management can minimize agriculture's impact on global $CO_2$ increase. Maintaining or even increasing the soil organic matter to the highest levels obtainable under economic crop production may require both reduced tillage and crop rotation that maximize crop residue return to the soil. The temporal trends in carbon dioxide loss superimposed on spacial variation within the landscape further complicates the analysis and will require further detailed research to provide policy makers with quantitative data for environmental quality decisions.

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**NOON - 1:00 P.M. LUNCH**

1:00 IMPACT OF NARROW–ALTERNATE STRIP CROP SYSTEMS ON CROP YIELD AND RESIDUE COVER

*T.K. Iragavarapu and G.W. Randall, University of Minnesota, Southern Experiment Station, 35838 120th Street, Waseca, MN 56093*

Current corn (*Zea mays* L.) and soybean (*Glycine max* L.) production practices used by many US farmers are quite energy intensive while allowing excessive soil erosion. An experiment was conducted at two locations in southern Minnesota on a Webster clay loam soil to investigate narrow (4.57–m), alternate strip systems planted on ridges (ridge till). a 3–crop [corn–soybean–wheat (*Triticum aestivum* L.) interseeded with Nitro alfalfa (*Medicago sativa* L.) or hairy vetch (*Vivia villosa* Roth)] system was compared to a conventional corn–soybean strip system. Rows were oriented N–S at one location and E–W at the other. Results from 3 years suggest that narrow alternate strips of corn, soybean, and wheat in a ridge–till system provide excellent surface residue coverage and satisfy erosion control goals. Corn production was increased by 3% with E–W rows and 13% with N–S rows due to the positive border effects in the narrow strips. Soybean yields in strips alternated only with corn were reduced by 7% (N–S rows) and 10% (E–W rows) due to competition and shading by the corn. When grown in a 3–crop system, soybean yields were reduced only by 3% (N–S rows) and 5%(E–W rows) because of less shading when bordered by wheat. Wheat yields were unaffected by the border crops in the E–W scenario and were reduced by 10% in the west 1/3 strip bordering corn in the N–S rows. Wheat introduced into the traditional corn–soybean strip system not

only reduced border effects on soybeans but also aided interseeding of legumes. In the unusually cool and wet year of 1993, legumes provided a nitrogen credit of about 45 kg N $ha^{-1}$.

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1:20 Establishment of Cover Crops Before Harvest of Corn and Soybean Crops at 6 Farms and 2 UM Agricultural Experiment Stations of West Central Minnesota.

*Dennis Warnes, N. Barber, A. Olness, Don Reicosky, D. Huggins, R. Alderfer, West Central Experiment Station, University of Minnesota, Morris, MN 56267 and ARS North Central Soil Conservation Research Laboratory, North Iowa Avenue, Morris, MN 56267*

We conducted studies to evaluate methods of establishment of cover crops within a primary crop before harvest. Hairy vetch (*Vicia villosa* Roth) was planted at tasseling (maize; *Zea mays* L.) or last cultivation (soybean; *Glycine max* L.), and winter rye (*Secale cereale* L.) was planted in maize at tasseling, at silage stage, at maturity, and after harvest, and in soybean at last cultivation, at leaf yellowing (silage), and after harvest. At cooperative farm sites, hairy vetch was planted with an endgate seeder on August 12 or 16; with adequate precipitation after planting, good stands were established. A mixture of hairy vetch and sweet clover (*Melilotus officinalis* Mill.) was planted July 24; only fair stands were established when the soil was wet at planting but received only sparse precipitation for 3 weeks after planting. Winter rye planted by airplane on September 16–17 produced a good stand because of adequate rainfall in the week after planting; this provided protection against erosion and provided forage for grazing in the following spring. Winter rye planted September 27 with an endgate seeder with and without 'topping' maize produced stands of rye adequate for some protection against erosion with only sparse precipitation after planting. Stands of annual medics (*Medicago lupulina* L.) and winter rye planted September 15, 1993 by airplane were very poor because of inadequate precipitation after planting and because annual medics establish poorly with only broadcast seeding. Drilling the cover crop after harvesting maize or soybean for silage provided the best stands of cover crops. Drilling the cover crop after harvesting cash crops allowed germination but inadequate growth of winter rye to protect against erosion over winter or provide for early spring grazing.

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1:40 Benefits of Cover Crops Established at 6 Farms and 2 Experiment Stations in West Central Minnesota

*Dennis Warnes, N. Barber, A. Olness, Don Reicosky, D. Huggins, R. Alderfer, West Central Experiment Station, University of Minnesota Morris, MN 56267 and ARS North Central Soil Conservation Research Lab., North Iowa Avenue, Morris, MN 56267*

Concerns about soil erosion, water quality, and synthetic agricultural chemicals encourages development of more sustainable systems for maize (*Zea mays* L.) and soybean (*Glycine max* L.). We conducted field studies in West Central Minnesota to evaluate potential erosion and weed control from competitive crops and their allelopathic effects. At two sites winter rye (*Secale cereale* L.) was planted in the fall and killed with glyphosate before no–till– planting maize or soybean. Winter rye residue eliminated the need for preplant incorporated or pre–emergence herbicides which have soil residual activity; but, post emergence herbicides were needed to control weeds. Planting a legume as a cover crop may provide nitrogen for the succeeding crop. Hairy vetch, hairy vetch with sweet clover (*Melilotus officinalis* Mill.), or annual medic (*Medicago lupulina* L.) from Australia was planted into maize. Good stands of hairy vetch were established with adequate precipitation; but, the stand of medic was very poor and stands of hairy vetch and sweet clover were only fair because of inadequate rainfall after planting. Mineral nitrogen content of the soil was measured in the areas seeded to legumes. Winter rye was aerially planted into soybean on rolling fields to prevent erosion and to provide grazing forage. Soil surface cover measurements (both fall and spring) were used to predict erosion control. Biomass was measured in the spring. Winter rye, planted into maize with and without 'topping', reduced erosion risk. Percentage cover from winter rye or hairy vetch (*Vivia villosa* Roth) was measured in the fall and spring; those measurements were used to estimate erosion control. Soil moisture was measured to determine if the previous cover crop aided water infiltration and /or used excess soil moisture.

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2:00 Restoring Agricultural Drained Wetlands: A "Reinvest in Minnesota" (RIM) Initiative

*Thomas A. Wenzel and David H. Behm, Minnesota Board of Water & Soil Resources, 155 S. Wabasha, Suite 104, Saint Paul, MN 55107*

About 1850, Minnesota possessed approximately 18.5 million acres of wetlands; by the 1980s, the acreage had been reduced to 7.5 million acres. An innovative, locally-administered state program is helping to bring back a part of this heritage.

The wetland restoration component of the Reinvest In Minnesota (RIM) Reserve Program pays landowners to restored drained wetlands and convert them back to their natural state. The program also provides necessary funding to the landowner to cover the costs of establishing the conservation practices, including restoring the drained wetland, up to specified limits. The Board of Water and Soil Resources administers the program through local soil and water conservation districts (SWCDs). Cooperating agencies and conservation organizations often contribute financial assistance to participating landowners whose costs exceed the state's payment limits. In addition, cooperating agencies provide technical assistance directly to the participating landowners or to SWCDs.

Program accomplishments and a discussion of wetland restoration program considerations will be presented.

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2:20 MINNESOTA WETLAND CONSERVATION ACT: WETLAND BANKING SYSTEM

*John Jaschke and Greg Larson, Water and Land Management Section, MN Board of Water & Soil Resources, One West Water Street, Suite 200 St. Paul, MN 55107*

The MN Wetland Conservation Act (WCA), is a "no-net-loss" state wetland protection program that passed in June 1991. The WCA prohibits the draining and filling of wetlands unless replaced by restored or created wetlands of equal or greater public value under an approved replacement plan. Local government units (LGUs) administer this state program that includes a comprehensive yet simple wetland function and value assessment to achieve wetland replacement. The WCA also was the impetus for the development of a state wetland banking system which allows both public and private sector project sponsors to participate.

The resultant system evaluates existing wetlands based on type, location, inlet/outlet characteristics and special or local factors. An LGU can use the system to determine the amount of replacement wetland needed to mitigate adverse impacts. System implementation began in January 1994 and agencies will monitor results for needed improvements (such as regionalization).

The MN state wetland banking program incorporates the same evaluation methodology, and was designed to be simple and flexible while conserving wetland functions and values. The banking program was based on federal models to assure maximum consistency with the mitigation requirements of Section 404 of the Federal Clean Water Act. Projects will be approved, managed, and monitored by LGUs and landowners with the Minnesota Board of Water and Soil Resources providing oversight and central record keeping. Public and private interests can buy and sell credits at costs determined by free-market factors.

The objective of this paper is to point out the highlights of the WCA, and particularly the wetland banking system.

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2:40 THE IMPACT OF PHORATE ON THE GENETIC DIVERSITY OF WETLAND AQUATIC INVERTEBRATES.

*M.A. Brinkman[1], W.G. Duffy[2], and C.F. Facemire[3]*

*[1] South Dakota State University, Department of Plant Science, Brookings, South Dakota 57007; [2] National Biological Survey, South Dakota Cooperative Fish and Wildlife Research Unit, South Dakota State University, Department of Wildlife and Fisheries Sciences, Brookings, SD 57007; [3]U.S. Fish and Wildlife Service, Region 4, Atlanta, GA 30303*

The impacts of the insecticide phorate on the genetic diversity of wetland invertebrates were investigated using field and laboratory studies in 1991. Electrophoretic methods were evaluated for revealing the impact of insecticides. Objectives were to determine the ability of electrophoresis to reveal the impact of phorate on invertebrates and to determine the influence of phorate on the genetic diversity in two common invertebrates. Amphipods, *Hyallela azteca* and mayflies, *Callibaetisferrugineus* (Walsh) were placed in constructed mesocosms in wetlands and were exposed to varying amounts of phorate. Survivors and individuals from the parent population were genetically tested using cellulose acetate electrophoresis techniques. Allele frequencies were calculated for invertebrates in treatments and invertebrates from populations not exposed to phorate. Mortality oftest invertebrates was significantly higher ($F = 5.97$, $P = 0.0190$) in phorate treatments than in controls. Chi-square analysis revealed significant differences ($X^2 > 8.5$; df= 1,2; $P < 0.05$) in allele frequencies between the untreated populations and individuals of both species treated with phorate. In addition, phorate appeared to eliminate, or reduce the frequency of certain genotypes in both species. Results indicate phorate selected against sensitive individuals and electrophoresis was effective at detecting differences between untreated populations and invertebrates that survived treatments. Genetic techniques should enable wetland scientists to detect the effects of pollution on invertebrate populations by monitoring genetic composition.

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3:20 HYDROLOGY OF PRAIRIE WETLANDS IN SURFACE COAL MINELANDS OF NORTH DAKOTA

*P.P. Sharma[1], F.S. Carter[1], B.J. Baker[2], and J.L. Richardson[2]*

*[1] North Dakota State University, Land Reclamation Research Center, Highway 6 South, Mandan, ND 58554; [2] North Dakota State University, Dept. of Soil Science, Fargo, ND 58105*

Prairie wetlands in the Fort Union Lignite region of western North Dakota provide habitat for migratory waterfowl and other wetland species and contribute to groundwater recharge. During surface mining of coal and reclamation of minelands, the mitigation for reconstruction of wetlands is based on equivalent replacement of hydric soils and hydrophytic vegetation. Given the semiarid climate of the region, the reconstructed wetlands may meet the 'duck test' of premine surficial functions, but the desired near-surface and subsurface hydro-ecological attributes may not be recovered or sustained for long times. Information on hydrology of wetlands and their catchment characteristics are needed to ensure sustainability of these wetlands towards maximum potential for surficial habitat protection and ground water recharge.

A research program on comparative hydrology of various types of wetlands associated with the surface coal minelands of North Dakota began in 1993 . The research program aims to: (a) characterize wetlands, their catchment, and soil parameters that affect the quantity and quality of water in selected premine and postmine landscapes; (b) evaluate components of water balance model for the wetlands, and assess the role of these wetlands in ground water recharge.

Six wetland sites, two each from natural prairie, abandoned minelands, and reclaimed minelands are instrumented with electronic data loggers to continuously monitor near surface micrometeorological parameters of rainfall, solar radiation, wind speed, relative humidity, and air, water and soil temperatures. Water surface elevations on wetland ponds, on near surface piezometers, and evaporation pans as well as

macro-quality parameters such as total dissolved solids, pH, electrical conductivity, total cations and anions are also being monitored periodically. It is anticipated that the research information from this study will be useful in establishing sustainable postmine wetland habitat with provisions for ground water recharge.

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3:40 WETLANDS/GROUNDWATER QUALITY IN AGRICULTURAL LANDSCAPE.

*D.H. Rickerl, D. E. Kringen and T. A. Machacek. Department of Plant Science, South Dakota State University, Brookings, SD 57007.*

In the Prairie Pothole Region (PPR - SD, ND, MN, tA), wetlands classified as "semipermanent" or "seasonal" can act as groundwater recharge sites. The nutrient filtering capacity of wetlands has been investigated for both natural and constructed wetlands linked to surface water, but there is little information available on their subsequent impact on groundwater quality. This study investigates four seasonal and two semipermanent wetlands in the Prairie Pothole Region of eastern South Dakota. The wetlands are situated in transitional no-till (TNT) and organic (ORG) farm management systems. The objective is to determine the effects of farm management system an wetland classification on wetland surface water and groundwater quality (as part of a more comprehensive study including wildlifelhabitat investigation and economic analyses). Water quality data includes nitrate and orthophosphate concentrations from wetland surface water, groundwater at wetland and upland sites, and run-offwater from weirs. The results will be used to determine to what extent wetlands in the PPR act as sinks for nutrient run-offand to establish baseline nitrate and orthophosphate data for the development of wetland water quality standards for the PPR.

The results thus far indicate that surface water nitrate concentrations were higher in semipermanent than seasonal wetlands. Surface water concentrations of orthophosphate, however, were higher in seasonal than semipermanent wetlands. Groundwater sampled near the wetland perimeter had higher orthophosphate concentrations than groundwater sampled from nearby upland sites. The effects of farming system were seen in weir data which indicated high concentrations of nitrate in run-off following nitrogen application in the TNT system. High nitrate concentrations were also found in groundwater sampled from the ORG semipermanent wetland site which is cropped to alfalfa and receives manure application. Orthophosphate concentrations were significantly higher in the groundwater near the seasonal wetland in the ORG (0.68 ppm) than the TNT (0.20 ppm). Water quality monitoring will continue in 1995, but preliminary results suggest that both wetland classification and adjacent farming practices impact wetland and groundwater quality.

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4:00 INFLUENCE OF VEGETATED WETLANDS ON THE WATER QUALITY OF TWO GLACIAL PRAIRIE LAKES.

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We investigated the influence of vegetated wetlands on water quality of two glacial prairie lakes, Enemy Swim and Cochrane, in eastern South Dakota. Surface water enters each lake from two drainages. Land use in one drainage of each lake consisted of grasslands and upstream wetlands. Surface water flows from these drainages through vegetated littoral wetlands as it enters the lakes. Land use in the second drainage to each lake consisted of row crops, grassland and wetlands. Surface water from these drainages enters the lakes through an open water area; a sediment retention pond adjacent to Lake Cochrane, and a large slough adjacent to Lake Enemy Swim. Water then enters Lake Cochrane through a vegetated littoral zone, and enters Enemy Swim adjacent to a vegetated littoral zone. Water frequently flows out of Enemy Swim and into the slough, influenced by wind direction.

In each lake, we measured water quality parameters in the two upstream drainages, in the adjacent littoral wetlands, and in two midlake sites on multiple dates in 1992 and 1993. In both lakes, total N and chlorophyll a concentrations were greater ($P < 0.05$) in the drainages from upstream open water sites than at all other sites. In Cochrane, Total P, dissolved Si and nitratenitrite N were also highest in the drainage from the upstream openwater site. In both lakes, drainages entering from a grassland-wetland area had significantly greater Fe concentrations ($P < 0.05$), but lower Total Kjelldahl nitrogen (TKN), pH, and chlorophyll *a* concentrations than the other sites. In Enemy Swim, Si concentrations were greatest and turbidity was lowest in the drainage arising in grassland-wetland. Total P showed no significant differences between stations and nitrate N was seldom present in measurable concentrations in Enemy Swim.

In both lakes total N and total P concentrations were lower in the drainages from grasslandwetland areas than in the drainages from open water areas. High entering concentrations of N and P were reduced by passing through a vegetated littoral zone. Water downstream from vegetated wetlands also had higher Si:P and Fe:P ratios than other sites. These changes make water passing through vegetated wetlands less likely to stimulate nuisance blooms of bluegreen algae.

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4:20 MORPHOLOGICAL INDICATORS OF SEASONALLY-SATURATED SOILS FOR A HYDROSEQUENCE IN SOUTHEASTERN MINNESOTA.

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The duration and depth of seasonal soil saturation affects soil suitability for many land-uses and are critical factors in the

determination of hydric soil boundaries for jurisdictional wetland delineations. Biochemical processes in saturated7 anaerobic soil conditions lead to the genesis of soil morphological features that indicate the duration of seasonal saturation. However, few prior studies confirm the relationships between soil hydrology and soil morphology in Minnesota landscapes. We monitored water table and piezometric elevations7 soil temperature7 redox potential, and soil matric potential at multiple depths for five locations along a hillslope hydrosequence of well to very poorly drained prairie soils (Mollisols) in southeastern Minnesota. Sites were monitored at two-week intervals for two years. Detailed soil profiles were described and sampled during the summer of 1992 along this hydrosequence. The duration that water tables were within the upper 30 cm ofthe soil ranged from O weeks at the shoulder to 10 weeks at the toeslope and 30 weeks in the drainageway. Low (<300 mV) soil redox potentials7 dark A-horizon colors (chroma $\leq$ 1)7 low chroma subsoil matrix colors (chroma $\leq$ 2)7 and high organic carbon contents (> 3%) were observed for the toeslope and drainageway soils subjected to extended periods of high water tables. An increase in abundance of soil morphological features associated with depletions and/or concentrations of Fe and Mn on mineral soil grains was also associated with periods of prolonged soil wetness. Preliminary results suggest lateral movement of water through the soils above a layer of dense till linking the hydrology of upland and wetland soils.

4:40 RELATIVE SOIL AERATION IN A CULTIVATED PRAIRIE POTHOLE

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Prairie potholes receive surface runoff from their catchments and serve as a focal point of ground water recharge. Soil aeration controls the solubility and form of many soil chemicals. Platinum electrodes are sensitive to oxygen and provide a very sensitive indicator of its presence. Electrodes were installed at the 15–, 30–, and 45–cm depth across two transects within a shallow, cultivated depression which serves as a recharge site for groundwater. Soils on the rim of the depression remained aerobic throughout two consecutive cropping years even at 45 cm. Soils within the depression became anaerobic briefly in the first year and very intensely anaerobic in the second year. Electrode potentials decreased with depth. Values of –250 mV were measured at 45 cm and these values suggest that sulfate sulfur was reduced to sulfide within the depression. Because the subsoil was anaerobic, all nitrate–N should be reduced to nitrogen gas. Thus, leaching of nitrate–N into the groundwater during the growing season is a very unlikely event. The degree of anaerobiosis was sufficient to dissolve iron and manganese oxides; organic chemicals adsorbed to these oxide surfaces may be at enhanced risk of leaching into groundwater.