

**ENVIRONMENTAL RESEARCH
AT THE UNIVERSITY OF MINNESOTA**

**An Inventory of Research Related
to Public Policy, 1990-1992**

**Thomas L. Anding
Sheryl A. Carter
Nancy M. Lange and
Margaret R. Wolfe**



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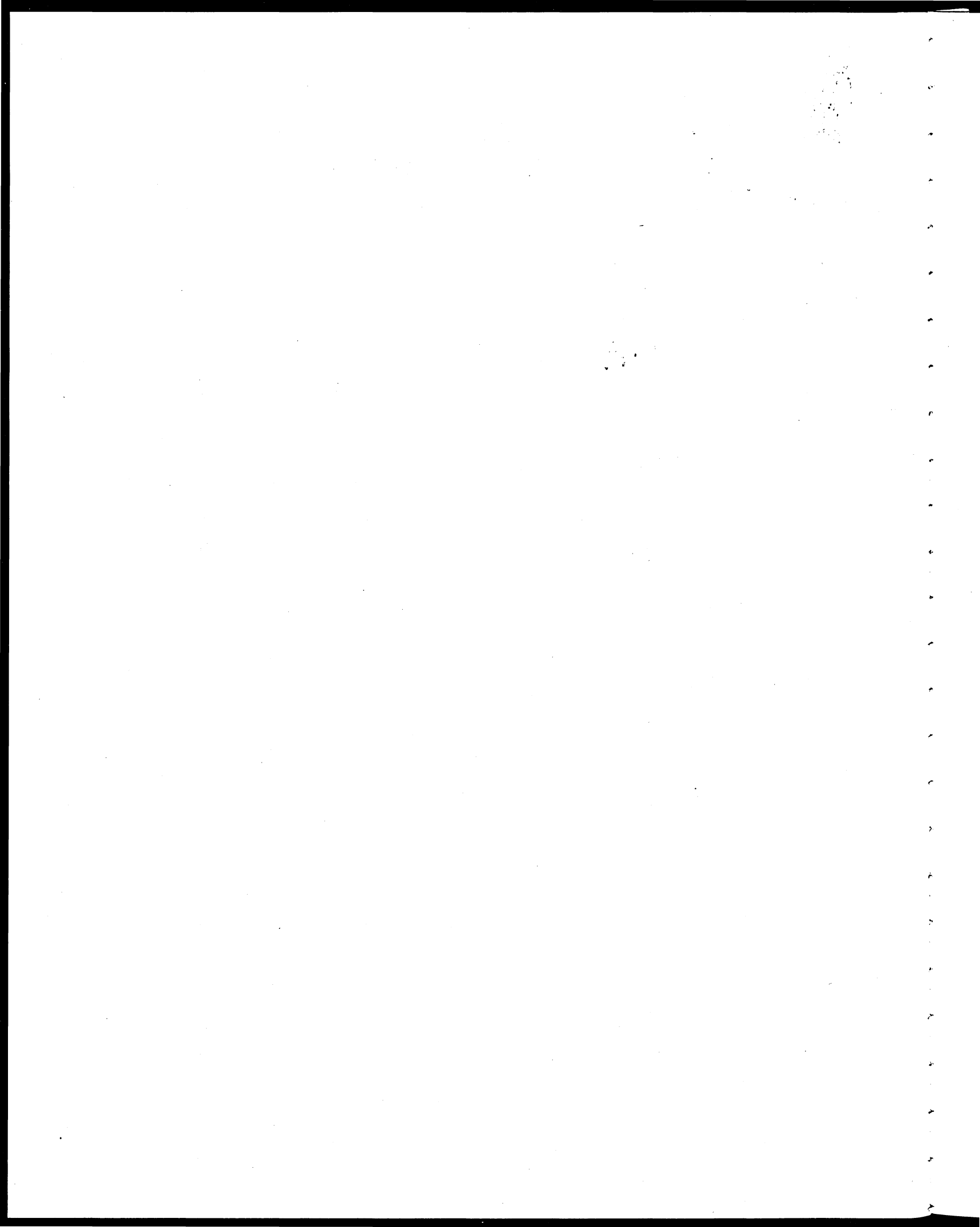


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TO THE READER

CURA has been in the business of gathering and disseminating information about University activities in the environmental area for two decades. Some of this activity has been systematic, comprehensive, and ongoing, as in the case of the annual *Courses on the Environment, A Student Guide to University of Minnesota Courses on Environmental Issues on the Twin Cities Campus*. In this present undertaking, CURA has compiled an inventory of recent environmental research at the University. The question of whether this becomes an ongoing effort will be answered in part by the use made of this report, relative to the real costs incurred in its development.

It is the first such effort to systematically and comprehensively look at research projects on the environment, and to collect the findings into a single publication. Project descriptions and keyword indexes are special features which will help readers find research relevant to their interests.

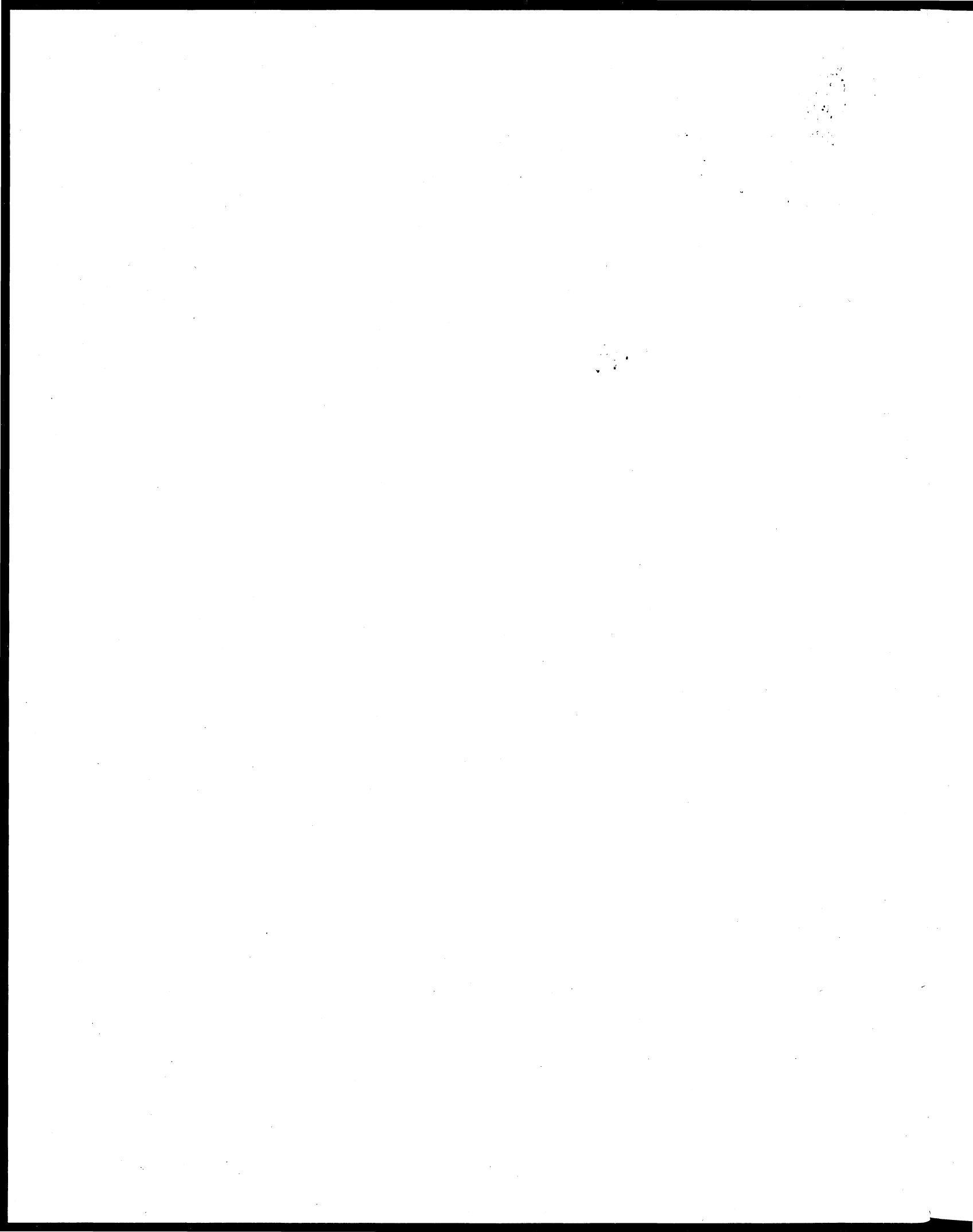
Any inventory of this type is limited by the willingness of the faculty to respond. We are most grateful to the contributors and thank them for providing the information that is included in this publication. This environmental research inventory has been made possible by their cooperation. What is the purpose of this research inventory? CURA's decision to go ahead with this project was made on the basis of the following assessment of need:

- No comprehensive inventory of University environmental research currently exists
- University researchers would benefit from better knowledge about and access to other on-going projects at the University
- Teaching, both inside and outside the University, could be improved by making better use of existing environmental research
- Future research programming would be improved by having a better understanding of current strengths and weaknesses in the environmental research area
- Consistent and heavy demand for information about University environmental research comes from outside the institution and a means of response is needed for these requests
- Efforts aimed at improving environmental quality, both within the University and in the broader community, would be enhanced by better information about environmental research being carried out at the University of Minnesota

Probably the most difficult part of this project has been the development of parameters for inclusion or exclusion of research projects. In order to provide some focus and to manage the magnitude of the project, the decision was made to try to emphasize research with a public policy aim, to concentrate on research with a Minnesota or Midwest fit, and to include only those projects underway since the beginning of 1990. If we have not been entirely successful in meeting our stated objectives, I apologize, and take full responsibility for the decisions on which projects were included.

Please let us know your reactions to this publication. We welcome your comments and will use them in making decisions about subsequent updates.

Thomas L. Anding
Associate Director
Center for Urban and Regional Affairs



INTRODUCTION

In an effort to identify relevant environmental research projects, input was sought from a broad variety of sources at the University of Minnesota. Letters describing the inventory and a questionnaire asking for detailed project information were sent to all deans, directors, and department heads. They were asked to circulate our request to faculty members conducting research which would be important to include in the inventory. In addition, we developed a list of individual faculty members active in environmental teaching and research from many different guides, directories, and databases. Each was sent an individual letter and questionnaire.

Information is presented on 267 research projects from 59 different departments. Researchers at the Twin Cities campus contributed information on 205 projects, while 62 projects were carried out by faculty at the Duluth and Morris campuses; the Crookston, Grand Rapids, Lambertson, Morris, and Waseca agricultural experiment stations; and the Carlton Extension Service. There are 279 investigators represented in the inventory. Among the 184 projects that reported using research assistants, 580 students were employed. There were 323 at the graduate level and 257 at the undergraduate level. The 120 sources of funding which were identified include thirteen different units at the University of Minnesota; county, state, and federal government agencies; and various associations and foundations.

Research projects are organized into sixteen broad subject categories as noted on the contents page. Within each category, entries are arranged by department, principal investigator, and project title. Also included are project number, investigators, address and phone number of the principal investigator, project description, location of research, funding source and amount, start and ending dates, and number of graduate and undergraduate students. In some cases, a blank space occurs after a heading name. This indicates that information for that item was either not applicable or not available from the investigator at the time of publication. Since most projects in the inventory are ongoing, interested readers can use this space to record updated information obtained from the investigator.

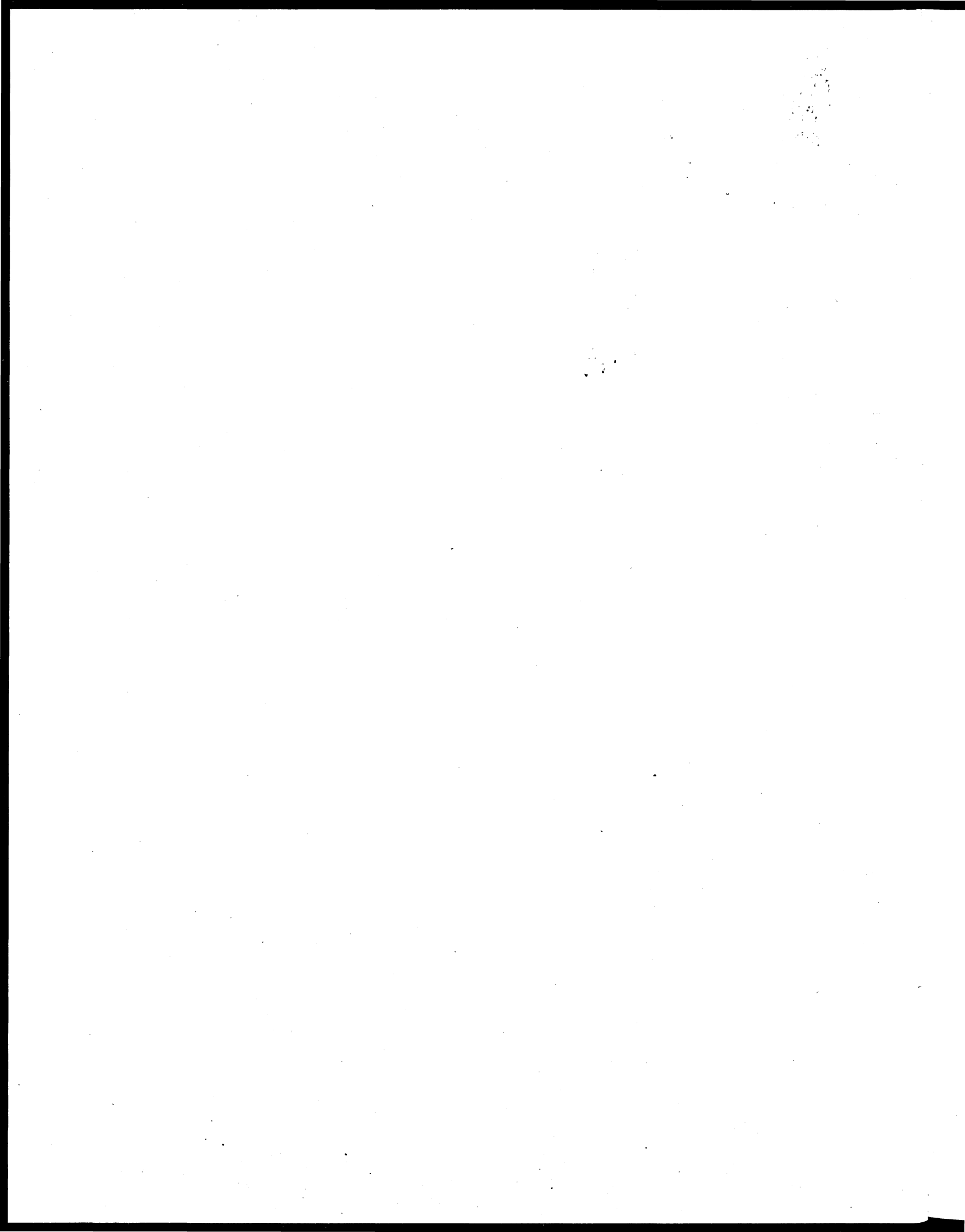
A topical arrangement of research projects was chosen so that readers can quickly scan the sections corresponding to their interests. The interdisciplinary nature of environmental research is illustrated by the variety and number of departments represented within each subject category. For example, the first category, "Ecology," contains fifteen projects from nine different departments.

To further assist readers in locating research matching their interests, four indexes are provided in the back of the book:

1. Department index
2. Funding source index
3. Investigator index
4. Subject keyword index

The subject keyword index provides access to the wealth of information covered in the environmental inventory. Use of this index will lead the reader to both broad and specific topics via over 410 keywords.

Many members of the CURA staff have contributed to this report. Our production unit merits special acknowledgment—Christine McKee for her precision and diligence in proofreading the manuscript, and Louise Duncan for her skill and creativity in desktop publishing and design. Special thanks also to Monica Colberg from the All-University Council on Aging for sharing the expertise she gained in compiling *Research on Aging*, Ronald Kroese for his help in defining agricultural terms, Judith Weir for her editorial ideas, and Elizabeth Reed and Heather Juujarvi for their assistance in handling mailings and messages.



ECOLOGY

1

Abundance and Distribution of Mussels in the Rivers of Minnesota

Robert C. Bright

Bell Museum of Natural History
College of Biological Sciences
300 Bell Museum
10 Church St. S.E.
Minneapolis, MN 55455
(612) 624-2866 or (612) 624-0349

Project Description: The purpose of this project is to determine the distribution and abundance of mussels in the streams and rivers of Minnesota. This provides baseline data for establishing change and regulation where needed.

Location of Research:

Dates: 01/87—Ongoing

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$78,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2-4

Related Research Publications:

2

Breeding Strategies of Waterfowl

Frank McKinney and Susan Evarts

Bell Museum of Natural History
College of Biological Sciences
300 Bell Museum
10 Church St. S.E.
Minneapolis, MN 55455
(612) 624-1698

Project Description: Comparative studies of the breeding behavior of waterfowl have been carried out since 1964 in specially constructed aviaries at Cedar Creek Natural History Area in Bethel, Minnesota. These studies of captive birds have been complemented by field studies in Canada, Africa, Australia, New Zealand, and South America. Currently research is in progress on several South American dabbling duck species, and special attention is being given to the endangered Laysan Teal. The focus of this research program is on the social systems of dabbling ducks, including the behavior related to mating, spacing, parental care, and communication. Differences between the social behavior of closely related species are interpreted in relation to ecological factors such as climatic conditions, habitat characteristics, food, and predators. These studies provide a basic understanding of the needs of each species and yield information that can be used in management and conservation.

Location of Research: Cedar Creek Natural History Area, Bethel, Minnesota; field sites in South America

Dates: 04/89—09/91

Funding Source: National Science Foundation

Funding Amount: \$75,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 1

Related Research Publications:

McKinney, F., D. Buitron, and S.R. Derrickson. 1990. Persistent quacking in dabbling ducks: A predator-luring signal? *Wildfowl* 41: 92-98.

McKinney F., L.G. Sorenson, and M. Hart. 1990. Multiple functions of courtship displays in dabbling ducks (Anatini). *Auk* 107: 188-191.

McKinney F. and G. Brewer. 1989. Parental attendance and brood care in four Argentine dabbling ducks. *Condor* 91: 131-138.

3

Biological Diversity and Population Distribution of Birds: Continuing Sampling of Habitats and Collection of Specimens

David F. Parmelee

Bell Museum of Natural History
College of Biological Sciences
300 Bell Museum
10 Church St. S.E.
Minneapolis, MN 55455
(612) 624-0564

Project Description: The Bell Museum maintains a bird collection for research and to provide information for conservation efforts. Accurate knowledge of avian diversity and classification, and the likelihood of future change in climate, habitats, and populations, makes the tracking of these changes very important. The application of new techniques to bird specimens is leading to a revolution in our understanding. Hundreds of new bird species have been discovered in the past decade through the accumulation and examination of specimens. Research projects now underway include these being carried out by doctoral students:

Kevin S. Winker

- Avian Distribution and Abundance Records for the Sierra de los Tuxtlas, Veracruz, Mexico
- The Birds of Cape Peirce, Bristol Bay, Alaska
- Genetics of Two Flycatchers: *Empidonax traillii* and *Empidonax alnorum*
- The Long-Tailed Sabrewing (*Campylopterus excellens*) in Southern Veracruz Hummingbird
- Microhabitat Preferences of Songbirds Wintering in Tropical Rainforest
- Morphometrics of Migrant Songbirds
- Molt and Migration of the Least Flycatcher in Southern Veracruz, Mexico
- Morphometrics of Resident, Monochromatic Tropical Birds
- Timing of Autumn Migration in the Yellow-Bellied Flycatcher

John T. Klicka

- The Biological Status of the Black-Spotted Newt (*Notophthalmus meridionalis*)
- Breeding Biology of the Rock Sandpiper (*Calidris ptilocnemis*) at Cape Peirce, Alaska
- Intraspecific Phylogeny of the Hooded Oriole (*Icterus cucullatus*)
- Observations of Ravens Preying on Adult Kittiwakes
- Phylogeography of the Common Yellowthroat (*Geothlypis trichas*): A Study of Geographic Variation

Richard D. Benson

- Pleistocene Avifauna of the Cisneros Mine Cave System, Northern New Mexico

Dwain D. Warner

- Migratory Stopover Site Use by Transient Songbirds: Diurnal Mass Gains and Habitat Preferences

Location of Research: Various locations including central Minnesota; Taos, New Mexico; Togiak National Wildlife Refuge, Cape Peirce, Alaska; Bristol Bay, Alaska; Welder Wildlife Refuge, Sinton, Texas; south Texas; northern Tamaulipas, Mexico; Veracruz, Mexico

Dates: Ongoing

Funding Source: National Science Foundation; Bell Museum of Natural History, University of Minnesota; and others

Funding Amount: \$270,000 (NSF/5 years) plus other grants

Number of Graduates Working with Project: 5

Number of Undergraduates Working with Project: 20

Related Research Publications:

Call investigators at the Bell Museum for further information on projects and publications.

4

Genetic Analysis of Peregrine Falcons Released in the Upper Midwest

Harrison B. Tordoff, Sharon Moen, and Patrick Redig

Bell Museum of Natural History
College of Biological Sciences
300 Bell Museum
10 Church St. S.E.
Minneapolis, MN 55455
(612) 624-1852

Project Description: Due largely to DDE poisoning, peregrine falcons (*Falco peregrinus*) became endangered in most parts of their range in North America and extinct east of the Rocky Mountains. Two major reintroduction efforts have been undertaken since the extirpation of *F.p. anatum* from the eastern and midwestern regions of the United States. One area of concern in such reintroduction programs is whether newly established populations retain adequate levels of genetic diversity. This is an ideal time to explore the genetic aspect of the peregrine falcon reintroduction in the Midwest because the founding population is still alive and identifiable birds are beginning to nest. The pedigree of each established wild bird can be derived from existing records to estimate inbreeding and founder contributions. DNA analyses can provide accurate measures of genetic diversity and population relationships.

The objectives of this project are: 1) construct pedigrees to calculate the contribution of founders to current populations, 2) calculate and review effective population size, genetic variation, and inbreeding coefficients in new populations, 3) develop a management program based on the genetic information gathered and the goals of the reintroduction program, and 4) design a computer model using life history information and genetic data to project the future of the reintroduced peregrine population.

Location of Research: Bell Museum of Natural History and the Raptor Center, University of Minnesota

Dates: 07/90—09/92

Funding Source: U.S. Fish and Wildlife Service; Minnesota Department of Natural Resources; University of Minnesota Graduate School Grant-in-Aid

Funding Amount: \$20,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

5

Field Investigations of Food Chain and Game Fish Accumulations of Dioxin from Incinerator Emissions

Steven J. Eisenreich, Deborah L. Swackhamer, and Keith B. Lodge

Civil and Mineral Engineering
Institute of Technology
122 Civil and Mineral Engineering
500 Pillsbury Drive S.E.
Minneapolis, MN 55455
(612) 625-5522

Project Description: The objective of this research was to monitor and study the pathways dioxin travels from a waste incinerator into the human food chain in order to evaluate and improve the existing health risk assessment model used in the environmental review and permitting process for waste incinerators required by the Minnesota Pollution Control Agency. Presently, the scientific models have shown that the uptake of dioxin by game fish and eventual human consumption can be a major component of the cancer risk from incinerator emissions. While these models represent present best estimates of the extent to which dioxin moves from air to water to fish, they have not been validated under actual conditions. The outcome of this project will be a working model for predicting fish concentrations in aquatic systems impacted by incinerator emissions.

Location of Research:

Dates: 12/89—12/91

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

6

The Role of Secondary Chemicals in the Consumption of Watercress

Raymond M. Newman

Fisheries and Wildlife
College of Natural Resources
120 Hodson Hall
1980 Folwell Ave.
St. Paul, MN 55108
(612) 625-5704

Project Description: The role of chemical deterrents or defensives in plant herbivore interactions is well established in terrestrial systems, but only recently have chemical defenses been studied in aquatic systems. Previous research has shown that watercress possesses a classic example of chemical defense found in terrestrial crucifers. This defense agent is quite toxic to several aquatic herbivores. This project will provide additional evidence of this feeding deterrent and characterize the deterrent effects of the glucosinolate and isothiocyanate chemical defenses. Further work on aquatic plant chemistry and feeding deterrence may help explain the general lack of aquatic herbivory and suggest approaches to enhance biological control of nuisance aquatic weeds.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 09/91—Ongoing

Funding Source: A.S. Cargill III, Stream Research Grant

Funding Amount: \$8,500

6

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1-2

Related Research Publications:

Newman, R.M., W.C. Kerfoot, and Z. Hansom, III. 1990. Watercress and amphipods. Potential chemical defense in a spring stream macrophyte. *Journal of Chemical Ecology* 16(1): 245-258.

Newman, R.M. 1991. Herbivory and detritivory on freshwater macrophytes by invertebrates: A review. *Journal of the North American Benthological Society* 10(2): 89-114.

7

Remote Sensing Approach to Avian Conservation: A Greater Sandhill Crane Model

Lloyd P. Queen and Francesca Cuthbert

Forest Resources
College of Natural Resources
115 Green Hall
1530 N. Cleveland Ave.
St. Paul, MN 55108
(612) 624-9271

Project Description: The goal of this project was to develop a descriptive GIS model to identify potentially suitable nesting habitat of Greater Sandhill Cranes in northwestern Minnesota. Four primary objectives of the project were: 1) to produce a digital map of plant communities in the study area from Landsat-5 Thematic Mapper data to be used as a primary data layer in the GIS model, 2) to characterize the habitat of twenty-two known nest sites in Espelie and Veldt townships of Marshall County using the EPPL7 GIS software package, 3) to identify potentially suitable nesting habitat in Poplar Grove and Golden Valley townships of Roseau County using the descriptive model developed from the nest site characteristics studied in Espelie and Veldt, and 4) to compare the results of the model in Poplar Grove and Golden Valley to the locations of ten known nest sites. The primary outcome derived from this research was less a working nesting habitat model than an understanding of the assumptions and limitations that are inherent in such modeling procedures.

Location of Research: Marshall and Kittson counties, Minnesota

Dates: 04/91—12/91

Funding Source: Minnesota Department of Natural Resources, Nongame Wildlife

Funding Amount: \$9,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Ecology

8

Modeling Grassland Changes

Dwight Brown

Geography
College of Liberal Arts
414 Social Sciences
267-19th Ave. S.
Minneapolis, MN 55455
(612) 625-9097

Project Description: Simulation modeling of dispersal and changes in patterns of abundance of native grass species in the midcontinent Plains over the past 15,000 years.

Location of Research: Department of Geography, University of Minnesota

Dates: 01/88—Ongoing

Funding Source:

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

9

Maps of Natural Communities and Rare Species of Minnesota by County

Gregory H. Chu

Geography
College of Liberal Arts
414 Social Science
267-19th Ave. S.
Minneapolis, MN 55455
(612) 625-0892

Project Description: To design and produce maps for four different papers (Professional Papers, #1405-C, #1404-G, #1414-B, and #1454) under a project titled "A Regional Groundwater Flow Model of the Cambrian-Ordovician Aquifer System in the Northern Midwest, United States." To date, three maps have been produced: 1) Natural Communities and Rare Species, Washington County, Minnesota, 1987-1989; 2) Threatened Natural Communities and Rare Species, Big Stone County, Minnesota, 1987-1989; and 3) Threatened Natural Communities and Rare Species, Lac Qui Parle County, Minnesota, 1987-1989. Data for maps were provided by the Department of Natural Resources as a result of the DNR's Biological Survey of Minnesota.

Location of Research: Twin Cities Campus, University of Minnesota

Dates: 01/90—Ongoing

Funding Source: Minnesota Department of Natural Resources; U.S. Geological Survey

Funding Amount: \$71,234

Number of Graduates Working with Project: 8

Number of Undergraduates Working with Project: 4

Related Research Publications:

8

10

Animal Influences on the Aquatic Landscape: Vegetation Patterns, Successional Transitions, and Nutrient Dynamics

Carol A. Johnston, John Pastor, and John Bonde

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: By building dams and cutting trees for food and shelter, beaver greatly alter the productivity and distribution of aquatic and terrestrial resources in northern areas. For example, previous work on this project has shown that 13% of the land area of Voyageurs National Park is underwater in beaver ponds, and perhaps an additional 10-15% is in upland forests adjacent to ponds where beaver cut large aspen. The present project will quantify the effect of beaver on streams and forests of Voyageurs National Park, International Falls, Minnesota, and make extensive use of the Geographic Information System Laboratory. Beaver ponds were mapped using 13 dates of aerial photos taken between 1927 and 1990, and forest cover was mapped using 1940, 1961, and 1986 photos. GIS databases prepared from these maps are being analyzed to determine transitions under natural succession, and under the influence of the beaver. This project is in cooperation with the University of Washington.

Location of Research: Voyageurs National Park

Dates: 03/89—08/92

Funding Source: National Science Foundation

Funding Amount: \$387,909

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 4

Related Research Publications:

Johnston, C.A. and R.J. Naiman. 1990. Aquatic patch creation in relation to beaver population trends. *Ecology* 71: 1617-1621.

Johnston, C.A. and R.J. Naiman. 1990. Browse selection by beaver: Effects on riparian forest composition. *Canadian Journal of Forest Research* 20: 1036-1043.

Johnston, C.A. and R.J. Naiman. 1990. The use of geographic information system to analyze long-term landscape alteration by beaver. *Landscape Ecology* 4: 5-19.

Naiman, R.J., T. Manning, and C.A. Johnston. 1991. Beaver population fluctuations and tropospheric methane emissions in boreal wetlands. *Biogeochemistry* 12: 1-15.

11

A Cooperative Facility for Research on the Ecology of Spatial Heterogeneity

Carol A. Johnston, John Pastor, and Lucinda Johnson

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: This equipment grant was used to establish a state-of-the-art geographic information system facility within the University of Minnesota. The core facility is at the Natural Resources Research Institute in Duluth, with auxiliary facilities at the University of Minnesota's St. Paul and Minneapolis campuses. The facility is fully networked, both internally with Ethernet connec-

tions and externally through the University of Minnesota's computing network. To date, the capabilities of the GIS facility have been used by 24 investigators on 28 projects funded by 15 different federal, state, and private agencies.

Location of Research:

Dates: 11/88—04/91

Funding Source: National Science Foundation

Funding Amount: \$354,342

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Johnson, L.B. 1990. Analyzing spatial and temporal phenomena using geographic information systems: A review. *Landscape Ecology* 4: 31-43.

Johnston, C.A. 1991. GIS technology in ecological research. *Encyclopedia of Earth System Science, Vol. 2*. Academic Press, San Diego, CA.

Pastor, J. and C.A. Johnston. 1992. Using simulation models and geographic information systems to integrate ecosystem and landscape ecology. In *New Perspectives for Watershed Management*, ed. R.J. Naiman, and J. Sedell. Springer-Verlag, New York.

12

Sediment Contamination and Bioaccumulation in Wildlife: An Experimental Approach Using Tree Swallows (*Tachycineta bicolor*)

Gerald J. Niemi, Michael E. McDonald, and D. Beaver

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: Exposure of wildlife to bioaccumulative environmental contaminants can be evaluated through measurements of tissue concentrations and through monitoring adverse biological effects. This project will determine the effectiveness of using Tree Swallows as wildlife sentinel species for detecting areas of high or low sediment contamination. Tree Swallow eggs and nestlings, emerging insects, benthic insects, and sediments were collected from each of three sites representing a relatively clean area in the headwaters above Midland, Michigan, a moderately contaminated site near the Shiawassee National Wildlife Refuge, and a relatively contaminated site near Saginaw Bay, Michigan. A wildlife residue data base will be established to enable modeling of environmental contaminant effects.

Location of Research: Saginaw River Basin, Michigan

Dates: 09/91—09/93

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$140,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

13

Biological Control of Purple Loosestrife**Robert F. Nyvall**

North Central Experiment Station
Institute of Agriculture, Forestry, and Home Economics
1861 Highway 169 East
Grand Rapids, MN 55744
(218) 327-4490

Project Description: Purple loosestrife, (*Lythrum salicaria*), is a plant of European origin that has invaded wetlands of the United States, displacing native vegetation. Purple loosestrife is not known to provide any useful purpose to wildlife; therefore, it is considered to be an undesirable weed species. Research is being initiated in the use of biological control, specifically fungi that would serve as effective mycoherbicides. Fungi are being isolated from purple loosestrife plants gathered from throughout Minnesota using standard mycological isolation techniques. Fungi will be evaluated as candidate mycoherbicides based on their pathogenicity on purple loosestrife.

Location of Research: North Central Experiment Station, Grand Rapids, Minnesota

Dates: 07/91—Ongoing

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$7,000/year

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

14

**Life History, Demography, and Genetics of *Aconitum noveboracense*:
Implications for Preservation and Management of a Threatened Species****Margaret A. Kuchenreuther**

Science and Mathematics
General College
166 Science
University of Minnesota, Morris
Morris, MN 56267
(612) 589-6335

Project Description: The life history, demography and genetics of Iowa and Wisconsin populations of *Aconitum noveboracense* (northern monkshood) were studied over a six-year period, with the aim of developing preservation and management guidelines for the species. Populations grow in several habitats, that differ mainly with respect to temperature. Populations in different habitats exhibited variation in density, size class structure, and degree of reliance on sexual versus asexual modes of reproduction.

A matrix population model was used to compare population growth rates during the period from 1987-1989. A majority of lambda values fell below one, indicating that most populations were declining during this period. The decline coincided with two years of extreme drought and therefore may not represent long-term trends of population growth. Populations growing on the coldest sites showed the smallest rates of decline, indicating they may have been buffered somewhat from the effects of the drought.

Populations were surveyed for ribosomal DNA repeat length variation. Variation was found both within individuals and within populations. The degree of variation observed was not correlated to population size or mode of reproduction. Genetic similarity among populations was not correlated with geographic proximity.

Ecology

Data analysis is continuing and manuscript preparation is in progress. Additional genetic studies are anticipated.

Location of Research: The "Driftless Area," specifically northeast Iowa and southwest Wisconsin

Dates: 05/84 (project moved to U of M 09/91)—Ongoing

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

15

Plants as Indicators of Elevated Ozone Concentrations

David F. Grigal

Soil Science

College of Agriculture

439 Borlaug Hall

1991 Upper Buford Circle

St. Paul, MN 55108

(612) 625-1244

Project Description: Common milkweed (*Asclepia syriaca* L.), soybean (*Glycine max* L. Merr.) and potato (*Solanum tuberosum* L.) were grown as ozone indicators in field plots throughout the state as part of the Minnesota Bioindicator Project. Every two weeks, plants were assessed for foliar symptoms induced by ozone and other abiotic and biotic factors. Electronically monitored ozone data were provided by state and federal agencies.

Location of Research: Minnesota

Dates: 01/89—12/90

Funding Source: U.S. Department of Agriculture, Agricultural Research Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on ECOLOGY, see project numbers 36, 37, 42, 72, 151, 161, 252, 238.

ENERGY

16

Parametric Modeling of Minnesota Building Type Energy Use

Lance LaVine

Architecture
College of Architecture and Landscape Architecture
110 Architecture
89 Church St. S.E.
Minneapolis, MN 55455
(612) 624-5236

Project Description: This project will use computer simulation analysis of a range of potential energy conserving strategies on a 60,000 square foot suburban office building. Six alternative design strategies will be analyzed using the following procedures: development of technology bundles that reduce the energy use of this base building by 30% or more; analysis of the energy impacts of these strategies on the use of electricity and natural gas; development of costs for these strategies; a cost benefit analysis of these strategies; and a comparison of the costs and savings of these strategies with those available using existing Northern States Power's rebate program.

Location of Research:

Dates: 11/88—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$100,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

17

Human Factors and Energy Performance of Buildings

Julia W. Robinson

Architecture
College of Architecture and Landscape Architecture
110 Architecture
89 Church St. S.E.
Minneapolis, MN 55455
(612) 624-7866

Project Description: Present models for human comfort are based on laboratory studies. A more comprehensive and integrated model of human comfort must account for relationships between human variables, characteristics of the environment (defined to include more than standard thermal comfort variables), and reported perceived comfort in everyday environments. There have been few attempts at determining what data are necessary for more comprehensive modelling and collecting such data. In this project, residents of multi-family buildings energy use is studied relative to user factors and unit design in multi-family buildings. Data were collected (temperature, relative humidity, mean radiant temperature, air movement, energy consumption and lighting) in similar units in selected buildings. In conjunction with this, data on residents' activity and perceived comfort were collected with questionnaires and an activity diary. Residents' perceived comfort and activity are compared to standard comfort predictions.

Location of Research: Twin Cities metropolitan area

Dates: 10/88—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$126,316

Number of Graduates Working with Project: 5

Number of Undergraduates Working with Project: 4

Related Research Publications:

18

Simulation and Analysis of Wind-Related Heat Losses and Building Comfort

Cesar Farell and Charles Song

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157 Civil and Mineral Engineering
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Project Description: This program will study the effect of wind on infiltration heat losses and user comfort in buildings using wind tunnel measurements and numerical simulations. Included in it are the utilization of experimental testing in the new atmospheric boundary layer wind tunnel of the St. Anthony Falls Hydraulic Laboratory and the development of computational models making use of the latest supercomputers. Atmospheric winds including turbulence intensities and eddy sizes will be modeled, allowing for the study of the effect of wind flow patterns on infiltration losses and comfort parameters. Specific project objectives include: the wind tunnel modeling of the characteristics of atmospheric boundary layer winds for different terrain and building conditions; the measurement of surface pressures and velocity field parameters for single-building shapes, and verification of the mathematical model; the determination of the effect of skyways on microclimate conditions and pedestrian comfort in downtown urban areas; and the development of the basis for extending the analyses for single-buildings to building groups under various topographic conditions.

Location of Research:

Dates: 11/88—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$480,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 1

Related Research Publications:

19

**Environment, Energy and Everyday Living: The Impacts of Lifestyles,
An Anthology****Bonnie M. Morrison**

Design, Housing and Apparel
College of Human Ecology
240 McNeal Hall
1985 Buford Ave.
St. Paul, MN 55108
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Project Description: This anthology makes explicit the dynamic interrelationships of environment, energy demand, and patterns of everyday activities and choices. It is a conceptual breakthrough because it not only summarizes that most important residential energy use research of the past two decades but also demonstrates the utility of research that goes beyond housing alone. This new research is defined as the lifestyle approach, in which the daily activities and consumption paths of households are measured and assessed for their energy and environmental implications. In contrast to sectoral analysis, which structured earlier investigations, lifestyle research provides the data necessary for the understanding of the dynamics behind the resultant energy demand and environmental impacts. The anthology represents the work of scholars from around the world, using case studies and cross-cultural comparisons to provide a rich international perspective.

Location of Research:**Dates:** 01/74—Ongoing**Funding Source:** Minnesota Building Research Center, University of Minnesota; Minnesota Agricultural Experiment Station**Funding Amount:****Number of Graduates Working with Project:****Number of Undergraduates Working with Project:****Related Research Publications:**

Morrison, B.M. 1987. Chapter in *Perspectives on Individual Behavior*, American Council for an Energy Efficient Economy. ACEEE Press.

Morrison, B.M. 1985. Exploring an energy myth: Eighty years of household energy consumption in the United States, 1900-1980. *Second International Conference, Consumer Behavior and Energy Policy, Paris, April 10-15, 1985.*

20

Cold Climate Performance of Radiant Barrier Systems in Residences**Robert Erickson and Timothy Larson**

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203 Kaufert Laboratory
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Project Description: A great deal of interest has been generated in the use of radiant barrier systems in warm climates because they can save 8% to 10% on cooling costs when installed in attic spaces. There are questions as to the cost effectiveness of radiant barrier systems in cold climates, where heating is the predominate mode of conditioning indoor air. The main objective of the research project is to evaluate the impact of radiant barrier systems on heat flux out of a ceiling/roof system depending

Energy

on location of the radiant barrier, insulation level, and inside/outside temperature gradient. The research will also assess the impact of radiant barriers on moisture content of wood in the ceiling/roof system as well as the cost effectiveness of radiant barriers in cold climates.

Location of Research:

Dates: 10/89—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$110,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

21

Performance of Wood-Based Siding in Energy Efficient Housing in Cold Climates

Roland O. Gertjejansen and Robert E. Kroll

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203 Kaufert Laboratory
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St. Paul, MN 55108
(612) 624-4730

Project Description: Homes built in cold climates frequently have severe exterior wall cavity moisture problems. High levels of moisture in exterior walls can result in severe deterioration of wood-based sidings and sheathing, including extreme thickness swelling, loss of surface particles or fibers, accelerated decay, strength loss and paint failure. This project will identify, by means of a newly constructed test house, the construction techniques and wood-based siding products which are best suited for energy-efficient homes in cold climates. The results from the project will provide homeowners, builders, and designers with specific information concerning the proper selection and application of wood-based siding materials.

Location of Research: Cloquet Forestry Center, Cloquet, Minnesota

Dates: 10/89—08/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$91,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

Kroll, R.E., K.C. Au, and R.O. Gertjejansen. 1992. Performance of wood-based siding in energy efficient homes located in cold climates. *Proceedings of the Thermal Performance of Exterior Envelope of Buildings Conference V, December 7-10, 1992.*

22

Evaluation of Performance-Based Standards for Energy Efficient New Homes**Patrick H. Huelman**

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203 Kaufert Laboratory
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St. Paul, MN 55108
(612) 624-1286

Project Description: During the 1991 Minnesota Legislative Session, House File 911 was introduced which proposed performance-based energy standards for new residential construction. This project will evaluate these performance standards, addressing concerns about affordability, availability of equipment and techniques to meet the standards, reliability of new techniques, and the implications these standards will have on home buyers and the home building industry. In addition, the effectiveness of various design and construction approaches to meet such standards, the potential energy savings over existing standards, and the cost impact to builders and consumers will also be analyzed. A pilot builder training program is planned as an outgrowth of the evaluation of the standards.

Location of Research:

Dates: 12/91—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$75,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

23

Micro- and Meso-Climate Effects on Energy Use and Comfort**Lance Neckar and Roger Martin**

Landscape Architecture
College of Architecture and Landscape Architecture
432 Alderman Hall
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(612) 624-3259

Project Description: This project will examine measurements of local microclimate conditions at building sites to establish a database of climatic variation at the site scale and the impact of land form and vegetation on the energy performance of selected building types. Specifically, this project will investigate ways of ameliorating undesirable wind conditions in outdoor spaces as a way of encouraging use of outdoor spaces rather than the construction of more highly enclosed and energy-consumptive spaces. The overall goal is to understand the general and specific patterns of winds around skyways as baseline data to begin to suggest design moves to ameliorate inhospitable conditions. Measurements will be made at the University Arboretum, models of the effects of structural and land form variation and vegetation will be developed and models will be tested in the Atmospheric Boundary Layer Wind Tunnel. Results will be produced in a manner accessible to design professionals. Specifically, improved design techniques for skyways will enable designers to ameliorate conditions in the pedestrian environment below the skyway and to enhance the energy performance of the skyway itself.

Location of Research: Arboretum, University of Minnesota

Energy

Dates: 11/88—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$150,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project:

Related Research Publications:

24

Planting for Energy Conservation in Minnesota Communities

**Margaret Sand, Patrick H. Huelman, David Grismrud, Edward Sucoff,
Donald G. Baker, and Charlie Huizinga**

Landscape Architecture
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Project Description: This project will quantify the heating and cooling energy conservation potential of alternative landscape designs for a range of Minnesota building types and climatic regions using computer building energy simulation models. In addition, a range of site plans using test buildings and plants will be developed to represent alternatives with potential for energy conservation. A model for assessing cost-effectiveness of alternative planting scenarios will be enhanced and applied to alternative designs. Results will be translated into useful planting guidelines for both individual properties and for community scale programs, for use by the public and for evaluating cost-share projects.

Location of Research:

Dates: 10/91—06/93

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$199,450

Number of Graduates Working with Project: 4-5

Number of Undergraduates Working with Project:

Related Research Publications:

Sand, Margaret. 1991. *Planting for Energy Conservation in the North*. USDA Forest Service, Northeastern Area, State and Private Forestry, and the Minnesota Department of Natural Resources, Division of Forestry. 19 pp.

Energy and the Indoor Environment**Thomas Kuehn and James Ramsey**

Mechanical Engineering
Institute of Technology
125 Mechanical Engineering
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Project Description: Reductions in ventilation rates in an effort to achieve energy efficiency have caused moisture and other indoor air contaminants to increase to unhealthy levels. The purpose of this project is to study the effect of moisture source control, moisture storage in building materials and moisture removal by ventilation to determine which control strategies are the most effective and the most energy efficient in northern climates. Residential kitchen exhaust equipment has been studied to determine its effectiveness in capturing and removing typical indoor contaminants, including moisture. Typical building materials are being investigated to determine how much moisture they absorb and how readily moisture penetrates through these materials. Ventilation effectiveness is being measured for typical office buildings.

Location of Research:

Dates: 01/87—06/92

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$600,000

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project: 1

Related Research Publications:

Han, H., T. Kuehn, M. Perkovich, J. Ramsey, and S. Youssef. 1989. A study of air flow patterns near kitchen range exhaust systems. *Proceedings of the 40th Annual International Appliance Technical Conference*, 107-118, Purdue University, West Lafayette, IN.

Kuehn, T.H., J.W. Ramsey, H. Han, M. Perkovich, and S.W. Youssef. 1989. A study of kitchen range exhaust systems. *ASHRAE Transactions* 95(1): 744-752.

Kuehn, T.H., J.W. Ramsey, H. Han, M. Perkovich, and W.W. Olson. 1991. Performance of kitchen range exhaust systems. Presented at the National Association of Home Builders Annual Conference, Atlanta, GA.

Kuehn, T.H., J.W. Ramsey, H. Han, M. Perkovich, M. Corpron, and H. Liang. 1991. Study of airflow patterns and ventilation effectiveness in a half-scale office building. Presented at the 3rd International Symposium on Ventilation for Contamination Control, Cincinnati, OH.

Han, H., T.H. Kuehn, J.W. Ramsey, H. Liang, and K. Elayed. 1991. Turbulent modeling of airflow patterns and ventilation effectiveness in a half-scale office building. Presented at the 12th AIVC Conference, Ottawa, Canada.

26

Institutional Lighting Audit Program

David Grimsrud and Charlie Huizenga

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(612) 626-7419

Project Description: Energy efficient lighting retrofits represent an important aspect on an institutional energy efficiency program. The process of identifying potential retrofits and having them installed can often be cumbersome. The purpose of this project is to develop an institutional lighting audit program which will identify appropriate lighting retrofits and generate sufficiently detailed information such that an institution can directly use the results of the audit for bidding and installation process. The lighting audit program will include the following components: lighting audit form used to collect detailed data from buildings; a lighting audit data base application to allow input, storage, review, sorting, and analysis of the audit data; retrofit analysis which can analyze potential retrofit measures for cost effectiveness; report generation; and program testing.

Location of Research:

Dates: 12/90—09/91

Funding Source: Northern States Power

Funding Amount: \$33,120

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

Huizenga, C., M. Fagerson, D. Grimsrud, G. Loisos, and M. Vogel. 1990. University of Minnesota building energy efficiency project. *Proceedings of the Energy Cost Avoidance in Educational Buildings Conference*, University of Michigan, Ann Arbor, MI, June 5-6.

Huizenga, C., M. Colman, and J. Smith. 1992. Evaluation of a major lighting retrofit program. Presented at the American Council for an Energy Efficient Economy Summer Study.

27

Energy Efficient Housing: A Technology Transfer of Swedish Manufacturing Techniques to Minnesota

Mary Vogel and James L. Bowyer

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Project Description: This project seeks to establish the viability of an energy efficient manufactured housing industry in Minnesota by building on the Swedish housing experience and combining the knowledge, expertise and resources available at the University of Minnesota and within the state. The project explores the anticipated market cost opportunities and constraints; investigates the use and development of Minnesota's resources and products for materials; determines the feasibility of possible production techniques; investigates the public policy framework for marketing industrialized housing; and assesses the importance of design in the marketing of manufactured housing.

Location of Research:**Dates:** 11/88—06/93**Funding Source:** Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature**Funding Amount:** \$250,000**Number of Graduates Working with Project:** 4**Number of Undergraduates Working with Project:** 0**Related Research Publications:**

Grace, C. and D. Herman. 1991. *An Evaluation of the Single-family Housing Market in the Twin Cities Metropolitan Area (1990-2010)*. Minnesota Building Research Center, University of Minnesota.

28

Energy Efficient Water Management Systems for Blueberries

David K. Wildung and Jerry A. Wright

North Central Experiment Station
Institute of Agriculture, Forestry, and Home Economics
1861 Highway 169 East
Grand Rapids, MN 55744
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Project Description: This project is intended to develop water use patterns and evaluate several irrigation systems for energy and water management efficiency in small fruit production. The test plant will be blueberries. Comparisons of the more common traditional sprinkler irrigation systems and potentially more efficient trickle irrigation systems will be made. Several possible trickle irrigation systems (buried, single line surface and double line surface) and scheduling systems (different soil moisture tensions and evaporation pan systems) will be compared for energy efficiency, water utilization, management and desirable plant development characteristics. We hope to identify the most energy and water conservative trickle irrigation system available for maximum blueberry plant and fruit development. Project results will be important for other crops utilizing trickle irrigation systems in Minnesota and the region. Results from the project will be disseminated through the University of Minnesota Agricultural Experiment Station, Minnesota Extension Service, and Minnesota Berry Growers Association, at Experiment Station Field Days, Berry Grower Field Days, Berry Growers Schools and industry newsletters. Extension bulletins will be revised to reflect the more energy and water efficient irrigation systems identified with this project.

Location of Research: Staples Irrigation Center**Dates:** 05/88—Ongoing**Funding Source:** Minnesota Agricultural Experiment Station; Minnesota Berry Growers Association**Funding Amount:** \$600**Number of Graduates Working with Project:****Number of Undergraduates Working with Project:****Related Research Publications:**

Wildung, David and Jerry Wright. 1991. Micro-irrigation management with blueberries. *Minnesota Fruit and Vegetable Growers Association Proceedings*. 11 pp.

29

Foundation Insulation Program

Louis Goldberg and Raymond L. Sterling

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Institute of Technology
790 Civil and Mineral Engineering
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Project Description: The Underground Space Center's Foundation Test Facility (FTF) was established in 1988 to demonstrate objectively and unambiguously that foundation insulation produces significant heating energy savings in Minnesota. The 12-acre, \$1.2 million facility at the University's Rosemount site includes a total of six foundation test modules. During the facility's second heating season, from December 1989 to April 1990, the heating and energy savings produced by interior and exterior thermal insulation were experimentally quantified. The second year test results showed that interior and exterior insulation strategies yielded almost identical energy savings. Specifically, foundation insulation can save more than 50% of the energy required to heat a below-grade conditioned space. The results also showed the effectiveness of interior extruded polystyrene insulation placement is preferable in the absence of any additional waterproofing. This is particularly relevant to retrofit installations where internal basement insulation is preferred because of its cost effectiveness.

Location of Research: Underground Space Center Test Facility, Rosemount, MN

Dates: 07/87—06/92

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$900,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Goldberg, L.F. 1989. *The Thermal Performance of an Insulated Foundation*. Underground Space Center, University of Minnesota.

Goldberg, L.F. 1990. *The Thermal Performance of an Insulated Foundation: Second Year Results*. Underground Space Center, University of Minnesota.

30

Enhanced Low-Income Weatherization

Lester S. Shen and Raymond L. Sterling

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Project Description: Low income residents of the state pay a disproportionate fraction of their income for utility costs but do not have capital available for weatherization. Previous work has shown that low-income weatherization programs have been too expensive to justify economically. The purpose of this project is to refine and transfer the procedures for enhanced weatherization that have been

identified by pilot projects performed in Minnesota and other parts of the United States and incorporate them in an approach that can be implemented by the local low income weatherization providers on a production basis. Training of weatherization crews was identified as a key component for improving the process. The M200 enhanced low income weatherization program was developed and implemented to test these procedures in nine areas of the state.

Location of Research:

Dates: 07/87—06/92

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$300,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Shen, L., G. Nelson, G. Dutt, B. Esposito, J. Fitzgerald, L. Gill, B. Hockinson, and J. Shaten. 1990. The M200 enhanced low-income weatherization demonstration project. *ACEEE 1990 Summer Study on Energy Efficiency in Buildings, August 26-September 1, 1990, Pacific Grove, CA.*

Shen, L., G. Nelson, G. Dutt, B. Esposito, J. Fitzgerald, L. Gill, B. Hockinson, and J. Shaten. 1990. *The M200 Enhanced Low-income Weatherization Demonstration Project.* Minnesota Department of Jobs and Training, St. Paul, MN.

Esposito, B., L. Gill, and L. Shen. 1991. *The MWX90 Protocol: A Model Minnesota Low-income Weatherization Program for the 1990s. Training Manual. Volume 1: Client Education.* Underground Space Center, University of Minnesota, Minneapolis, MN.

Shen, L. 1991. Mousing through the basement. *Home Energy*, 8(5): 20-22.

Shen, L., G. Nelson, G. Dutt, and B. Esposito. 1990. The M200 enhanced low-income weatherization project. *Energy Exchange.* Syracuse, N.Y.

Fitzgerald, J., G. Nelson, and L. Shen. 1990. Sidewall cavity fill insulation and air leakage control. *Home Energy* 7(1): 13-20.

31

The Impact of Radon Mitigation on Building Energy Use in a Cold Climate

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Project Description: The goal of this project is to ascertain the energy penalty incurred by the operation of radon mitigation systems in single-family, detached residential buildings in a cold, heating-dominated climate. Radon mitigation systems can affect the building energy performance in several ways. First, there is the inherent energy cost resulting from the electrical use of the mitigation system. Concomitant effects of the system include the energy losses produced from the interaction of the mitigation system with the air pressure and temperature distributions within the house. These interactions can augment the air infiltration and heat loss characteristics of the building. The system will also influence the moisture and temperature fields in the soil surrounding the house which can also have an impact on the whole house energy usage. Measured changes in energy use of two sets of houses were made by comparing energy use with the mitigation systems operating and when the systems were off.

Energy

Location of Research:

Dates: 07/90—09/91

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$122,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

32

Aquifer Thermal Energy Storage

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Project Description: Aquifer thermal energy storage is an economical method for storing abundant energy for use at a later time. The Underground Space Center has been active in the study of thermal storage since 1988 when it assumed operation of an aquifer thermal energy storage facility for the U.S. Department of Energy. A series of experiments has been conducted of hot water injection, storage and retrieval. Four short-term and three long-term cycles have been completed successfully. Field data from this project are being used in a multi-year study of aquifer energy storage and potential effects on water chemistry by the International Energy Agency.

Location of Research: Aquifer Thermal Energy Storage Test Facility, St. Paul, Minnesota

Dates: 01/88—05/92

Funding Source: Petroleum Violation Escrow Fund from the U.S. Department of Energy through the Minnesota Legislature

Funding Amount: \$1,113,242

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on ENERGY, see project number 100.

FISH AND WILDLIFE

33

COMPMECH Stream System Project (Compensatory Mechanisms in Fish Populations)

Ira R. Adelman, Raymond M. Newman, and Anne R. Kapuscinski

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Project Description: This project will develop improved understanding of the response mechanism of fish populations to alterations in stream flow and improved assessment techniques for determining the stream flow requirements of fish populations. Smallmouth bass will receive primary emphasis, but other fish that interact with smallmouth bass may be included.

Location of Research:

Dates: 04/91—03/96

Funding Source: Electric Power Research Institute (EPRI)

Funding Amount: \$315,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 1

Related Research Publications:

34

Avian Exposure to Agricultural Chemicals in Minnesota

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College of Natural Resources
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Project Description: We are investigating the feasibility of using selected bird species as bioindicators of exposure to cholinesterase-inhibiting insecticides. Results from this study will have direct application for policy and management activities relating to agricultural application of insecticides.

Location of Research:

Dates:

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

35

Direct and Indirect Effects of Agricultural Insecticides on Upland and Wetland Wildlife

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Project Description: We are investigating the direct and indirect effects of agricultural insecticides on upland birds and waterfowl in southern and western Minnesota. Results of this study will have direct application for policy and management activities relating to application of insecticides in agricultural landscapes.

Location of Research:

Dates:

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

36

Fall Migration Ecology of Ring-Necked Ducks in Minnesota

David E. Andersen

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Project Description: Ring-necked ducks (*Aythya collaris*) migrate through Minnesota in large numbers each fall. Rice Lake National Wildlife Refuge (RLNWR), near McGregor, Minnesota is an important fall staging area for these ducks along the Mississippi Flyway. Fall numbers have peaked at 50,000—113,000 during each of the last ten years. Ring-necked duck concentrations shift among several Minnesota lakes during the fall migration, but a major concentration area is centered at RLNWR. Management of RLNWR focuses on manipulation of water levels to encourage production of wild rice (*Zizania aquatica*), which is believed to be the primary fall food of migrating ring-necked ducks and other waterfowl on RLNWR.

Research on migrating ring-necked ducks by the Minnesota Cooperative Fish and Wildlife Research Unit has the following objectives: 1) development of a rules-based model of wild rice production on RLNWR. This will be based on existing data on historical wild rice production levels, ring-necked duck use, other waterfowl use, water levels, rice harvest, and local historic vegetative patterns at RLNWR, 2) complete a fall feeding study of migrating ring-necked ducks, using state-wide hunter-collected gastrointestinal tracts coupled with tracts collected at RLNWR, 3) conduct a study of fall migratory ecology of ring-necked ducks at RLNWR and other regional staging areas, including monitoring of food habits, movements, habitat use, and physiological condition, 4) prepare a final report with specific recommendations for ring-necked duck management at RLNWR. Results of computer modelling will be provided as a computer program to assist managers in management practice evaluation.

Location of Research: Rice Lake National Wildlife Refuge and the Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota

Dates: 05/90—07/93

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

37

Wolf Ecology in Northeastern Minnesota

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North Central Forest Experiment Station
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Project Description: The timber wolf (*Canis lupus*) is classified as threatened in Minnesota and endangered elsewhere in the contiguous 48 states. Two aspects of wolf ecology that are most important to understand in light of wolf recovery elsewhere are: 1) wolf dispersal from reservoir populations, and 2) the precise nature of wolf predation on wild prey. Dispersal supplies the colonizers for new areas, and the potential effects of wolf predation on game herds is the most controversial aspect of wolf recovery.

Objectives for the wolf dispersal portion of the study are to describe the characteristics of wolf dispersal, such as season, distance, direction, and other dispersal variables, and to determine the age, sex, condition, and hormonal and nutritional correlates of dispersing wolves. On the topic of wolf predation on deer fawns the objectives are to determine the role and importance of wolf predation to fawn recruitment in winter and to identify the significance of factors contributing to fawn mortality to wolf predation.

As of October 1, 1990, 7 of the 13 fawns captured this summer were alive and wearing active radio-collars. Analysis of wolf scats collected in 1989 and 1990 was completed. We flew surveys in January to determine doe:fawn ratios.

Location of Research: United States Fish and Wildlife Service; Superior National Forest, Minnesota; Department of Fisheries and Wildlife, University of Minnesota

Dates: 01/90—12/92

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Del Guidice, G.D., K.E. Kunkel, L.D. Mech, and U.S. Seal. 1990. Minimizing capture-related stress on white-tailed deer with a capture collar. *Journal of Wildlife Management* 54: 299-303.

Del Guidice, G.D., L.D. Mech, K.E. Kunkel, E.M. Gese, and U.S. Seal. 1992. Seasonal variation of weight, rectal temperature, and hematology of white-tailed deer in Minnesota. *Canadian Journal of Zoology*.

Kunkel, K.E., R.C. Chapman, L.D. Mech, and E.M. Gese. 1991. Testing the "Wildlink" activity system on wolves and white-tailed deer. *Canadian Journal of Zoology* 69: 2466-2469.

Mech, L.D., K.E. Kunkel, R.C. Chapman, and T.J. Kreeger. 1990. Field testing of commercially manufactured capture collars on white-tailed deer. *Journal of Wildlife Management* 54: 297-299.

38

Effect of Beaver on Trout Streams in Minnesota

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Project Description: There is considerable concern and disagreement about the effects of beaver and beaver dams on trout and trout streams in the Upper Midwest. The aim of this project is to examine the effect of beaver on brook trout populations (density, recruitment, biomass, and growth) in low gradient streams. A manipulative approach will permit comparisons with and without beaver dams and allow for determination of the results of the beaver dam removal.

Three trout streams surveyed for beaver and brook trout in Pine County were selected: Little Hay Creek, Spring Brook, and West Fork Crooked Creek. None of the streams have been recently stocked and all trout (brook trout only) are naturally produced. Trout populations and stream habitat were assessed above and below dams during the summer of 1990. Preliminary analyses indicate that there was only one trout (6.3 cm) present in 1.5 km of Little Hay; mud minnows were dominant. West Fork Crooked Creek contained about 13 trout in 1.5 km. Spring Brook contained the greatest number of trout: 84 < 9 cm, 18 9 to 14 cm, and 2 > 15 cm. However, within Spring Brook, all trout were found within a 0.8 km reach, bounded by an active downstream beaver dam and an inactive series of dams in the middle of the stream. No trout were found in the 1.5 km up and 0.15 km downstream of this middle reach.

Based upon these results and logistical and logistical constraints (access, number of dams, landowner approval), we removed dams from Little Hay in 1991 and used West Fork Crooked Creek and Spring Brook as control streams. Trout populations and habitat were assessed in spring and summer of 1991. Fish will be aged from scales collected in the field and estimates of age specific growth, density, and biomass will be made for data collected in 1990 and 1991.

Location of Research: Department of Fisheries and Wildlife, University of Minnesota; Pine County, Minnesota

Dates: 07/89—06/93

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$43,600

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3

Related Research Publications:

39

Percid Growth as an Index of Environmental Change

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Project Description: A basic understanding of walleye (*Stizostedion vitreum vitreum*) growth in the Red Lakes, Minnesota is important for effective management of the commercial fishery located there. Smith and Pycha (1961) provided age and growth information for the 1940 to 1956 year-classes, but

more recent data are necessary to determine the extent to which growth reflects changes in the fish community.

Growth of commercially-caught walleye over 31 years between 1941 and 1987 is being described using the linear model of Weisberg and Frie (1987). The scale growth increment of a fish in a given year is modeled as the sum of an effect due to the age of the fish and an effect due to the year in which the growth occurs: $\text{Growth} = \text{Age Effect} + \text{Year Effect}$. Age coefficients are estimates of the growth increments which would occur in a constant environment. Year coefficients are estimates of the amounts which would be added to or subtracted from the age coefficients in a given year in order to account for higher or lower growth than that which would occur in a constant environment.

The model shows that from 1979 to 1987, growth increments fluctuated less than in the earlier periods, and exhibited an increasing trend to an exceptionally high level. The observed pattern may be a density-dependent response to a shift in commercial exploitation which has resulted in an age distribution dominated by young fish.

Location of Research: Red Lakes, Minnesota; Department of Fisheries and Wildlife, University of Minnesota

Dates: 07/89—06/91

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$45,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

40

Red Lake Fisheries Yield Assessment

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Project Description: The Red Lakes, Minnesota, have supported a commercial fishery for walleye (*Stizostedion vitreum vitreum*) and yellow perch (*Perca flavescens*) since 1917. Since 1972, harvests indicate increased variance in recruitment of percids and an increase in biomass of freshwater drum (*Aplodinotus grunniens*). I subjected commercial catch-per-unit-effort records of walleye, perch, and animal feed (composed primarily of drum) to spectral analysis. Estimated power spectra displayed peaks at 8.5, 10, and 17 years for walleye, yellow perch, and animal feed, respectively. Walleye and yellow perch CPUE time series were significantly coherent at periods ranging from 5 to 10 years, confirming the predator-prey relationship and common recruitment patterns of these two species. The apparent exponential increase in drum biomass as indicated by commercial CPUE is primarily due to strong year classes in 1955, 1970, and 1983. While drum recruitment and growth are consistent with the periodicity in the autospectrum, I find little evidence from coherencies that drum recruitment is related to the dynamics of walleye or perch populations.

I analyzed growth and recruitment of freshwater drum and estimated correlation with climate variables. I assembled a biochronology of growth from 1879 through 1989 using sagittal otolith increments from relatively large fish (i.e., average total length 525 mm). Otolith growth of freshwater drum has increased over the past 100 years, and continued to be relatively high following recent, large increases in biomass. The power spectrum for growth displayed a significant periodicity of approximately seven years from 1940 to 1979. Growth during this 50-year period was coherent with both winter and summer temperature indices. Growth was not coherent with the Southern Oscillation. Growth showed strong,

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contemporaneous correlation with summer temperature ($R^2 = 0.49$), but no correlation with winter temperature ($R^2 = 0.05$). In years of document recruitment, otolith growth was greater and summer temperatures were warmer than in years with no apparent recruitment. There was no correlation with winter temperature. The Southern Oscillation was lower during years of recruitment. I discuss potential applications of biochronology and the use of fish growth and recruitment as indices of climate change.

Location of Research: St. Paul Campus, University of Minnesota and Red Lakes, Minnesota

Dates: 06/87—12/91

Funding Source: U.S. Bureau of Indian Affairs

Funding Amount: \$86,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project:

Related Research Publications:

41

Thermal Impacts of Beaver Impoundments in Wisconsin Headwater Streams

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Project Description: Increasing beaver activity in the Upper Midwest has resulted in resource management conflicts, most notably in terms of the possible impact on fish habitat. Concern for brook trout is particularly strong. The purpose of this study is to determine the thermal impacts of beaver impoundments on small headwater streams in order to assess potential effects on brook trout populations.

Two streams in the Nicollet National Forest in northeastern Wisconsin were selected for study. Twelve continuously recorded thermographs were placed above and below major impoundment systems in each stream. A set of two thermographs, one each for air and ground temperature, were also placed on each stream (sampling frequency 0.5—1 h). One dam on Rock Creek was removed with explosives in August 15, 1990, and stream temperature observations (sampling frequency = 1 h) were recorded immediately below the dam both before and after the dam removal. Electrofishing was conducted at four locations on Rock Creek and two locations on Halley Creek during the first week of September, 1990. No trout species were found. Overall, surprisingly few fish (seven total) were found. More extensive electrofishing will be conducted throughout the 1991 field season. Preliminary analysis of the data indicates that air temperature accounted for 50 to 85% of the variability in stream temperature. Removal of the dam on Rock Creek had little effect on water temperatures immediately downstream, and air temperatures were closely correlated with air temperatures both before and after dam removal.

Recording thermographs will be placed at the same locations on the two creeks during the 1991 field season. To more accurately assess the impact of beaver impoundments on downstream temperatures, all major dams in Halley Creek will be removed with explosives mid-field season 1991.

Location of Research: Nicollet National Forest, U.S. Forest Service, Wisconsin

Dates: 08/91—12/91

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

42

Use of Ecological Land Classification and Geographic Information Systems to Assess Habitat Suitability for Black Bear

George Host, Lucinda Johnson, Jim Jordan, and Lynn Rogers

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Project Description: For species such as black bear, with habitat spanning broad geographic regions and forage/cover requirements varying by season, the spatial analysis abilities of geographic information systems (GIS) allow the identification of areas with a suitable complex of ecological units. This project will incorporate the information from the Ottawa National Forest's ecological classification system into a GIS in order to develop a prototype system which can be used to determine the suitability of regional-scale habitat for management of black bear.

Location of Research:

Dates: 10/90—12/92

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$3,700

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Johnson, L.B., G.E. Host, J.K. Jordon, and L.L. Rogers. 1991. Use of GIS for landscape design in natural resources management: Habitat assessment and management for the female black bear. *Proceedings of GIS/LIS '91, October 28-November 1, 1991, Atlanta, Georgia*, 507-517.

43

Effects of Extreme Low Frequency Electromagnetic Fields on Birds

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Project Description: The overall objective of this project is to assess the potential effects of the extreme low frequency (ELF) antenna system on bird species and communities. The Illinois Institute of Technology and the Department of the Navy are funding studies to determine whether bird species in northern Wisconsin and northern Michigan are affected by the antenna system. In addition to the central question being addressed, these studies will produce the largest inventory of natural populations of birds available in the Upper Midwest. To date, there have been no detected negative effects of ELF fields on birds; however, it has been found that numbers of birds can fluctuate up to 100% from year to year, presumably related to weather and resource abundance.

Location of Research: Clam Lake, Wisconsin; remote areas of northern Michigan

Dates: 06/84—10/94

Funding Source: U.S. Department of the Navy

Funding Amount: \$700,000

Fish and Wildlife

Number of Graduates Working with Project:
Number of Undergraduates Working with Project:
Related Research Publications:

44

Monitoring Bird Populations in Minnesota's National Forests

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Project Description: The objectives of this project are to establish long-term bird monitoring programs in the Chippewa and Superior National Forests, to assess abundance and habitat requirements of select indicator birds species and common birds within each forest. Point counts will be used to monitor bird populations. Initially, 400 points will be established in the Chippewa National Forest; 200 will be located in lowland and upland conifer habitat to monitor populations of indicator species (Blackburnian Warbler, Northern Parula Warbler and Pine Warbler). A total of 600 points will be established in the Superior National Forest; all points in this forest will be stratified by the major habitat types in the forest. One hundred points will be located in the Boundary Waters Canoe Area Wilderness. Each point will be censused one time during the breeding season. In addition, counts along roads will be conducted to determine the suitability of this method for monitoring forest birds.

Location of Research: Chippewa and Superior National Forests, Minnesota

Dates: 04/91—03/93

Funding Source: Chippewa and Superior National Forests; North Central Forest Experiment Station; U.S. Fish and Wildlife Service

Funding Amount: \$80,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

45

Caribou Habitat Assessment of Northern Minnesota

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Project Description: Woodland caribou were native to northern Minnesota in presettlement times, and are occasionally sighted in the Gunflint area today. The North Central Caribou Corporation, a nonprofit sportman's and conservation group, and the Superior National Forest contracted with the Natural Resources Research Institute to aid in assessing potential sites for possible reintroduction. To date, the map of caribou habitat for northeastern Minnesota has been analyzed statistically for the best possible areas to reintroduce caribou.

Location of Research: Northeastern Minnesota

Dates: 02/91—03/92

Funding Source: Caribou Corporation; U.S. Department of Agriculture, Forest Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

46

Biological Inventory of a Flood Control Impoundment and Potentials for Wildlife Management

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Institute of Agriculture, Forestry, and Home Economics
University of Minnesota, Crookston
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Project Description: In this project, a base-line biological and water quality inventory of a multiple-use impoundment in northwestern Minnesota will be conducted. In addition, an evaluation of the use of the impoundment by migratory and breeding birds will be completed so as to develop a management plan incorporating flood control, wildlife, and public uses.

Location of Research: Crookston, Minnesota

Dates: 03/90—06/92

Funding Source: Minnesota Agricultural Experiment Station; U.S. Department of Agriculture, Soil Conservation Service; Red Lake Watershed District; Minnesota Department of Natural Resources, Nongame Program

Funding Amount: \$7,750

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

For additional information on FISH AND WILDLIFE, see project numbers 2, 3, 4, 7, 9, 10, 12, 67, 81, 87, 116, 117, 152, 228, 232, 245, 246, 247, 256, 260, 263, 264.

FOREST RESOURCES

47

Survey and Analysis of White Pine Stands and Regeneration

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Project Description: Survey white pine plantations in Minnesota to gather information related to survival success and insect and disease problems. The project will attempt to correlate stand environmental and ecological conditions with plantation establishment to provide baseline information pertinent to white pine planting programs.

Location of Research:

Dates: 02/91—08/92

Funding Source: Iron Range Resources and Rehabilitation Board (IRRRB), Minclard Reclamation Division

Funding Amount: \$5,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

48

The History, Intensity, and Vegetational Effects of Fire on an Indiana Dune Prairie

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Project Description: Many habitats at Indiana Dunes National Lakeshore are dependent upon fire for their preservation. Research is being conducted to examine the costs and benefits of various fire treatments in these natural habitats. Detailed research at Howes Prairie has produced information on many subjects including: 1) effects of fire frequency on vegetation, 2) fire history reconstructed from fire scars and stand structure, 3) fire and late Holocene successional history reconstructed from fossil pollen, 4) fire intensity causes and effects during prescribed burns, and 5) ground water controls on prairie vegetation. Four manuscripts reporting this research are underway.

Location of Research: Indiana Dunes, Sleeping Bear Dunes, and Pictured Rocks National Lakeshore

Dates: 06/84—06/93

Funding Source: National Park Service, Midwest Region

Funding Amount: \$70,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Cole, K.L. 1986. Late Holocene dune formation, erosion, and vegetational development along the southern shore of Lake Michigan. In *Quaternary Records from Northeastern Illinois and Northwestern Indiana*, Hansel et al., eds., 45-51. Illinois State Geological Society, Champaign, Illinois.

Cole, K.L., R.P. Futyma, D.R. Engstrom, and N.B. Pavlovic. 1986. Plant revolutions at Indiana Dunes: High rates of vegetational change following settlement. *Bulletin of the Ecological Society of America* 67: 117-118.

49

Long-Term Primary Plant Succession on Great Lakes Dune Forests

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Project Description: Fossil pollen analyzed from sediment cores collected from Indiana Dunes (Indiana), Sleeping Bear Dunes (Michigan), and Pictured Rocks (Michigan) national lakeshores demonstrate vegetational development on late Holocene dunes in the western Great Lakes. Most core support the traditional successional theories of Henry Cowles of long-term development occurring over thousands of years. However, all cores demonstrate that the settlement era brought changes to Great Lakes dunescapes which were unprecedented in their severity. This research will extend our understanding of changing ecosystems and the forces which control them.

Location of Research: Indiana Dunes National Lakeshore

Dates: 06/89—12/92

Funding Source: National Park Service, Washington Office

Funding Amount: \$500,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Cole, K.L. 1988. Historical impacts on communities in disequilibrium. In *Proceedings of the First Indiana Dunes Research Conference*, ed. K.L. Cole, et al. National Park Service, Science Publication Office, U.S. Department of Interior, Atlanta, Georgia.

Cole, K.L., P.K. Benjamin, and K.F. Klick. 1990. The effects of prescribed burning on oak woods and prairies in the Indiana Dunes. *Restoration and Management Notes* 8: 37-38.

50

Origin and Maintenance of a Forest Mosaic in Hemlock Hardwood Forests at Sylvania, Michigan

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Project Description: The U.S. Forest Service is developing management strategies that will preserve old growth forests and promote stand characteristics that resemble old growth. The most extensive remnants of the original forest cover of eastern North America are located in the upper Great Lakes region. In the old-growth forest, hemlock and sugar maple are the dominant species, whereas cut-over areas support aspen, paper birch, red maple and sugar maple. This project is examining the distribution of trees in the old-growth forests of the Sylvania Wilderness Area of Michigan. Since the project began, mapping of 27 hectares of forest in four permanent plots, located on four different parent soil types has been completed. For each tree and sapling we have documented species identification, canopy class, stem diameter, and location in space. Ground flora and seedlings have been sampled in randomly located plots. The plot data are part of the permanent data set that will be curated in the Long-term Ecosystem Research Center. During the next four years, permanent plots will be recensused to document rates of turnover in forest ecosystems. Pollen records and tree ring analysis are also being applied which permits documentation of forest changes over hundreds of years. Studies of the long-term history of the forests will reveal more about the effect of climate on forest composition. This information will enable researchers to gain a better understanding of the relationship of climate to disturbance and the effects of environmental factors on forest composition and structure.

Location of Research: Sylvania Wilderness Area, Michigan

Dates: 01/86—Ongoing

Funding Source: National Science Foundation; Mellon Foundation

Funding Amount: \$170,000/year

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 3

Related Research Publications:

51

The Use of Fractal and Chaos Theory to Verify, Simplify and Extend Forest Ecosystem Models

Yosef Cohen and John Pastor

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Project Description: Much of the variation in the patterns of nature that we observe may not be random, but may in fact be the result of complex interactions between parts of systems. The mathematical term for this "randomness that isn't random" is chaos. LINKAGES, the forest ecosystem model developed at the Natural Resources Research Institute, University of Minnesota, Duluth, is one of the most widely tested models of its kind. LINKAGES incorporates accurate mathematical descrip-

tions of soil fertility into tree growth equations. However, these same soil processes cause the model, and possibly forests themselves, to sometimes behave in seemingly random fashion when perturbed by management or climate change. There are two important implications of these findings: 1) there is a fundamental, theoretical limit to how well we can predict the responses of forests, even given the most accurate and up-to-date inventory possible; 2) intensive management that ignores soil properties runs the risk of exacerbating chaotic behavior if it exists.

Location of Research:

Dates: 03/91—03/93

Funding Source: National Science Foundation

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

52

Assessment of the Impact of High Flotation Tires on Aspen Regeneration and Timber Harvesting Productivity

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Project Description: The purpose of this project is to study the impact of high flotation tires on the soil and regeneration of aspen in central Minnesota forests, as well as evaluate the economic feasibility of this equipment. The data collected will determine harvesting differences and soil impact between high flotation tires and conventional tires. Specific factors to be addressed are: 1) impact on density and growth of suckering, 2) impact on harvest timing (length of season), 3) effect on physical properties of the soil, 4) determine the economic feasibility of the tires.

Location of Research: Mille Lacs, Kanabec, and Aikin counties, Minnesota

Dates: 07/89—Ongoing

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$40,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Smidt, M. and C.R. Blinn. 1990. Biological and financial impacts of high flotation tires for aspen harvesting. In *American Society for Agricultural Engineers International Winter Meeting Proceedings, Chicago, IL, December 18-21, 1990*. Paper No. 90-7535. 18 pp.

Forest Resources

53

Effects of Management Activities on Water Quality and Quantity in Forested and Peatland Watersheds

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235 Natural Resources Administration
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Project Description: This research will improve the understanding and quantification of hydrological processes in forested uplands and upland-peatland watersheds. Models will be developed and improved which will be capable of simulating stream flow response of undisturbed and altered watersheds with emphasis on northern Lake States.

Location of Research:

Dates: Ongoing

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

54

Evaluation Methodology for Forest Ecosystems Models

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Project Description: Purpose is to evaluate existing and develop new methodologies for examining the performance of ecosystem models designed to study environmental change. Resampling and variance expansion techniques alone and in combination with one another will be studied through computationally intensive simulations. Modeling is at the center of many components of the Northern Stations Global Change Research Program. Model evaluation is an often overlooked step in the modeling process. Consistent, valid evaluation methodologies need to be recommended if the full utility of modeling efforts are to be realized.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 09/91—09/93

Funding Source: U.S. Department of Agriculture

Funding Amount: \$55,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Burk, T.E. 1988. Prediction error evaluation: Preliminary results. *Natural Resources Bulletin* 1927: 81-88.

55

North Central Tree Volume Equation Data Base and Framework

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Project Description: Compile available data and recommend approaches useful in the development of a regional volume prediction system to be applied in broad scale forest inventories.

Location of Research: St. Paul, Minnesota

Dates: 07/91—06/92

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$11,500

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Burk, T.E., R.P. Hans, and E.H. Whardon. 1989. Individual tree volume models for the northeastern United States: Evaluation and new form quotient board foot models. *Northern Journal of Applied Forestry* 6: 27-31.

56

Hybrid Aspen/Larch

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Project Description: This study looks at the breeding of hybrid and native aspen, and the breeding of larch in an effort to improve forest productivity with respect to timber supply. Related research concerns disease resistance and propagation methods.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 07/91—06/93

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$147,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Forest Resources

57

Minnesota GEIS on Timber Harvesting and Forest Management

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Project Description: Analysis of the impacts of timber harvesting and forest management on forest and related resources of Minnesota.

Location of Research: St. Paul Campus, University of Minnesota and statewide

Dates: 05/91—08/92

Funding Source: Jaako Poyuy Consulting, Inc.

Funding Amount: \$66,865

Number of Graduates Working with Project: 10+

Number of Undergraduates Working with Project: 2+

Related Research Publications:

58

Assessment of Current Status of State Regulation of Private Forestry Practices

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Project Description: This project's overall objective is to carry out a comprehensive nationwide assessment of state regulatory laws that are designed to guide the application of forestry practices on private forest land. Specifically, identify states that implement such laws, assess the administrative structures used to do so, determine the magnitude of state investments in regulatory laws, and evaluate the effectiveness of regulatory laws focused on private forests.

Location of Research:

Dates: 05/91—09/92

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$17,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

59

Evaluation of Administrative Structures for Implementing State Programs Focused on Conserving the Biological Diversity of Forests

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Project Description: Overall project objective is to conduct a preliminary evaluation of organizational and administrative patterns used by state governments to accomplish goals related to conserving the biological diversity of forests. Special attention is focused on determining the status of existing administrative structures and on a preliminary analysis of administrator opinions as to the effectiveness of alternative administrative arrangements.

Location of Research: St. Paul, Minnesota

Dates: 12/91—09/92

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$7,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

60

Revitalization of Rural Forested Areas: Assessment of Government Infrastructures

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(612) 624-3400

Project Description: The focus of this project is on the presentation and interpretation of statistical information that portrays a national and state picture of the physical and social infrastructures that are supplied or supported by governments in rural forested areas. Information about physical infrastructure will focus on capital investments such as school buildings, transportation and communication systems, and water supply and sewage treatment facilities. Social infrastructure information will focus on social welfare programs, medical care programs, and housing.

Location of Research:

Dates: 05/91—06/92

Funding Source: U.S. Department of Agriculture, Forest Service; Minnesota Extension Service

Funding Amount: \$26,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

61

Assessment of Forestry Project Impacts

Hans M. Gregersen and Allen L. Lundgren

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Project Description: The Guidelines for Assessment of Forestry Impacts (GAFPI) initiative is intended to provide up-to-date, user-friendly guidelines for assessing the multiple (social, environmental, economic, financial, institutional) impacts of forestry projects throughout all stages of the project process. The guidelines are meant to complement, not replace, manuals of procedure used by various agencies and organizations.

The objectives of GAFPI are: 1) to provide practical, user-friendly guidelines for project assessment activity that can be introduced during all stages in the project development process, from identification, through design, appraisal, and implementation and ex-post evaluation of the sustainability of development activities, and 2) to provide a means for improving the quality and accessibility of information on impacts for decision makers before they make decisions at various stages in the forestry project development process.

Location of Research:

Dates: 12/90—12/91

Funding Source: Food and Agriculture Organization of the United Nations; The United Nations Environment Programme; The World Bank; The Forestry for Sustainable Development Program

Funding Amount: \$30,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

62

A Program for Technical Assistance to Enhance the Planning and Management of Sustainable Forest-Based Projects and Programs

Hans M. Gregersen, Allen L. Lundgren, Kenneth N. Brooks, and James A. Perry

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(612) 624-9697

Project Description: The idea of this work is that activities that are conducted to improve the quality of life should be "sustainable" through space and time. This is a multi-year effort involving several scientists. The plan outlines nine measurable objectives: 1) to publish a book on technical institutional means of enhancing sustainable development, this will be a practical treatment for policy makers, planners and managers rather than a theoretical discussion for academics; 2) a series of short, specialized guides dealing with how to introduce existing technical knowledge and concepts of sustainability more effectively into the planning and implementation of development programs have been produced; 3) to prepare an annotated bibliography on sustainable development and a specialist list; 4) to prepare two training modules for use in workshops and courses for professionals involved in development; 5) to organize and conduct a minimum of three workshops utilizing the materials developed by program participants and involving interaction between professionals and members of the scientific community and conservation organiza-

tions; 6) to introduce concepts, ideas and information from the program into both undergraduate and graduate courses at the University of Minnesota and other universities; 7) to establish a network of organizations and individuals interested in the themes of the program; 8) to submit interim reports on accomplishments and plans as requested by PEW Charitable Trusts; and 9) to submit a final report evaluating program accomplishments and containing a plan of action.

Location of Research:

Dates: 01/87—Ongoing

Funding Source: Pew Charitable Trust; United Nations Food and Agriculture Organization; United Nations Environment Programme; United Nations Development Programme

Funding Amount: \$450,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Perry, J.A., H. Gregersen, A. Lundgren, N.H. Troelstrup, Jr., and C. Blinn. 1988. *Improving Water Quality Monitoring for Decision Making: A Plan of Action and Proposal for Implementation*. Forestry for Sustainable Development, Working Paper 4, University of Minnesota, St. Paul. 26 pp.

63

Timber Prices, Timber Values and Public Forest Management in Minnesota

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(612) 624-4221

Project Description: The forest products industry in Minnesota has seen unprecedented expansion within the past five years. This expansion has resulted in increased employment in the industry. It will also require increasing supplies of wood. Future expansions and perhaps even maintaining current production levels will not be possible without continued investments in timber management. Investments on public forest lands will be especially important because more than half of the commercial forest land base in Minnesota is publicly owned. The purpose of this project will be to help determine the need for funding for timber investments on state and county lands and to identify ways this might best be achieved.

This study will identify and enumerate forest management investments needed to sustain forest industry in northern Minnesota. These investment needs will be compared with current state and county investment priorities and constraints to determine the extent to which a gap exists between current investment levels and needs. Timber sale practices currently used by public agencies will be identified and compared to determine whether some approaches are more likely to result in higher prices. Ways that these sale procedures can be improved will be explored. Marketing practices and investment mechanisms used in neighboring states will be identified and evaluated to determine their suitability for use in Minnesota. Finally, the extent to which the non-timber values associated with forest management justify the use of non-timber funds to pay for management investments will be evaluated.

Location of Research: Department of Forest Resources, University of Minnesota

Dates: 07/91—06/93

Funding Source: Charles K. Blandin Foundation, Grand Rapids, Minnesota

Funding Amount: \$193,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

64

Improving Forest Vegetation Management Techniques

Thomas J. Nichols and Edward I. Sucoff

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Forest Resources
College of Natural Resources
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Cloquet, MN 55720
(218) 879-0850

Project Description: Not available at the time of publication. Contact the principal investigator for further information.

Location of Research: Northern Minnesota and Wisconsin

Dates: 09/84—Ongoing

Funding Source: Forest Vegetation Management Cooperative; several chemical companies; National Agricultural Pesticide Impact Assessment Program

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

65

Nutrient Cycling in Hardies Creek Experimental Forest

James A. Perry

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Project Description: Hardies Creek is a mixed-oak, experimental forest in southwestern Wisconsin. Over a multi-year period, the effects of different harvesting regimes on nutrient cycling, decomposition, fine root dynamics, leaf litter production and element cycling were assessed. Measurements included soil properties, litter fall, decomposition, chemistry of leaf litter during decomposition, cationic and anionic chemistry of fine roots, and lysimeter measures for soil water analysis.

Location of Research: Hardies Creek, Wisconsin

Dates: 03/84—06/91

Funding Source: Laird Norton Foundation; Minnesota Agricultural Experiment Station; McIntire-Stennis Cooperative Forestry Program

Funding Amount: \$75,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 0

Related Research Publications:

Yin, X., R.K. Dixon, and J.A. Perry. 1988. Effects of management on microbial populations in forest soil. *Braun Blauquetia*.

Yin, X., J.A. Perry, and R.K. Dixon. 1989. Fine root dynamics and biomass distributions in a *quercus* forest following harvesting. *Forest Ecology and Management* 27: 159-177.

Yin, X., J.A. Perry, and R.K. Dixon. 1989. Harvesting effects on floor litter decomposition in a *quercus* forest. *Canadian Journal of Forest Resources* 19: 204-214.

Yin, X. and J.A. Perry. 1991. Factors affecting nitrogen concentration of fine roots in forest communities: Regression analysis of literature data. *Forest Science* 37: 374-382.

66

Voluntary Adoption of Forest Water Quality Best Management Practices

James A. Perry

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Project Description: Minnesota landowners have been national leaders in developing a series of voluntary Best Management Practices (BMPs) for forest water quality. Adoption of voluntary practices requires educational programs that help landowners understand the benefits of such practices. This project assesses the variables that correlate with adoption of BMPs which will be used to design educational programs for the timber industry and landowners.

Location of Research: Minnesota

Dates: 01/89—12/92

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$40,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

Gathman, J., N.H. Troelstrup Jr., and J.A. Perry. 1992. *Voluntary Adoption of Forest Management Practices*. University of Minnesota, Department of Forest Resources.

67

Impacts of Present and Potential Road Systems on Timber, Tourism, Wildlife, and Aesthetic Resources

Dietmar Rose

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Project Description: The objectives of this project are: 1) to develop forest road inventory data collection procedures and an inventory data base for the pilot project area, 2) to develop a software analysis package for road inventory information including the framework for program analysis using geographic information systems that link natural resource and transportation data, 3) to develop procedures and guidelines that promote better cooperation among agencies and developing land use patterns over time with respect to spatial concerns for regions, landscapes and ecosystems, and 4) to address transportation planning for specific issues and possible impacts for timber supply, wildlife habitat, recreation and tourism development.

Forest Resources

The impact of forest roads on the environment in which they exist is not well understood. This project takes the approach that forest roads are one component of a much larger system operation in the forest. Forest road influences are intertwined with timber, wildlife, fisheries, recreation, aesthetic and tourism management and goals. In order to determine the consequences of changes to this large system, models were created to simulate and evaluate area outputs. Critical to this modeling approach were relationships between model components. The design of components and linkages between components allows the models to take on proactive or reactive roles. A model was developed that allows simulation of all components over time. The ability to generate outputs over time and space allows for more complete analysis of potential forest road designs. The project models will not prescribe optimal road placements, but provides useful information to forest road planners that may avoid potential conflicts, access desirable recreation areas or forest stands, and generate specific resulting impacts.

Location of Research:

Dates: 01/90—06/91

Funding Source:

Funding Amount: \$122,500

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

68

Lake States Regional Forest Resources Assessments

Richard A. Skok

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2003 Upper Buford Circle
St. Paul, MN 55108
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Project Description: Michigan, Minnesota, and Wisconsin developed individual state forest plans in the early 1980s. The forest planners and managers working in these states recognized many common resource problems that transcended state boundaries. Since then they have also recognized the potential strength in regional cooperation. They realize that they may accomplish more by working together than by pursuing individual objectives. The Lake States Forest Planners have met annually to discuss opportunities for joint approaches to common problems over this past decade. The three states jointly undertook several studies concerning wood products trade and the economic importance of forest resources in the Lake States Region. The need for a Lake States assessment of forest resources became prevalent in the minds of Lake States planners from these studies and plans. Individual gaps in knowledge existed and solutions to resource problems were less effective when state plans stopped at state boundaries or were based on varying assumptions.

The analysis will have six major components: 1) ecological importance of Lake States forests including their history and physical and biological makeup, 2) economic importance of Lake States forests, 3) economic, institutional, and political forces shaping resource trends and issues, 4) projected changes in demand and supply for forest resources in the Lake States, 5) economic, social, and environmental implications of apparent trends and selected future scenarios, and 6) opportunities to develop a more favorable sustainable forest economy and environment in the Lake States.

Location of Research:

Dates: 05/90—05/93

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$280,000

Number of Graduates Working with Project:
Number of Undergraduates Working with Project:
Related Research Publications:

69

Effect of Three Herbicides on Nontarget Forest Plants

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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 05/91—09/92

Funding Source:

Funding Amount: \$16,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

70

Forest Vegetation Management/Weed Control

Edward I. Sucoff and Marna Butler-Fasteland

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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 10/90—06/91

Funding Source:

Funding Amount: \$8,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Forest Resources

71

Lake States Regional Forest Resources Assessment

Henry H. Webster, Richard A. Skok, and Paul V. Ellefson

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Project Description: This project is an analysis of major trends and opportunities associated with forest resources in the Lake States. It looks at how best to sustain and continue expansions of employment associated with forest resources. It also looks at how best to make the tourism and forest products sectors additive, rather than competitive.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 07/90—01/95

Funding Source: U.S. Department of Agriculture, Forest Service; state forest resource agencies of Minnesota, Wisconsin, Michigan; North Central Forest Experiment Station

Funding Amount: \$310,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

72

Ecological Land Classification System Development for Long-term Site Productivity Plot Location, Chippewa National Forest

George Host, David Alban, and David Shadis

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(218) 720-4279

Project Description: Stratification of a sample population is a critical step in developing sound experimental design. When forest stands across a regional landscape form the population of interest, stratification for statistical analysis becomes a difficult process. Ecological Classification Systems (ECS) provide a means to identify homogeneous landscape units for selection of sample stands. The objective of this study is to develop an ECS for a particular land form on the Chippewa National Forest; this ECS will then be used to stratify plots for a Long-term Site Productivity Study to be established in 1993.

Location of Research: Chippewa National Forest

Dates: 08/91—06/92

Funding Source: Chippewa National Forest

Funding Amount: \$12,600

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

73

Effect of Soil Compaction and Organic Matter Removal on Nitrogen Mineralization

George Host, David J. Mladenoff, and David Alban

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(218) 720-4279

Project Description: The research branch of the U.S. Forest Service has recently initiated a nationwide study to assess the impacts of forest management practices on long-term site productivity. The experimental treatments are factorial levels of soil compaction and organic matter removal. A study conducted in the Marcell Experimental Forest north of Grand Rapids provides an opportunity to study the effects of these treatments on the rates of nitrogen mineralization in upper soil horizons.

Location of Research: Marcell Experimental Forest, Ottawa National Forest

Dates: 05/90—12/91

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

74

Effects of Harvest Season, Soil Compaction and Organic Matter Removal on Ground-flora Diversity

George Host and David Alban

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Project Description: This project has been undertaken to determine the effects of different harvesting practices on species diversity in the ground-flora and understory layers of aspen forests. Region 9 of the Forest Service has a strong interest in the impacts of forest management on species diversity. As part of the national long-term site productivity study being conducted by the U.S. Forest Service, changes in species diversity due to management will be quantified. Vegetation composition and abundance patterns will be monitored following installation of the soil compaction and organic matter removal treatments to determine if significant changes in species diversity can be detected.

Location of Research: Chippewa National Forest, Ottawa National Forest

Dates: 06/90—06/92

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$9,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

75

GIS Analyses for Forest Management and Landscape Design in Superior National Forest

George Host, Lucinda Johnson, John Pastor, David Thom, and Robert Berrisford

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(218) 720-4279

Project Description: NRRI is working with the Superior National Forest to develop land management plans which include principles of landscape design for multiple use management. The intent is to include the spatial elements of landscape design in conducting opportunity area analyses. For example, the spatial arrangement of timber sales can be used to increase the amount of edge or decrease the amount of forest fragmentation. The analytical capabilities of GIS will be used to help develop forest management plans for two areas of the Superior National Forest.

Location of Research:

Dates: 08/91—06/92

Funding Source: Superior National Forest

Funding Amount: \$20,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

76

Interregional Validation of ECOPHYS, an Ecophysiological Growth Process Model for Poplar

George Host and Jud Isebrands

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(218) 720-4269

Project Description: Objective is to compare model simulation runs with field data collected from three regionally-dispersed sites. Validation is an essential part of model development. In 1988 and 1989, field plantations were established on the same date with the same poplar clones in East Lansing, Michigan, Rhinelander, Wisconsin, and Puyallup, Washington. Morphometric measurements were made throughout the field season and hourly temperature and radiation collected via weather stations. These data will be processed and summarized. Model simulation will be conducted using collected weather data. Simulated and observed growth patterns will be compared. Growth data from the three field sites are being summarized. The ECOPHYS model is being adapted to process multiple weather data files.

Location of Research: Natural Resources Research Institute, Duluth, Minnesota

Dates: 12/91—12/92

Funding Source: U.S. Department of Energy

Funding Amount: \$12,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

77

Modeling Impacts of Carbon Dioxide, Ozone and Climate Change on Tree Growth

George Host, Michael Rauscher, and Jud Isebrands

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Duluth, MN 55811
(218) 720-4279

Project Description: Understanding the influence of ozone, carbon dioxide and changing climate regimes on basic plant physiological processes is essential for predicting the response of forest ecosystems. The link between physiological process modeling and field and growth chamber experimentation allows the development and testing of mechanistic theories of plant response. Mechanistic submodels relevant to global change for an established whole-tree physiological process model will be developed in cooperation with other research laboratories. Modelling efforts will focus on the impact of ozone and carbon dioxide levels on photosynthesis and carbon allocation, stomatal conductance, and the development of an expert system knowledge base to emulate the plant response regulatory system.

Location of Research:

Dates: 09/91—05/93

Funding Source: U.S. Department of Agriculture, Forest Service; Northeastern Forest Experiment Station

Funding Amount: \$50,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 0

Related Research Publications:

78

Landscape Approach to Biological Diversity

David J. Mladenoff, John Pastor, and Thomas R. Crow

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: The objective of this project was to develop an approach of managing for biological diversity within the context of the larger landscape which is managed for commodity uses. Through the use of a geographic information system and linking it to a forest succession model, a technique was developed for examining the arrangement of forest patches in the managed landscape, assessing compatible adjacent uses, and projecting forest change in this patch network over time and given various management treatments. This will provide forest land managers with the tool they need to integrate various competing land uses within large management units, and predict the consequences of actions on forest change.

Location of Research:

Dates: 03/89—12/91

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station; The Nature Conservancy

Funding Amount: \$32,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

79

Minnesota Old-Growth Forests: Characterization and Identification

David J. Mladenoff and Kurt Rusterholtz (DNR)

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Project Description: The growing interest in managing old-growth forests creates a need for information that can be easily used by land managers and foresters in the field to identify and classify old-growth stands. This research will employ field sampling techniques to develop objective descriptions of old-growth red pine, white pine, northern hardwoods, and upland cedar stands. Old-growth stands will be compared with an equal number of younger stands, to develop criteria that adequately distinguish them.

Location of Research:

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

80

Structure and Function of Regional Landscapes

David J. Mladenoff, George Host, and Thomas R. Crow

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Project Description: To consider integrating all forest land uses, from commodity production to biodiversity management, a broad scale regional landscape context must be examined. This project will examine a large area encompassing an entire national forest and surrounding lands to compare landscape patterns and relate these to management practices. As part of this research, satellite remote sensing and analysis by geographic information systems will be employed.

Location of Research: Northwestern Wisconsin

Dates: 09/91—08/96

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station

Funding Amount: \$87,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 2

Related Research Publications:

81

Effects of Large Mammal Browsing on the Dynamics of Northern Forest Ecosystems

John Pastor and David J. Mladenoff

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(218) 720-4279

Project Description: Moose and beaver can greatly influence the species composition of forests because they browse heavily on aspen and avoid spruce. Aspen and spruce, in turn, affect soil fertility because their litters have different nutrient contents and decompose at different rates. This project will determine how moose and beaver foraging can change soil fertility, forest productivity, and forest composition.

Location of Research:

Dates: 09/89—08/92

Funding Source: National Science Foundation

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

82

Analyzing Wood Supply with Multiple Market Locations

Howard Hoganson

North Central Experiment Station
Institute of Agriculture, Forestry, and Home Economics
1861 Highway 169 East
Grand Rapids, MN 55744
(218) 327-4490

Project Description: Methods for analyzing timber supply will be improved to address concerns in northern Ontario. Methods will focus on incorporating recognition of the multi-product nature of timber supply with focus on stand-sorting options, market location, and the transport costs associated with alternative shipping options. This study will build on new forest management scheduling models developed at the University of Minnesota. A case study for northern Ontario will be developed and will utilize information collected as part of recent timber supply studies for that region.

Location of Research: St. Paul and Grand Rapids, Minnesota

Dates: 04/90—03/92

Funding Source: Ontario Ministry of Natural Resources

Funding Amount: \$47,139

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

83

Dwarf Mistletoe on Jack Pine in Manitoba

David W. French, Keith Knowles, and Fred Baker

Plant Pathology
College of Agriculture
495 Borlaug Hall
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Project Description: The dwarf mistletoe project has been underway since about 1960 and was a continuation of our mistletoe project on black spruce in northern Minnesota. We are currently cooperating with the forestry personnel in Manitoba. Our objective is to keep this species of mistletoe out of the Lake States (Minnesota, Wisconsin, and Michigan). We have succeeded thus far in moving the parasite 80 to 100 miles further from the Lake States. We also are developing management practices to reduce the impact of this parasite in stands of jack pine. The procedures for handling jack pine have been modified resulting in significantly less loss to the jack pine resource in Manitoba.

Location of Research: Manitoba

Dates: 01/60—Ongoing

Funding Source: U.S. Department of Agriculture, Forest Service; Province of Manitoba

Funding Amount:

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project:

Related Research Publications:

84

Oak Wilt

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Project Description: The Oak Wilt program has been underway from before 1950 and has gradually been expanded to include the Minnesota Department of Agriculture and the Minnesota Department of Natural Resources. Our role at the University has been to research oak wilt with the objective of developing control measures and in this process to learn more about how this fungus infects trees, its way of spreading, and what can be done to reduce the impact of this fungus on a very important group of tree species which are valuable trees for shade, landscape beauty, and raw material for many wood products. More research is needed; however, we are well on our way to significantly reduce the losses to this fungus.

Location of Research: Minnesota

Dates: 01/50—Ongoing

Funding Source:

Funding Amount:

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project:

Related Research Publications:

85

Impacts of Intensified Forest Management and Atmospheric Change on Nutrient Cycling and Tree Species Suitability

David F. Grigal

Soil Science
College of Agriculture
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Project Description: Minnesota's forests will come under increasingly intensive management in the next several decades. That poses questions about the choice of forest stand rotation age that favors the sustainability and enhancement of soil and site productivity. At the same time, air quality changes, perhaps including changes in precipitation and temperature patterns, may impact fundamental plant and soil processes. Fundamental understanding of nutrient cycling processes and tree requirements is needed soon to deal effectively with the management questions concerning species-site matching, choice of rotation lengths, and appropriate levels of tree and stand utilization. The question is complicated by the range of soils and ecosystems in the state and the fact that long-term studies are essential to this research. Answers to the above questions have implications for understanding the dynamics of a variety of forest flora and fauna. This study will assess the role of nutrient cycling and associated management practices for sustainability of Minnesota's forest resources under scenarios of increased harvesting and atmospheric change.

Location of Research:

Dates: 01/91—12/92

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

86

Spatial Patterns and Temporal Trends in Carbon Storage in Lake States Forests

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Project Description: Carbon (C) storage in forest ecosystems, and its potential for change over time, are central issues of the Global Change Program. Our objectives are to quantify C storage across the landscape, and its potential for change. Using geographic information system-based techniques, with thematic data including standard soil surveys, digital elevation models, National Wetlands Inventory, forest cover type maps, and information from empirical transects, we will estimate the storage of C in biomass, forest floor, and soil at two well-documented locations that differ in physiography and soils: Cedar Creek Natural History Area, an NSF-LTER site, and Marcell Experiment Forest. Both sites have abundant peatlands, and C storage in peatlands will be included in our estimate. Relationships developed at these sites can be extrapolated to wider areas of the Lake States. We will also determine response of C storage to a variety of scenarios of changes in management and climate. High

Forest Resources

uncertainty currently exists in estimates of C storage in forested ecosystems. This is especially true in relatively recently glaciated areas such as the Lake States, where a combination of climate and a poorly-developed drainage network lead to abundant peatlands. A method is necessary to assess not only the areal extent, but also the depth of organic deposits in such landscapes. These static estimates must be accompanied by predictions of response to scenarios of change.

Location of Research: Cedar Creek Natural History Area, Bethel, Minnesota; Marcell Experiment Forest

Dates: 01/91—12/94

Funding Source: U.S. Department of Agriculture, Forest Service, Global Change Program

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

87

Testing the Habitat Suitability Index Models: Moose in the Lake Superior Region

David F. Grigal

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429 Borlaug Hall

1991 Upper Buford Circle

St. Paul, MN 55108

(612) 625-4232

Project Description: This project uses geographic information systems (GIS) to aid in evaluation of two recently developed habitat suitability index (HIS) models for moose. Project objectives are: 1) to develop a GIS database for two adjacent areas with different land use management goals and activities in the Lake Superior region, 2) to develop a model that will predict forest understory species occurrence based on GIS database information, 3) to test the contributions of different types of remotely sensed data in the GIS database to HIS evaluation, and 4) to combine the HIS model with the GIS database information to identify areas of varying habitat quality for moose on both actively managed and unmanaged lands, and to compare resulting predictions of habitat quality to observed winter densities of moose in these areas.

Location of Research: Voyageurs National Park and on adjacent federal and county lands

Dates: 07/88—12/92

Funding Source: Rob and Bessie Welder Wildlife Foundation

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on FOREST RESOURCES, see project numbers 41, 44, 158, 161, 162, 176, 177.

GEOLOGY

88

Quaternary Mapping and Stratigraphy in North-Central Minnesota

Priscilla Grew, Gary N. Meyer, and Kenneth L. Harris

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Newton Horace Winchell School of Earth Sciences
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(612) 627-4780

Project Description: The analysis of Quaternary glacial deposits is finding increasing use as an exploration tool in the search for bedrock-hosted ore deposits beneath glacial cover. Minnesota, with its ubiquitous blanket of glacial material covering Precambrian terrains known to host economic mineral deposits in Canada, would seem to be an ideal milieu for using drift-based exploration strategies. The methods have had little use here, however, mainly because the three-dimensional distribution of glacially deposited materials has not been mapped in sufficient detail to provide the necessary regional framework. This project is an effort to provide that framework for an area in north-central Minnesota where drilling by state agencies and private industry has generated a much-better-than-average data base for three-dimensional synthesis of the Quaternary glacial deposits. The results should be applicable in principle to a wider region, and provide a starting point from which to build a broad, regional stratigraphic synthesis that will be of value to a number of resource management issues in addition to mineral exploration.

Location of Research: Eastern Beltrami, southern Koochiching, and northern Itasca counties, Minnesota

Dates: 06/91—02/93

Funding Source: Minnesota Department of Natural Resources, Minerals Division

Funding Amount: \$92,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

89

Ramsey County Geologic Atlas

Priscilla Grew and Gary N. Meyer

Minnesota Geological Survey
Newton Horace Winchell School of Earth Sciences
2642 University Ave.
St. Paul, MN 55114
(612) 627-4780

Project Description: Produce digital and analog maps depicting the database, bedrock geology, Quaternary geology, depth to bedrock, hydrogeology, sensitivity to pollution, and water well construction and abandonment for Ramsey County. Develop increased understanding of Paleozoic and Quaternary history, stratigraphy, and hydrogeology for Ramsey County and the surrounding region.

Location of Research: Ramsey County, Minnesota

Dates: 07/90—06/92

Funding Source: Ramsey County; Minnesota Department of Natural Resources, Waters Division; Legislative Commission on Minnesota Resources

Geology

Funding Amount: \$208,430

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 10

Related Research Publications:

90

Regional Ground Water Assessment in Anoka Sand Plain

Priscilla Grew and Gary N. Meyer

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Project Description: The goal of this regional assessment program is to assemble enough environmental information to enable federal, state, county, and local officials to evaluate land-use and water-use problems and to make judgments about the urgency and direction of future investigations. The Anoka Sand Plain is a prototype area for the regional assessment program. It was selected because of the rapid expansion of the Minneapolis-St. Paul and St. Cloud metropolitan areas into Anoka, Chisago, Isanti, and Sherburne counties. In addition, the sandy surficial materials of the area are extremely vulnerable to pollution. The products of this study are a database, a surficial geologic map, a Quaternary hydrologic map, and a map showing the susceptibility of groundwater to pollution.

Location of Research: Anoka, Chisago, Isanti, and Sherburne counties, Minnesota

Dates: 08/89—06/92

Funding Source: Minnesota Department of Natural Resources, Waters Division; Legislative Commission on Minnesota Resources

Funding Amount: \$437,456

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 14

Related Research Publications:

91

Red River Valley Regional Assessment

Kenneth L. Harris

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Project Description: This program provides systematic summaries of the geology and hydrogeology that is designed to assist state, regional, county, and local officials with land- and water-use planning. Regional assessments are jointly produced by the Minnesota Geological Survey (MGS) and the Department of Natural Resources (DNR). Cooperating agencies may include the Minnesota Department of Health and the United States Geological Survey, Water Resources Division. The MGS is the lead agency in the production of databases and in developing the basic geologic interpretations presented in maps and plates. MGS produced elements include: 1) a database of existing water well data, 2) a GIS-compatible, geo-reference system, 3) a surficial geology plate, 4) a Quaternary stratigraphy plate, 5) a bedrock topography/drift thickness plate. The DNR is the lead agency in the

production of a hydrogeology plate, and in the interpretation of the sensitivity of groundwater systems to pollution. These maps are produced in both analog and digital formats at a scale of 1:200,000 (.32 in/mi or .5 cm/km). The Red River Valley Regional Assessment is a three-year study that was started on July 1, 1991. The study is being conducted in the Moorhead-Breckenridge area of northwestern Minnesota. The area that will be mapped consists of about 2,485 square miles; it includes all of Wilkin County and parts of Becker, Clay, Grant, Otter Tail, and Traverse counties.

Location of Research: Red River Valley

Dates: 07/91—06/94

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$291,655

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

92

Rice County Geologic Atlas

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Project Description: A county geologic atlas supplies basic geologic information for county staff and citizens who are interested in determining the controls and limitations that local geology may exert on land and water. It is also a mechanism for training staff in the appropriate application of geologic data. Such involvement between professional staffs in the Minnesota Geological Survey (MGS), Department of Natural Resources (DNR), and Rice County should be encouraged and is essential for the best use of the atlas and the information used to prepare it. The MGS has investigated many aspects of the geology of southern Minnesota, especially within the last ten years. The MGS has also worked with the staff of area counties to develop databases of geologic and hydrologic information, notably water well data. As a result, a substantial amount of geologic information and staff expertise have been accumulated in the region, but no compilation of this knowledge as it pertains to guiding land use and water resource management in Rice County has been done.

The development of a Rice County geologic atlas will be conducted over a three-year period. Effort in the first year will be concentrated on collecting data, developing the GIS/GRS, and conducting geologic and hydrologic field work. These databases of site-specific geologic and hydrologic information will be established within the county for staff and residents to use and to update. The second year will concentrate on continued fieldwork to prepare the county-wide geologic and hydrologic maps, drilling of two to four stratigraphic test holes, and the installation, refinement, and application of digital data and the GIS/GRS. Efforts in the third year will involve finalizing the geologic and hydrologic interpretations, preparing the derivative plates, and printing the atlas plates. The derivative plates evaluate geologic conditions as they relate to the special county concerns such as sensitivity of the groundwater system to pollution, water-well construction/abandonment, economic resources, or karst features and the probability of sinkhole development.

Location of Research: Rice County

Dates: 07/91—06/94

Funding Source: Legislative Commission on Minnesota Resources; Minnesota Department of Natural Resources, Waters Division; Rice County

Funding Amount: \$350,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 5 or 6

Related Research Publications:

93

Geologic Drilling and Mapping in Northwestern Minnesota

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Project Description: The Minnesota Geological Survey is conducting a two-year study (1991-1993) of the bedrock geology in northwestern Minnesota. It is part of our ongoing program to improve the quality of geologic maps throughout the state, and provide a better understanding of the state's geology, including its water and mineral potential. The project is funded by the state legislature under the Mineral Diversification Program that is administered by the Minerals Coordinating Committee. Because the bedrock in northwestern Minnesota is covered by thick deposits of glacial drift, the major component of the study involves test drilling to acquire samples. Drill hole locations are selected largely on the basis of geophysical maps that are made from airborne surveys. These surveys identify anomalies in the physical properties of the deeply buried bedrock. A summary report and preliminary geologic map will be published June, 1993. These data will be used primarily by mineral exploration companies to help focus their efforts on the most promising geologic targets and avoid areas that appear to lack resource potential. In addition, the map and reports will be of interest to state and local agencies concerned with natural resources and land-use planning, and to geologists studying topics that range from the evolution of the earth's crust to the glacial history in this part of the continent.

Location of Research: Northwestern Minnesota: parts of Kittson, Roseau, Marshall, Pennington, Red Lake, and Polk counties

Dates: 07/91—06/93

Funding Source: Minnesota Department of Natural Resources, Minerals Division

Funding Amount: \$325,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1-3

Related Research Publications:

94

Radium in the Mt. Simon-Hinckley Aquifer, East Central and Southeastern Minnesota

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Project Description: The Minnesota Geological Survey has completed a study of the distribution of radium in the Mt. Simon-Hinckley aquifer. A total of 66 municipal and private wells that obtain water only from the Mt. Simon-Hinckley aquifer were sampled for radium and other radioactive and chemical parameters. Analytical protocol included the collection of duplicate samples and replicate analyses. Five wells were resurveyed for radium concentrations to determine temporal stability.

Seventy-five percent of the wells within the Mt. Simon-Hinckley aquifer have total radium levels that exceed the current standard of 5 pCi/L, but do not show a distinctive distribution pattern. The activity of total radium ranges from less than 2 pCi/L to greater than 25 pCi/L and has a geometric mean of

0.95 ± 0.23 . Eighty-five percent of the wells have 228 Ra activities (G.M. of $.072 \pm 0.026$, range -10 pCi/L) that are higher than those of 226 Ra (G.M. of $.054 \pm 0.026$, range -12 pCi/L).

Measurements of uranium and thorium in rock samples indicate that the aquifer matrix is the most likely source of the radium in the solution. Correlations were observed between radium and certain chemical constituents.

Location of Research: East-central and southeastern Minnesota

Dates: 07/90—06/91

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$100,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

95

Fillmore County Geologic Atlas

John H. Mossler

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School of Earth Sciences
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St. Paul, MN 55114
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Project Description: The development of the Fillmore County Geologic Atlas will be conducted over a three-year period. Effort in the first year will be concentrated on collecting data, developing the GIS/GRS, and conducting geologic and hydrologic fieldwork. These databases of site-specific geologic and hydrologic information will be established within the county for staff and residents to use and to update. The second year will concentrate on continued fieldwork to prepare the county-wide geologic and hydrologic maps, drilling of two to four stratigraphic test holes, and the installation, refinement, and application of digital data and the GIS/GRS. Efforts in the third year will involve finalizing the geologic and hydrologic interpretations, preparing the derivative plates, and printing the atlas plates. The derivative plates evaluate geologic conditions as they relate to the special county concerns such as sensitivity of the groundwater system to pollution, water-well construction/abandonment, economic resources, or karst features and the probability of sinkhole development.

Location of Research: Fillmore County

Dates: 07/91—06/94

Funding Source: Legislative Commission on Minnesota Resources; Minnesota Department of Natural Resources, Waters Division; Fillmore County

Funding Amount: \$350,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 5 or 6

Related Research Publications:

96

Southwest Minnesota Regional Geological Assessment

Dale R. Setterholm and Kenneth L. Harris

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Project Description: This project is a geologic and hydrologic assessment of that part of Minnesota that is south of 44° 30' latitude and west of 95° 15' west longitude. This area of approximately 5,100 square miles includes all of Murray, Nobles, Pipestone, and Rock counties and parts of Cottonwood, Jackson, Lyon, Lincoln, and Redwood counties. The assessment is intended to provide baseline geologic information to local decision makers, and to provide the foundation for future, more detailed, investigations.

This project is a cooperative effort between the Minnesota Geological Survey and the Minnesota Department of Natural Resources Waters Division. The MGS staff will produce a database of existing water well data, a surficial geologic map, and a Quaternary stratigraphic plate. Together, MGS and DNR will produce a hydrogeologic plate. Based on those products, DNR staff will produce a map of groundwater sensitivity to pollution. All the MGS maps will be presented in both analog and digital forms, with the digital geo-reference system based on USGS 1:24,000 scale topographic maps.

Location of Research: Southwestern Minnesota

Dates: 07/91—06/94

Funding Source: Minnesota Department of Natural Resources; Legislative Commission on Minnesota Resources

Funding Amount: \$340,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 4

Related Research Publications:

97

Subsurface Greenstone Belts in Southwestern Minnesota

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Project Description: The recently completed aeromagnetic survey of southwestern Minnesota shows anomalies that may be related to the presence of greenstone sequences in subsurface rocks. Other geologically reasonable hypotheses for the aeromagnetic patterns are possible, however, and it is only through direct drilling into buried bedrock that the attributes of the magnetic source rocks can be defined. Because greenstone sequences are the host for major deposits of gold, copper, and zinc in Canada and elsewhere, verification of such rocks in the subsurface of southwestern Minnesota would stimulate mineral exploration in the area. Although the first-order question addressed by this project is minerals-related, the data acquired during drilling will contribute substantially to improved understanding of groundwater resources in southwestern Minnesota. The greater part of the groundwater used in the region is withdrawn from shallow aquifers that are vulnerable to surface contamination

and susceptible to periods of low yield during drought. The present work provides badly needed data on potential aquifer systems that lie at greater depth, and have been little studied.

Location of Research: southwestern Minnesota: Nobles, Murray, Lincoln, Lyon counties

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$120,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Chandler, Val W. 1989. Aeromagnetic map of Minnesota, southwestern region. Minnesota Geological Survey Aeromagnetic Map Series, Map A-8, Scale 1:250,000.

For additional research on GEOLOGY, see project number 165.

GLOBAL WARMING

98

Sensitivity of Peatland Watersheds to Climate Change

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Project Description: Using the Peatland Hydrologic Impact Model (PHIM), water table, evapotranspiration, and streamflow discharge from peatland watersheds are being investigated under conditions of projected changes in temperature and precipitation.

Location of Research:

Dates: 01/91—12/93

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station

Funding Amount: \$11,400

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

99

The Effects of Climatic Variability and Greenhouse Effect Scenarios on Minnesota's Water Resources

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414 Social Sciences
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Project Description: This project examines the sensitivity of Minnesota's water resources to predicted climate changes due to global warming. Statistical models, for the current climate of the relationship between Thornthwaite's moisture surplus and river discharge, were built for nine watersheds in Minnesota. The General Circulation Model's predicted temperature changes and precipitation ratios were used to adjust the observed climatic record. The moisture surplus values were recalculated for this doubled carbon dioxide world and became the predictor variables in the statistical model. The results indicate a general and substantial decrease in river discharge. However, there is great spatial variation in the magnitude of the decrease.

Location of Research:

Dates: 07/89—06/91

Funding Source: Water Resources Research Center, University of Minnesota

Funding Amount: \$25,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

100

Policy Responses to Global Climatic Change and Evaluation of Non-Fossil Energy Supply Options

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Project Description: This project analyzes responses to global climatic change, including means for reduction of greenhouse gas emissions and mitigation strategies for climatic change which seems unavoidable due to the accumulation of previously-emitted greenhouse gases in the atmosphere. The primary focus will be on the comparison of environmental and political implications of non-fossil primary energy sources.

Location of Research:

Dates: 01/90—12/94

Funding Source: Joyce Mertz-Gilmore Foundation

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

101

Regional Modeling of Trace Gas Production in Grassland and Boreal Ecosystems

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Project Description: Northern ecosystems contain large soil pools of carbon and nitrogen that are largely inert because of the cold temperatures and short growing season. However, should the climate warm as projected, increased decomposition of organic matter stored in upland soils and peatlands will cause increased release of greenhouse gases such as carbon dioxide, methane and nitrous oxide. Failure to take into account the role of northern ecosystems in controlling atmospheric chemistry can underestimate the magnitude of the greenhouse effect. This project will study the factors controlling the rates by which these gases are released during decomposition of wetland soils and make estimates of regional fluxes using the geographic information system laboratory. This work is in cooperation with Colorado State University.

Location of Research: Voyageurs National Park

Dates: 07/89—12/92

Funding Source: National Aeronautics and Space Administration (NASA)

Funding Amount: \$209,458

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Global Warming

102

Monitoring and Analysis of Climate in Minnesota

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Project Description: The objectives of this project are to: 1) monitor the agroclimate, 2) summarize the store and databases for computer access, 3) continue the Climate of Minnesota series, and 4) initiate additional climate variability studies.

Objective 1 will be based on measurements from the St. Paul Climatological Observatory plus statewide weather networks. Objective 2 includes placing quality-checked weather data on computer files and providing statistical analysis of same. Objective 3 plans are to add studies on longwave and net radiation plus soil temperature to the Climate of Minnesota series. Objective 4 approach is to: a) analyze the long-term eastern Minnesota precipitation record for trends, b) analyze the temperature record for analogues to 2X CO₂ climate scenarios provided by General Climate Models, and c) attempt a separation of the temperature "signal" in the long-term eastern Minnesota record (1920-1989) from the "noise" or natural variation common to temperature records.

Location of Research: Soil Science Department, University of Minnesota

Dates: 09/90—09/95

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$29,500/year

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

103

Variables in Agricultural Weather Information Systems

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Project Description: Objectives: 1) determine spatial and temporal variability and long-term trends of standard and derived climatic variables, 2) determine the effects of weather and climate variability and change on biological systems and agricultural sustainability, 3) evaluate potential components and technologies pertinent to improved weather and climate systems.

Approach: Objective 1: a) provide time of observation judgments, b) long-term trends compared for spatial and temporal consistency, c) growing season heat-stress frequencies will be determined. Objective 2: a) global climate model results will be applied to crop models to estimate the effects of greenhouse scenarios, b) soil moisture data will be analyzed and regional soil moisture patterns used in GIS packages. Objective 3: precipitation and radiation networks to be analyzed for density requirements.

Location of Research: Soil Science Department, University of Minnesota

Dates: 09/89—09/94

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$56,330/year

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Baker, D.G., D.L. Ruschy, and D.B. Wall. 1990. The albedo decay of prairie snows. *Journal of Applied Meteorology* 29: 179-187.

Baker, D.G., D.L. Ruschy, R.H. Skaggs, and D.B. Wall. 1992. Temperature and radiation depressions associated with snow cover. *Journal of Applied Meteorology* 31: 247-254.

Baker, D.G., R. H. Skaggs, and D.L. Ruschy. 1991. Snow depth required to mask the underlying surface. *Journal of Applied Meteorology* 31: 387-392.

Ruschy, D.L., D.G. Baker, and R.H. Skaggs. 1991. Seasonal variation in daily temperature ranges. *Journal of Climate* 4: 1211-1216.

Sharratt, B.S., C.C. Sheaffer, and D.G. Baker. 1989. Base temperature for the application of the growing-degree-day model to field-grown alfalfa. *Field Crops Resources* 21: 95-102.

Sharratt, B.S., D.G. Baker, D.B. Wall, R.H. Skaggs, and D.L. Ruschy. 1992. Air and soil temperature variations for given snow depths. *Agriculture and Forestry Meteorology* 57: 243-251.

104

Global Carbon Study: Simultaneous Decomposition of C-3 and C-4 Plant Sources

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Project Description: Plant photosynthate has increased root biomass about 4 percent since 1950 just from the direct influence of increased carbon dioxide in the atmosphere. Annual additions of carbon to the soil are about 15 percent of the atmosphere content, but most is returned to the atmosphere during the decomposition process. Research is needed to evaluate the dynamics of carbon in soil as related to crops, cropping systems and tillage. Associated with these descriptions of dynamics, the mineral-organic interface needs to be evaluated to identify techniques for sequestering carbon. This project will evaluate and describe simultaneous decomposition rates for old soybean residue (C-3) in the presence of current corn residue (C-4). In addition, evaluations of the influence of long-term tillage systems on the relative decomposition rates when producing continuous corn after a long history of soybeans will be conducted.

Location of Research: Southwest Experiment Station, Lamberton, Minnesota

Dates: 05/91—Ongoing

Funding Source:

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on GLOBAL WARMING, see project numbers 50, 77, 151, 173, 260.

GREAT LAKES

105

Zooplankton Pathways for the Transport of Hydrophobic Organic Compounds to Fish in Lake Superior

Melbourne C. Whiteside, R.O. Megard, and Deborah L. Swackhamer

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Project Description: The vast majority of hydrophobic organic compounds (HOCs) in commercial and sport fish are due to food chain uptake. The objectives of this study will be to determine the burdens of toxic HOCs in zooplankton layers and planktivorous fish of western Lake Superior; to discern food chain pathways by which HOCs are transported to fish; and to develop a quantitative model for food web structure that delineates the food chain pathways by which fish acquire their toxic burdens from different zooplankton aggregations. This project will provide information needed by modelers to calculate how HOC burdens of fish will be affected by changes in quantities of HOCs entering lakes and will help fisheries personnel select management practices that will minimize HOC burdens.

Location of Research: Lake Superior

Dates: 06/89—12/93

Funding Source: Graduate School, University of Minnesota

Funding Amount: \$21,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

106

Atmospheric Deposition of Toxic Contaminants to the Great Lakes: Assessment and Importance

Steven J. Eisenreich, Deborah L. Swackhamer, and David Long

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Institute of Technology
122 Civil and Mineral Engineering
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(612) 625-5522

Project Description: The overall objective of this project is to provide an accurate assessment of the atmospheric deposition of all 14 toxic contaminants on the International Joint Commission "critical pollutant" list, to the Great Lakes ecosystem. Specific goals are to: 1) collect and analyze a selected number of sediment cores from the Great Lakes, small remote lakes, and peatlands for critical pollutants; 2) collect and integrate all existing data on the air and precipitation concentrations and fluxes (or accumulations) of the critical pollutants; and 3) perform a complete post-audit of the mass balance model used by Strachan and Eisenreich (1988) to estimate the magnitude and importance of the atmospheric pathway of pollutants to the Great Lakes.

Location of Research: Great Lakes

Dates: 10/90—09/93

Funding Source: Great Lakes Protection Fund
Funding Amount:
Number of Graduates Working with Project: 4-5
Number of Undergraduates Working with Project:
Related Research Publications:

107

Organic Contaminants in Sediments/Waters of Lakes Michigan and Ontario

Steven J. Eisenreich and Deborah L. Swackhamer

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122 Civil and Mineral Engineering
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Project Description: The overall objective of this project is to determine the concentrations, spatial distribution, and accumulation chronology of hydrophobic organic compounds (HOCs) and trace metals in sediment cores of Lakes Michigan and Ontario. A secondary objective is to determine the dissolved and particulate concentrations of selected HOCs in the surface waters of these lakes.

Location of Research: Lake Michigan and Lake Ontario

Dates: 08/91—08/93

Funding Source: U.S. Environmental Protection Agency; Great Lakes National Program Office

Funding Amount:

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project: 0

Related Research Publications:

108

PCB Sediment Trap Fluxes in Green Bay

Steven J. Eisenreich and Deborah L. Swackhamer

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Project Description: The objectives of this study are to determine the flux of PCBs, dieldrin, and organic carbon to Green Bay based on sediment trap deployments, and to characterize particles for OC, pigments, Al and Fe, lipid classes and particle type.

Location of Research: Green Bay, Wisconsin

Dates: 04/90—03/92

Funding Source: U.S. Environmental Protection Agency; Great Lakes National Program Office

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

109

Measurement of Gas Transfer in Lake Superior

John S. Gulliver

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Project Description: Models of toxic pollution in the Great Lakes have a number of parameters that are largely unknown or untested. Gas transfer from air to water is one of the large unmeasured sources or sink of toxic pollution in the Great Lakes. This project will develop a technique for the measurement of gas transfer rate in a stratified, large water body under a variety of wind and wave conditions. The results can be applied in models of toxic pollution in the Great Lakes as well as in models of the absorption of greenhouse gases by all water bodies.

Location of Research:

Dates: 01/90—12/93

Funding Source: National Ocean and Atmospheric Administration (NOAA); Minnesota Sea Grant

Funding Amount: \$75,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

110

Land Use Impacts on Lake Superior

Don McNaught, Carol A. Johnston, and Naomi E. Detenbeck

Ecology, Evolution, and Behavior
College of Biological Sciences
109 Zoology
318 Church St. S.E.
Minneapolis, MN 55455
(612) 625-4466

Project Description: This is a multi-investigator study which has measured and modeled the impacts of changing land use practices and erosion rates, stream water quality and biological communities in the near shore waters in Lake Superior.

Location of Research: Lake Superior North Shore

Dates: 07/89—06/91

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$240,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

Johnston, C.A., B. Allen, J. Bonde, J. Sales, and P. Meysembourg. 1991. Land use and water resources in the Minnesota North Shore drainage. *NRRI Technical Report*, No. NRRI/TR-91/07.

111

Data Certification and Interpretation for Green Bay Mass Balance Study

Deborah L. Swackhamer

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Project Description: The objectives of the proposed work are two-fold, and include: 1) providing an evaluation of the effectiveness of the quality assurance program of the Green Bay Mass Balance Study, and 2) analyzing and interpreting the data for organic compounds in Green Bay water samples beyond the basic needs of the mass balance model. Data will be evaluated for temporal and spatial variability, and for particle-water partitioning behavior.

Location of Research:

Dates: 06/90—05/92

Funding Source: U.S. Environmental Protection Agency; Great Lakes National Program Office

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

112

Microbial Recycling of Contaminants at the Sediment-Water Interface in Freshwater

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Project Description: The goal of this research is to understand the role of aerobic heterotrophic bacteria in the recycling of hydrophobic organic compounds (HOCs) within the context of the biodegradation of natural organic matter at the sediment-water interface in the Great Lakes. Recent evidence indicates that a substantial amount of particulate-associated HOCs leaving the water column by sedimentation are not incorporated into sediments and are recycled back to the water column, in the dissolved phase. Thus permanent burial is delayed, and the water column residence time is increased, allowing for longer exposures of HOCs to the aquatic food chain.

Location of Research: Great Lakes

Dates: 09/90—09/92

Funding Source: U.S. Environmental Protection Agency, Exploratory Research Program

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 0

Related Research Publications:

113

PCB Congener Analysis of Five Lake Cores in the Area of the Apostle Islands, Lake Superior

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Project Description: This study will analyze the concentrations of PCBs in sediment cores taken from Lake Superior near the Apostle Islands and compare them to those in lakes on the Apostle Islands to assess differences in contaminant sources to the lakes. This is to determine the role of atmospheric deposition in contributing to fish contaminant burdens in these lakes.

Location of Research: Lake Superior

Dates: 07/91—06/92

Funding Source: U.S. Geological Survey

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 0

Related Research Publications:

114

Role of Phytoplankton in Bioaccumulation of PCBs in Green Bay

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Project Description: This project examined the factors that control uptake and bioaccumulation of PCBs in algae in order to better understand the process of bioaccumulation in the entire aquatic food chain. This study focused on the Green Bay ecosystem. The objectives were: 1) to determine the factors that control the uptake and accumulation of PCBs by phytoplankton in controlled laboratory experiments; 2) to develop a mathematical model to predict bioaccumulation factors; and 3) to validate this model with field data collected from six Master Stations in Green Bay over a one-year period. Due to some of its unique features, these data will be used to develop the overall mass balance model for the Green Bay Mass Balance Study.

Location of Research: Green Bay, Wisconsin

Dates: 07/88—09/91

Funding Source: U.S. Environmental Protection Agency; Great Lakes National Program Office

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 0

Related Research Publications:

115

Role of Phytoplankton in Contaminant Fate in Lakes**Deborah L. Swackhamer**

Environmental and Occupational Health
School of Public Health
Box 197 Mayo
420 Delaware St. S.E.
Minneapolis, MN 55455
(612) 626-435

Project Description: Previous research on bioaccumulation of PCBs by phytoplankton has demonstrated that the uptake of PCBs is greatly affected by the algal growth rates because the time to equilibrium is long relative to growth. The project will evaluate the role that phytoplankton play in the fate of hydrophobic organic compounds (HOCs), and includes determining: 1) uptake of HOCs by phytoplankton; 2) magnitude and transfer rate of HOCs to higher trophic levels in food webs; 3) role of extracellular excretions in transport of HOCs; and 4) removal rate of HOCs to sediments by dead phytoplankton. This two-year study involved laboratory experiments as well as field studies in western Lake Superior to determine contaminant fate.

Location of Research: Lake Superior and the University of Minnesota

Dates: 01/90—12/91

Funding Source: Minnesota Sea Grant; National Oceanic and Atmospheric Administration (NOAA)

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

116

Trophic Relations of Ruffe (*Gymnocephalus cernuus*) in the St. Louis River Harbor, Lake Superior**Raymond M. Newman, Mary G. Henry, and James H. Selgeby**

Fisheries and Wildlife
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St. Paul, MN 55108
(612) 625-5704

Project Description: The ruffe (*Gymnocephalus cernuus*) have been increasing in number in the St. Louis estuary since their introduction to North America in 1986. Concern exists over their potential to compete with and prey upon desirable sport and commercial fishes. The objective of this study is to obtain ecological information on the trophic relations of the recently introduced ruffe to the indigenous fish species of the St. Louis River estuary of Lake Superior. Two aspects of ruffe ecology will be specifically examined: 1) the food habits of the ruffe will be determined by examining stomach contents of juvenile through adult life stages, and 2) predation on ruffe and other forage fish by indigenous piscivores (walleye and northern pike) will be determined. For both aspects, estimates of prey availability (benthos and zooplankton samples for ruffe feeding; indices of ruffe and forage fish abundance for piscivore feeding) will be used to assess feeding ecology. Site information dealing with ruffe feed habits and the potential for indigenous predators to control ruffe will be critical to resource agencies in developing effective management plans for ruffe eradication or control. Our results will suggest effective strategies that may save management time and money.

Great Lakes

Location of Research: St. Louis Harbor; Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota; U.S. Fish and Wildlife Service Ashland Biological Station, Wisconsin

Dates: 01/90—12/91

Funding Source: U.S. Department of Commerce; Minnesota Sea Grant

Funding Amount: \$41,650

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3-4

Related Research Publications:

Newman, R.M. 1989. Ballast water exotics: Impacts, costs, and solutions: Great Lakes exotic species. *Great Lakes Ports in a Changing Economy: Summary of a Conference*, 12-14, Minnesota Sea Grant Extension Program Publication, St. Paul, MN.

Newman, R.M. 1991. The invasion of foreign aquatic plants and animals. *Minnesota Out-of-Doors* 37(5/6): 16-17, 29.

117

Determining the Olfactory Sensitivity of Sea Lamprey: An Essential First Step in Evaluating Whether Natural Odors Can be Used for Biocontrol

Peter W. Sorensen

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St. Paul, MN 55108
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Project Description: In spite of almost 30 years of chemical control, lamprey eels continue to kill large numbers of lake trout in Lake Superior. To manage lamprey populations, the Great Lakes Fisheries Commission uses TFM, a chemical that kills lamprey larvae in streams. New, nontoxic methods of lamprey control will be investigated in this research project. Earlier research established the importance that smell plays in goldfish reproduction. By controlling the hormone metabolites that may function as sex pheromones in lamprey, reproductive behavior may also be controlled.

Location of Research:

Dates: 01/91—01/93

Funding Source: Minnesota Sea Grant

Funding Amount: \$25,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

118

Predicting Lake Superior Shoreline Erosion from Coastal Characteristics and Historical Trends

Carol A. Johnston

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University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: Coastal erosion costs Minnesotans millions of dollars each year for shoreline stabilization, harbor dredging, and property loss. Using historical aerial photography (1934-1986) and shoreline geology and geometry measurements, a model was developed for predicting recession of Lake Superior shoreline. This research provides county zoning officials, coastal engineers, and state regulatory agencies with a tool to plan development so as to minimize future erosion costs.

Location of Research: Lake Superior North Shore

Dates: 10/87—12/91

Funding Source: Minnesota Sea Grant

Funding Amount: \$86,570

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 6

Related Research Publications:

For additional research on the GREAT LAKES, see project numbers 49, 151, 163, 231, 251.

GROUNDWATER

119

Managing Groundwater Sensitivity

James A. Perry

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College of Natural Resources
115 Green Hall
1530 N. Cleveland Ave.
St. Paul, MN 55108
(612) 624-9697

Project Description: Using a recently developed technique for assessing groundwater sensitivity over large geographic areas, GIS applications of groundwater and surface water sensitivity algorithms are being developed which will guide communities in phrasing their water resource management questions, assist them in selecting the correct sensitivity metric(s) for their needs and then place the results of sensitivity analyses into defensible policy decisions.

Location of Research: Winona County and Minnesota in general

Dates: 01/87—12/91

Funding Source:

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 0

Related Research Publications:

Trojan, M.D. and J.A. Perry. 1989. Analysis of hydrogeologic sensitivity in Winona County, Minnesota. *Journal of the Minnesota Academy of Science* 54: 30-36.

Trojan, M.D. and J.A. Perry. 1988. Assessing hydrogeologic risk over large geographic areas. *Bulletin of the Minnesota Agricultural Experiment Station* 585. 65 pp.

120

Farming and Groundwater: An Introduction

Gerald Torres, John Davidson, and Lawrence Kurland

Law School
Law Building
229 19th Ave. S.
Minneapolis, MN 55455
(612) 625-2376

Project Description: This project was designed to survey the existing law on the subject of agriculturally related groundwater contamination. We aimed the primer at policy makers who were, at the time, unfamiliar with the complexity of the issue. We also surveyed farmers in five watershed areas to assess the state of farmer information on the issue.

Location of Research: University of Minnesota and University of South Dakota

Dates: 10/88—06/89

Funding Source: Mellon Foundation

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

Esseks, J.D., W. J. Andrews, C.J. Booth, S.E. Kraft, S.K.S. Lindquist, and L.K. Vinis. 1989. *Agriculture and Ground Water Quality: Farmers Perceptions in Five Diverse Sites*. Produced by the Center for Governmental Studies, Northern Illinois University, for the Agricultural Law and Policy Institute.

121

Integration of Nitrogen Management Alternatives to Minimize Groundwater Contamination

Gary L. Malzer and Robert Pierre

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Project Description: Expert systems are being developed in Minnesota and Nebraska that would allow for site specific N fertilizer recommendations that are economically and environmentally sound. Teams from Minnesota and Nebraska have met on a regular basis to coordinate activities and to define conditions for site specificity, economic and environmental concern, and economic and logistical feasibility. Prototype expert systems have been developed and are currently being evaluated. The expert system will utilize either soil information provided by the user, or will access site specific information from a digitized soil map and associated soil survey information. The latter feature will allow easy adaptability for variable N rates on-the-go. The site specific soil information is used along with user manager information to determine the minimum rate of fertilizer N needed for production. Both components are integrated together to provide management recommendations that will minimize N loss during the growing season.

Location of Research: central Minnesota

Dates: 08/89—04/92

Funding Source: Presidential Water Quality Initiative, Cooperative States Research Service (CSRS), U.S. Department of Agriculture

Funding Amount: \$63,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on GROUNDWATER, see project numbers 32, 88, 89, 90, 91, 92, 94, 95, 96, 97, 136, 165, 167, 172, 178, 205, 206, 227, 239.

LAND USE

122

Land Use and Design Strategies to Enhance Environmental Quality

Harrison Fraker

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College of Architecture and Landscape Architecture
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(612) 626-1000

Project Description: Recent urban design concepts have been developed which take advantage of the land use potential of new metropolitan transportation systems, like light rail and/or park-and-ride systems. These concepts provide alternative development strategies to the negative environmental impacts of suburban sprawl. One of these ideas which has received national publicity is the "pedestrian pocket." It proposes an intensification of land use (medium rise, high density) around station stops which is both mixed-use and seeks to create a walking scale environment with pedestrian access to most basic services. The concept has been shown to be an exciting alternative to sprawl. This project proposes to apply the pedestrian pocket concept to develop land use and urban design guidelines for typical station stops on the light rail transit system proposed for the Twin Cities and at potential locations for park-and-ride stations on the existing freeway system.

Location of Research: Twin Cities metropolitan area

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$100,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

Fraker, Harrison. *Filling In*. 1992. College of Architecture and Landscape Architecture, University of Minnesota. 14 pp.

123

Reclamation of Recreational Systems and Environmental Resources from Existing Urban/Suburban Neighborhoods

William R. Morrish, Catherine R. Brown, and Thomas A. Hammerberg

Design Center for American Urban Landscape
College of Architecture and Landscape Architecture
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86 Pleasant St. S.E.
Minneapolis, MN 55455
(612) 626-0333

Project Description: This project will investigate the potential for enhancing and enriching the recreational amenities and overall urban quality of existing urban/suburban neighborhoods through capital infrastructure investment and revitalization of existing local environmental resources. Using the Twin Cities metropolitan suburban community as a case study area, the program has three primary elements: 1) identification of existing recreational/environmental systems within the area; 2) development of alternative design scenarios for the revitalization and expansion of the systems into neighborhood fabric; 3) development of an urban design strategy handbook outlining design, finance,

policy and implementation steps. These materials will be used as primary educational material within the urban design program of the University and shared with city, county, and state organizations.

Location of Research: Twin Cities metropolitan area

Dates: 07/91—07/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$200,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

124

Trail Planning and Management

Dorothy H. Anderson and David W. Lime

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College of Natural Resources
115 Green Hall
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Project Description: Not available at the time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 11/90—06/91

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$28,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3

Related Research Publications:

Anderson, D.H., J.L. Thompson, and S.B. Sinn. 1991. *Minnesota Snow Mobiling: Results of 1988-89 Snowmobile Survey*. Final report to Minnesota Department of Natural Resources and The Legislative Commission on Minnesota Resources, contract number MNDNR 29000-55470. College of Natural Resources, Department of Forest Resources, University of Minnesota. 20 pp.

Anderson, D.H., J.L. Thompson, D. W. Lime, T.D. Scheicher, C.A. Penney, and S.M. Woodrich. 1991. *Long-Distance Trails in Minnesota: Planning and Management Concerns*. Final report to Minnesota Department of Natural Resources and the Legislative Commission on Minnesota Resources, contract number MNDNR 29000-55470. College of Natural Resources, Department of Forest Resources, University of Minnesota. 84 pp.

Lime, D.W., D.H. Anderson, J. Teigland, T. Sievanen, F. Jensen, and J.L. Thompson. 1991. *An Exploratory International Investigation of Long-Distance Trails: Ideas for Consideration in Minnesota*. Final report to Minnesota Department of Natural Resources and The Legislative Commission on Minnesota Resources, contract number MNDNR 29000-55470. College of Natural Resources, University of Minnesota. 38 pp.

Land Use

125

Land Cover Analysis for the Twin Cities Metropolitan Area

Marvin E. Bauer, Stephen D. Lime, and Daniel G. Sorenson

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(612) 624-3703

Project Description: Land cover information provides important inputs to local, regional, and state land use planning. The importance of accurate and timely information describing the kind and extent of land features is increasing. Historically, remote sensing in the form of aerial photography has been an important source of land cover/use information. However, the cost of aerial photography acquisition, interpretation, and digitizing cover types continues to grow. There is considerable evidence to suggest that digital analysis of satellite-acquired data can be used to increase the efficiency and timeliness of land inventory and mapping at considerable cost savings. This project was performed by the University of Minnesota Remote Sensing Laboratory in a cooperative effort with the Twin Cities Metropolitan Council. Data from a Landstat Thematic Mapper were used to classify the land cover in the Twin Cities metropolitan area, for purposes related to the siting of a new airport facility. In addition, a Level II classification with ten classes at the full spatial resolution of the satellite data were developed and will be integrated into the Metropolitan Council's geographic information system. Landstat is a type of earth resources observation satellite. The Thematic Mapper sensor located on Landstat senses and records the energy reflected from a given spot on the earth's surface.

Location of Research: Twin Cities metropolitan area

Dates: 07/90—08/91

Funding Source: Twin Cities Metropolitan Council

Funding Amount: \$30,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

126

Land Design for Bicycle Transportation in Minnesota Cities

Robert D. Sykes

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212 North Hall
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St. Paul, MN 55108
(612) 626-1242

Project Description: A renewed interest in developing and supporting modes of transportation that can be viable alternatives to the automobile is finding firm ground in the 1990s. The bicycle, as a mode of transportation, stands today as an important part of the solution of auto-generated pollution, congestion, urban sprawl, and dependency on fossil fuels. This study is developing a hierarchical strategy for adapting urban patterns to integrate the bicycle as an important and competitive form of transportation.

Location of Research:

Dates:

Funding Source: Center for Transportation Studies, University of Minnesota
Funding Amount:
Number of Graduates Working with Project:
Number of Undergraduates Working with Project:
Related Research Publications:

127

Model Residential Land Use Guidelines

Robert D. Sykes and Michael Robinson

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College of Architecture and Landscape Architecture
212 North Hall
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St. Paul, MN 55108
(612) 625-8285

Project Description: This project will clearly identify the status quo of land development standards in new suburban areas, and then measure the impacts attributable to those standards. Because impacts tend to compound when individual standards are combined in their application to design whole subdivisions, the environmental cost of maintaining the status quo in land development standards must also be examined in that context. For this reason, the impacts will be assessed through the use of actual projects which reflect status quo standards. The specific impact issue areas examined will focus on environmental objectives embodied in published policies affecting Minnesota communities which are affected by the spatial controls applied in regulating the subdividing process. These include, but are not limited to: stormwater runoff, downstream flooding, non-point source water quality, ground water recharge, energy consumption, wildlife habitat, urban forests, soil erosion, neighborhood aesthetics, and the cost of the land component of new housing.

Location of Research: Department of Landscape Architecture, University of Minnesota

Dates: 07/91—07/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$43,000

Number of Graduates Working with Project: 3-4

Number of Undergraduates Working with Project:

Related Research Publications:

128

Underground Station Design for Light-Rail Transit in the Twin Cities

Raymond L. Sterling and John Carmody

Underground Space Center
Civil and Mineral Engineering
Institute of Technology
790 Civil and Mineral Engineering
500 Pillsbury Drive S.E.
Minneapolis, MN 55455
(612) 624-0066

Project Description: Under a grant from the Regional Transit Board, the Underground Space Center has been studying critical design issues related to underground light rail stations in the Twin Cities geology. There are presently five underground stations included in the Hennepin County portion of a light rail system.

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The issues addressed fall into three categories: 1) station configuration constraints and opportunities in various local geological conditions; 2) station access and egress concepts; and 3) station image, psychological perceptions, and relation to the urban environment.

Location of Research: Underground Space Center Test Facility, Rosemount, Minnesota

Dates: 07/90—11/91

Funding Source: Regional Transit Board

Funding Amount: \$45,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Carmody, J. and R.L. Sterling. 1991. *Underground Station Design Issues for Light Rail Transit in the Twin Cities Geology*. Report to the Regional Transit Board, Minnesota.

129

Joint Research With Shimizu Institute of Technology

Raymond L. Sterling and John Carmody

Underground Space Center
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Institute of Technology
790 Civil and Mineral Engineering
500 Pillsbury Drive S.E.
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(612) 624-0066

Project Description: The Underground Space Center is currently engaged in a multiyear joint research project with the Shimizu Institute of Technology in Tokyo, Japan. The major emphasis of the research is to study the potentially negative psychological and physiological effects associated with windowless, isolated spaces. In addition to documenting these effects, the study will identify design strategies to alleviate them and attempt to evaluate the effectiveness of these strategies. The results of this research are being compiled in a guidebook to be published in 1992 and, although the primary emphasis of the research is to produce guidelines to improve underground space for human habitability, the guidebook will also address issues related to the overall planning and development of underground space in urban environments.

Location of Research:

Dates: 10/87—09/92

Funding Source: Shimizu Institute of Technology, Tokyo, Japan

Funding Amount: \$223,127

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Sterling, R.L. and J. Carmody. In Press. *Underground Space Design: A Guide to Subsurface Utilization and Design for People in Underground Spaces*. Van Nostrand Reinhold, New York.

For additional research on LAND USE, see project numbers 87, 91, 110, 239, 242, 243, 244, 248, 254, 258.

POLLUTION CONTROL

130

Political Economy of Transboundary Pollution

Harold W. Von Witzke and Marie L. Livingston

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(612) 625-1712

Project Description: In many countries, major efforts are now underway by national governments to improve environmental quality. National governments can be successful in improving environmental quality when the sources of pollution are located within the government's jurisdiction. This is not the case, however, when pollutants cross the boundaries between autonomous jurisdictions.

The research project's focus is on the political economy of transboundary pollution control. Public choice models have been developed that analyze the determinants of transboundary pollution regulation by governments acting alone as well as cooperatively. The models have been tested for phosphorus pollution by Great Lakes states and provinces and for greenhouse gas emissions by OECD countries. Supernational institutional arrangements are developed that can facilitate international coordination of transboundary pollution control.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 01/88—Ongoing

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

131

Characterization and Prediction of Drainage Networks of Field-Sized Areas

Bruce N. Wilson

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College of Agriculture
213 Agricultural Engineering
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Project Description: Physically-based simulation models are widely used to assess and manage runoff and pollutants from nonpoint sources. The detachment, entrainment and transport processes in field-sized areas are the primary sources of contaminants and therefore must be modeled accurately. Most physically-based models currently use crude methods, usually assuming sheet flow, to describe hydraulic processes. Sheet flow rarely occurs in nature. Flow paths converge with other flow paths to form small channels. Velocity and bed shear in these small channels are essential in determining detachment, entrainment and transport.

The concept of topologically random channel networks has been successfully used to describe the drainage network of river systems. In comparison to rill networks, these drainage systems are already

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developed and their major features can be determined from map data. A more powerful application of topologically random channel networks is to predict the development of rill networks as the result of future storms. This step has not yet been used but should prove valuable in characterizing the runoff process in field-sized areas. Not only can flow paths be predicted, but the uncertainty of a particular drainage pattern can also be determined. The application of this approach to upland processes of runoff and erosion is the thrust of this study.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 09/91—09/94

Funding Source: U.S. Geological Survey, Section 105

Funding Amount: \$87,125

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 2

Related Research Publications:

132

The Ability of Wet Deposition Networks to Detect Trends

Gary W. Oehlert

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School of Statistics
352 Classroom Office Building
1994 Buford Ave.
St. Paul, MN 55108
(612) 625-4758

Project Description: This research uses spatial-temporal statistics to analyze current wet deposition (acid rain) networks to determine the degree to which trends in the network can be detected and quantified. The eventual goal is to decide how the network should be improved to meet stated detection goals, that is, how many new monitoring stations are needed, and where should these stations be located. Alternatively, the research may also be used to determine which stations can be removed with least effect on the monitoring ability of the network.

Location of Research:

Dates: 07/90—07/92

Funding Source: U.S. Environmental Protection Agency

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

133

A Mobile In-Flight Plasma Process to Treat Electric Arc Furnace Dust

Malcolm T. Hepworth and Jozef K. Tylko

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Institute of Technology
122 Civil and Mineral Engineering
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Project Description: A reactor based on the use of Sustained Shock-Wave Plasma technology has been developed and successfully tested at a laboratory for the treatment of electric arc furnace dust. The reactor utilizes a conical, highly diffused, orbiting and pulsating discharge into which mixtures of carbon and electric furnace dust are introduced and treated in-flight. The unit is capable of wide regulation of the height of discharge, orbital speeds, pulse amplitude, and mark-space ratios. A particularly important feature of this unit is its ability to operate with very low flows of plasma forming gas (argon), which provides both high enthalpy of the ambient discharge and efficient condensation and collection of the volatile fraction in a bag filter.

Location of Research:

Dates: 07/87—09/91

Funding Source: Mineral Industry Waste Treatment and Recovery Generic Center, U.S. Bureau of Mines

Funding Amount: \$161,906

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

Hepworth, M.T., J.K. Tylko, M.K. Tylko, and S. Vrchota. 1990. A mobile in-flight sustained shock-wave plasma reactor for treating electric arc furnace dust. *Second International Symposium on Recycling of Metals and Engineered Materials, Williamsburg, VA, October 28-31, 1990*, 417-423. Minerals, Metals and Materials Society, Warrendale, PA.

Wang, J.C., M.T. Hepworth, and K.J. Reid. 1990. Recovering Zn, Pb, Cd, and Fe from electric arc furnace dust. *Journal of Metals* 41(4).

134

Biological Degradation of Slightly Soluble, Potentially Toxic Organic Chemicals

Walter J. Maier

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Institute of Technology
148 Civil and Mineral Engineering
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Minneapolis, MN 55455
(612) 625-3016

Project Description: This research includes bench scale laboratory testing to define the kinetics and develop mathematical models for the biological degradation of organic chemicals like fuels-related hydrocarbons, chlorinated organics and solvents.

Location of Research:

Dates: 01/91—12/93

Funding Source: U.S. Air Force

Funding Amount: \$105,000

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Number of Graduates Working with Project: 2
Number of Undergraduates Working with Project:
Related Research Publications:

135

Biological Treatment of Organic Pollutants in the Context of Municipal and Industrial Wastewaters

Walter J. Maier

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Institute of Technology
148 Civil and Mineral Engineering
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Minneapolis, MN 55455
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Project Description: This research will conduct bench scale testing and modeling of reaction kinetics of specific organic chemicals to develop engineering design criteria for use in municipal and industrial wastewater treatment.

Location of Research:

Dates: 01/91—12/92

Funding Source: Minnesota Waste Control Commission; 3M

Funding Amount: \$31,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

136

Remediation of Soils, Aquifers and Groundwater

Walter J. Maier

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Institute of Technology
148 Civil and Mineral Engineering
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Minneapolis, MN 55455
(612) 625-3016

Project Description: This research includes studies of transport, adsorption, and biological-chemical oxidation of organic pollutants to clean up contaminated aquifers and groundwaters. The findings can also be applied to studying the decontamination of leachates from landfills.

Location of Research:

Dates: 01/91—12/94

Funding Source: Minnesota Pollution Control Agency; Legislative Commission on Minnesota Resources

Funding Amount: \$250,000

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project: 3

Related Research Publications:

137

Study of Treatment Technologies for the Removal of Toxic Metal and Organic Pollutants from Bottom Sediments

Rodney L. Bleifuss, John R. Ludwig, and Keith B. Lodge

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Natural Resources Research Institute
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(218) 245-2200

Project Description: Contaminated sediments represent a global environmental issue of major ecological and economic proportions. The U.S. Environmental Protection Agency is evaluating remediation alternatives for contaminated bottom sediments and the objective of this research is to develop a viable treatment flowsheet for the remediation process. Mineral processing techniques that have been developed for the concentration of iron ores, non-ferrous ores and industrial minerals will be applied to isolate, and in some cases detoxify, contaminated sediment fractions. The ultimate objective is to reduce the cost of remediation by decreasing the volume of clastic material that would require rigorous treatment such as encapsulation, incineration, or permanent impoundment.

Location of Research: Coleraine Minerals Research Laboratory, Natural Resources Research Institute, University of Minnesota, Duluth

Dates: 07/91—06/93

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$1,000,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

138

Minnesota Technical Assistance Program (MNTAP)

Fay Thompson and Cindy McComas

Environmental and Occupational Health
School of Public Health
W140 Boynton Health Service
410 Church St. S.E.
Minneapolis, MN 55455
(612) 626-3676

Project Description: MNTAP provides to hazardous waste generators the following elements: outreach programs including telephone consultation, on-site consultation, seminars; assembles catalogs and disseminates information about hazardous waste reduction and management methods; evaluates and interprets information needed by generators; and identifies alternative technical solutions. Pollution prevention is the current focus of the MNTAP program.

Location of Research:

Dates: 01/84—Ongoing

Funding Source: Minnesota Office of Waste Management

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 5

Related Research Publications:

Pollution Control

139

Pollution Prevention Incentives to State's Program-Contractual Services

Fay Thompson and Cindy McComas

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School of Public Health
W410 Boynton Health Service
410 Church St. S.E.
Minneapolis, MN 55455
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Project Description: The Minnesota Technical Assistance Program will be responsible for providing multi-media technical assistance with primary focus on reduction of hazardous air emissions for individual companies. This will include demonstration projects to reduce air emissions and wastes, documentation of the impacts of process changes on solvent air emissions where work has been done in previous programs, and providing technical assistance and outreach to companies primarily seeking assistance in reducing air emissions.

Location of Research:

Dates: 04/91—04/93

Funding Source: Minnesota Office of Waste Management

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

140

Pollution Prevention Technical Assistance and Demonstration Projects Based on Environmental Risk Screening And Priority

Fay Thompson and Cindy McComas

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Minneapolis, MN 55455
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Project Description: This study is submitted in response to the availability of grants to state and regional organizations to establish and expand comprehensive cross-media, pollution prevention programs. Through an integrated approach involving the Minnesota Office of Waste Management and the Minnesota Pollution Control Agency, the Minnesota Technical Assistance Program will expand its pollution prevention assistance capabilities to handling inquiries about reducing air emissions.

Location of Research:

Dates: 06/90—06/92

Funding Source: U.S. Environmental Protection Agency

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

141

Bacterial Degradation of Toxic Contaminants**Alan Hooper**

Genetics and Cell Biology
College of Biological Sciences
250 Biological Sciences
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Project Description: Bacteria have cleansed the environment for eons by breaking down toxic compounds into harmless materials. These bacteria have not been able to contend, however, with complex chlorinated organic pollutants, such as PCBs, dioxin and pesticides. In previous research, it was found that by adding ammonia to some bacteria in soil and water, the bacteria will degrade some simple contaminants, such as TCE, chloroform and vinyl chloride. This project will assess whether these same bacteria will also degrade more complex compounds, such as PCBs. The bacteria could be used in several ways. In addition to removing toxins from contaminated soil, factory effluent could be decontaminated by adding ammonia to holding tanks and treating the polluted effluent before it leaves the plant.

Location of Research:**Dates:** 01/91—12/93**Funding Source:** Minnesota Sea Grant**Funding Amount:****Number of Graduates Working with Project:** 2**Number of Undergraduates Working with Project:** 2**Related Research Publications:**

Vannelli, T., M. Logan, D.M. Arciero, and A.B. Hooper. 1990. Degradation of halogenated aliphatic compounds by the ammonia-oxidizing bacterium *Nitrosomonas europaea*. *Applied Environmental Microbiology* 56: 1169-1171.

142

Microbial Biotransformations and the Biodegradation of Environmental Protection Agency Priority Pollutants**Lawrence P. Wackett**

Gray Freshwater Biological Institute
College of Biological Sciences
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Navarre, MN 55392
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Project Description: The various research projects conducted on an ongoing basis are designed to study microbial transformations and the biodegradation of the U.S. Environmental Protection Agency priority pollutants. In one project, microbial metabolism of organohalides is being investigated in order to assess the potential for using bacteria for the bioremediation of hazardous wastes. In another project, microorganisms use transition metals in key enzymes involved in the breakdown of natural product aromatic compounds. The overlapping roles of iron and manganese in these processes are being investigated. Projects are also underway in developing uses for biotechnology to develop non-polluting methods for the manufacture of chemicals. For example, bacteria have been used as biocatalysts to manufacture cis-dihydroxylated compounds that serve as industrial feedstocks in the production of speciality polymers.

Location of Research: Gray Freshwater Biological Institute

Pollution Control

Dates: 09/87—ongoing

Funding Source: National Institutes of Health (NIH); U.S. Air Force Office of Scientific Research

Funding Amount: \$1,000,000

Number of Graduates Working with Project: 8

Number of Undergraduates Working with Project: 8

Related Research Publications:

Gantzer, C.J. and L.P. Wackett. 1991. Reductive dechlorination catalyzed by bacterial transition-metal coenzymes. *Environmental Science Technology* 25: 715-722.

Newman, L. and L.P. Wackett. 1991. Production and fate of trichloroacetaldehyde (chloral hydrate) in methanotrophic cultures. *Applied Environmental Microbiology* 57: 2399-2402.

143

Development of Toxicity Testing Techniques and Methodologies for Field Application

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College of Natural Resources
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Project Description: Environmental contaminants are of increasing concern to natural resource managers, from both Research and Operations Divisions of the U.S. Fish and Wildlife Service (USFWS) and to the public at large. To date, operations personnel have largely relied on costly and time-consuming chemical analyses to determine the type and extent of contamination at a given field location. However, such analysis does not provide information on the biological effect of the toxicants.

The objectives of this research are: 1) to assess low level contamination under field conditions by evaluating, adapting, and refining existing bioassessment techniques for use in a variety of ecosystems; 2) to develop new approaches to better utilize and augment existing techniques; 3) to structure testing schemes using various water, sediment, and pore water matrices so that the type of test, the number of different techniques, and the combination of techniques required can be recommended for operations use; 4) to work with real-world samples collected by environmental contamination specialists of the USFWS to validate the recommended test schemes; and finally; 5) as a result of this research, to prepare a manual of standard protocols for use by field personnel and provide "hands-on" training in the form of workshops.

A program involving a battery of toxicity test techniques is proposed for screening the toxicity associated with samples of contaminated water and sediment from aquatic systems. Both acute and chronic tests are proposed. Toxicity in surface water, elutriate, and pore water samples will be determined using bacteria (MICROTOX[®]), *Daphnia magna*, *Ceriodaphnia*, and larval *Pimephales promelas*. Sediment toxicity will be evaluated using *Chironomus tentans*, *Hyallela azteca*, and *Hexagenia limbata*. These methods will be modified and evaluated for their use in the field and their applicability to screen for low levels of contaminant mixtures.

Location of Research: Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota

Dates: 08/90—01/94

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

144

**Assessment of Environmental Toxicity of Chemicals from Structure:
A Computational Approach****Subhash C. Basak and Gerald J. Niemi**

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: The purpose of this project was to develop computational models to predict toxic properties of industrial chemicals directly from structure. The U.S. Environmental Protection Agency is mandated by the Toxic Substances Control Act (TSCA) to develop methods for the risk assessment of chemicals already existing in the TSCA Inventory as well as those being submitted to the USEPA each year for premanufacture notification. Risk assessment can be accomplished by exhaustive testing of the chemical by experimental methods. But this is very costly and time consuming. Therefore, methods are needed whereby the hazard of a chemical can be predicted using its structure alone. This research resulted in the development of computer models which may be used to predict properties of chemicals directly from structure. These properties are useful in predicting the hazard of a chemical to the environment.

Location of Research:**Dates:** 05/89—05/91**Funding Source:** U.S. Environmental Protection Agency**Funding Amount:** \$297,456**Number of Graduates Working with Project:****Number of Undergraduates Working with Project:** 1**Related Research Publications:**

Basak, S.C., G.J. Niemi, and G.D. Vieth. 1990. Optimal characterization of structure for prediction of properties. *Journal of Mathematical Chemistry* 4:185.

Basak, S.C., G.J. Niemi, and G.D. Veith. 1990. A graph-theoretic approach to predicting molecular properties. *Mathematical and Computer Modeling* 14: 511.

145

**Computational Techniques to Quantify Chemical Similarity: Tools For
Risk Assessment****Subhash C. Basak, Gerald J. Niemi, Robert Hunter, and George Host**

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(218) 720-4279

Project Description: Risk assessment of chemicals is usually accomplished under conditions where there is a scarcity of relevant experimental data. One way of assessing risk is to select analogues of a chemical, called "similar chemicals," and perform a risk assessment for the target chemical from the toxic potential of these analogue chemicals. Similar chemicals are often chosen intuitively. This project will develop computational methods for calculating chemical similarity of molecules. It will also test the methods on chosen databases of properties to test the utility of the various similarity methods in risk assessment.

Location of Research:

Pollution Control

Dates: 07/92—06/95

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$322,148

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

146

Software Development for Predicting Carcinogenicity and Mutagenicity of Organic Chemicals

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Project Description: The purpose of this project was to develop a model to predict the mutagenic potential of organic chemicals from their structure. A database of mutagens was developed as well as a rule-based system for associating mutagenicity to chemical structure, via chemical topology. Work is in progress to develop a quantitative model for predicting mutagenicity from structure.

Location of Research:

Dates: 11/89—10/91

Funding Source: Greater Minnesota Corporation (now Minnesota Technology, Inc.)

Funding Amount: \$40,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

147

Lichens and Air Quality

Clifford M. Wetmore

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220 Biological Science
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Project Description: Lichens are very sensitive to air pollution. These projects study the lichen floras to determine air quality. If many of the most sensitive species are absent or damaged it indicates air quality problems. Some lichens are studied by elemental analysis to determine the levels of air pollution in the thallus. The lichen flora is studied by collecting all species found in the area. Each project lasts one to two years.

Location of Research: Various national parks; U.S. forests; fish and wildlife refuges

Dates: 01/80—Ongoing

Funding Source: National Park Service; U.S. Department of Agriculture, Forest Service; U.S. Fish and Wildlife Service

Funding Amount: \$20,000/year

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

148

Agricultural Drainage Practices for Improved Surface Water Quality Management in Minnesota

Jerry A. Wright and John L. Nieber

West Central Experiment Station

Institute of Agriculture, Forestry, and Home Economics

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Project Description: The objectives of this project are to incorporate into DRAINMOD the necessary subroutines to allow the calculation of the transport of nitrates through subsurface drainage systems under Minnesota conditions; to evaluate the fundamental assumptions underlying the use of the SEW-D method in drainage system design; and, to apply the model DRAINMOD in the evaluation of the potential for drainage and subirrigation in Minnesota.

Location of Research:

Dates:

Funding Source:

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on POLLUTION CONTROL, see project numbers 183, 185, 243, 249, 253, 257, 258, 266.

PUBLIC POLICY

149

Regional Responses to Economic Change: Environmental and Trade Policies in the Northwest Area

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Project Description: This project will develop a research and public policy education program focusing on the impact of environmental regulations on United States agriculture in an open world economy. Its primary purpose is to help define the appropriate balance between environmental quality goals and regional competitiveness in global agricultural markets. In addition, it will provide cross-country comparisons of agriculture's impacts on the environment, with particular reference to U.S./Canada and U.S./European Community comparisons. These comparisons are made possible by ongoing research linkages between the University of Minnesota, the University of Guelph, Ontario, and the University of Padova, Italy.

In both Canada and the European Community, the politics and economics of agriculture are increasingly defined by awareness of the environmental impacts of intensive agricultural production. What is less well understood is that environmental regulations will also have profound impacts on the pattern of international agricultural trade, affecting regional competitiveness and the political economy of protectionism. In the context of both the Free Trade Agreement with Canada, and the 1992 initiative in Europe, these issues will be of significance to the entire pattern of commerce in the Northwest Area in the century to come.

Location of Research: University of Minnesota

Dates: 06/89—06/92

Funding Source: Northwest Area Foundation

Funding Amount: \$295,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

150

Economic Analysis of Limited Property Rights Transfer

Steven J. Taff

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College of Agriculture
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St. Paul, MN 55108
(612) 625-3103

Project Description: This project will establish the economic and legal basis for limited property rights transfers for farmland preservation programs in the Twin Cities metropolitan area; conservation easement and acquisition program run by nonprofit organizations; and, timber harvest lease programs on public forest lands. In addition, an evaluation of public and private gains from each program,

particularly with respect to public finance, will be completed. Recommendations will be made for administrative procedures that might more cost-effectively implement each program's public purposes. Finally, procedures will be developed to determine the sales or acquisition costs of specified limited property rights.

Location of Research: Twin Cities metropolitan area

Dates: 01/91—12/96

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$22,318 x 5 years

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

151

Coalition Building for Wiser Water Management in the Great Lakes Basin: Climatic Uncertainties and Cultural Boundaries

Luther P. Gerlach

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Minneapolis, MN 55455
(612) 624-5542

Project Description: In 1991, complete the identification of actors, interests and coalitions in Great Lakes Basin water management; test theories of fundamental social processes whereby actors recognize and frame regional/global environmental risks as an issue; identify specific activities and events of institutional innovation and transference. In 1992, determine how people develop or do not develop sociocultural institutions to coordinate management of the water resources of Lake Superior from Minnesota to Wisconsin, Michigan to Ontario, Canada and further, link the management of the Lake Superior watershed to management of other lakes in the Great Lakes Basin. Determine the capabilities and limitations of polycentric network organization vis-a-vis centralized hierarchical organization, tidy vis-a-vis untidy process. In 1993, synthesize research findings to clarify how people negotiate and/or are frustrated by the tensions between ecoglobalism and ethnoclocalism. Determine how they coordinate resource uses across jurisdictional borders and cultural boundaries while building new systems of rights and duties in such resources and, hence, generate new cultures of human-environment interaction.

Science and public policy study find it necessary to reduce vulnerability to climatic variability and achieve resilience by wisely managing water and related resources. Case study research is essential to determine the social and cultural factors which impede or aid cooperation for positive management interaction across the Great Lakes, as well as more locally and globally. Findings will help local communities and will transfer nationally and internationally.

Location of Research: Lake Superior, Minnesota shores, specifically; Great Lakes Basin generally

Dates: 01/91—12/93

Funding Source: Minnesota Sea Grant

Funding Amount: \$130,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project:

Related Research Publications:

152

The North American Wildfowl Management Plan: A Case Study in Managing Critical Environmental Resources

Luther P. Gerlach

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College of Liberal Arts
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Minneapolis, MN 55455
(612) 625-5542

Project Description: How can humans manage their use of the natural environment on an ever larger scale, ever more expertly, integratively, interdependently, and at the same time protect or enhance personal and group freedoms, local control, and independence is a critical question. This project examines how people across a broad spectrum—government, voluntary associations, grassroots organizations and others—are seeking to turn the challenge of conflict into opportunity for cooperation in managing critical environmental resources. The case study to be used is that of governmental and nongovernmental cooperation to protect migratory waterfowl and related wetland habitats in the United States into Mexico. The findings from this project will help advance wetland protection and provide knowledge which will be transferred to other efforts to manage resources across territorial borders and cultural boundaries.

For the past twenty years, Dr. Gerlach, the principal investigator, has been studying sociocultural dimensions of environmental adaptation. He is currently synthesizing and building on this knowledge of how people deal with transboundary environmental problems in order to inform scholarship, public policy and grassroots action.

Location of Research: Numerous flyways in western United States and Minnesota

Dates: 03/91—02/92

Funding Source: Weyerhaeuser Family Foundation

Funding Amount: \$25,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

153

Improving Environmental Science Education From K-6 Teachers in West-Central Minnesota

Judy A. Kuechle

Center for Environmental Education
College of Education
University of Minnesota, Morris
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Morris, MN 56267
(612) 589-6413

Project Description: The focus of this project is to improve science education, related to environmental topics, through in-service training of K-6 classroom teachers in west-central Minnesota. Last year our institution received a HECB grant to in-service elementary teachers in 15 schools. Selected teachers were identified as Master Teachers and functioned as resource persons and coordinators of environmental science education in their schools. These Master Teachers attended three workshops and a summer institute and have designed plans for the implementation of environmental science

education curricula in their schools. The Master Teachers have improved their knowledge of environmental science and are prepared to help K-6 teachers in other elementary schools to improve environmental science knowledge and to devise a curriculum plan and implementation process in their own schools.

Location of Research: University of Minnesota, Morris

Dates: 10/90—12/92

Funding Source: Higher Education Coordinating Board

Funding Amount: \$55,085

Number of Graduates Working with Project: 30

Number of Undergraduates Working with Project:

Related Research Publications:

154

Energy and the Environment: The International Policy Options

Kenneth H. Keller

Chemical Engineering and Materials Science
Institute of Technology
151 Amundson Hall
421 Washington Ave. S.E.
Minneapolis, MN 55455
(612) 625-1313

Project Description: The purpose of this study is to examine the policy implications of the linkages between environmental problems and the increased energy demands that accompany: population growth, technical development, and improved standards of living throughout the world. In particular, we are examining international policy choices and negotiating strategies related to security arrangements, trade negotiations, development aid, intellectual property protection, and international cooperative research. We are also examining the appropriate balance of public action and private initiative.

Our approach is to convene a working group comprising 25 to 30 individuals knowledgeable in both technical and international policy areas to meet in several four-hour sessions to consider the following topics: private sector functions in technology transfer to developing countries; stimuli and impediments to technology transfer; the role of environmental consideration in trade negotiations; carbon taxes and tradable carbon permits; debt-for-nature exchanges; and mechanisms for managing international environmental protocols. Discussion papers will be prepared for each of the sessions and a short monograph will be produced as a final report.

Location of Research: Council on Foreign Relations, New York, New York

Dates: 09/91—11/92

Funding Source: Ente Nazionale Idrocarburi Corporation

Funding Amount: \$40,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

155

The Intelligence Community and Environmental Monitoring

Kenneth H. Keller

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Institute of Technology
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421 Washington Ave. S.E.
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(612) 625-1313

Project Description: The purpose of this study is to examine the value and the appropriateness of assigning to U.S. intelligence agencies data-gathering tasks associated with understanding environmental phenomena and/or with monitoring compliance with international agreements. Two kinds of questions are implied by this general purpose: Do intelligence agencies have singular technical capacities to provide vital information in this regard and are the organizations actively engaged in environmental research and monitoring able to work effectively with the intelligence community; and does it fit the accepted national purposes of intelligence agencies (or is it good public policy to expand their purposes) to assign them to such tasks?

To pursue the study, a group of 30 to 40 people split between those with intelligence backgrounds and those active in environmental matters will be assembled for a two-day workshop to discuss the first set of questions. Several case studies will be prepared outlining particular information needs and an indication of how the intelligence agencies might organize and carry out the task of providing information. The workshop discussions will consider both the value of information that already exists in intelligence data files and the potential data gathering. With the results of the two-day workshop in hand, a third meeting will be held in which the workshop participants will join with a separate Council group considering American security policy in the post-Cold War era. At that meeting, broader policy questions will be considered including: the pros and cons of expanding the definition of national security to include environmental issues, and the possible conflicts between environment considered in terms of national interests and considered as a global issue.

Location of Research: Council on Foreign Relations, Washington, D.C.

Dates: 02/92—05/92

Funding Source: Council on Foreign Relations

Funding Amount: \$10,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

156

Grand Portage National Monument and St. Croix National Scenic Riverways Observation Studies

Jerrilyn L. Thompson, Dorothy H. Anderson, and David W. Lime

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St. Paul, MN 55108
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Project Description: This project was established during the summer of 1990 as a pilot study using observation as a method to describe characteristics, behavior, and use patterns of people visiting the

monument. The information provides a better understanding of how these sites are used by the visitors, determines where visitors are spending their time at the sites, and describes the interactions between staff and visitors. Data will be used in making management and programming decisions. The intent is to develop a method of observation that can be conducted by park personnel in any National Park Service facility. The observation form was modified and implemented during the 1991 season at the monument and also at the four St. Croix National Scenic Riverway visitor centers.

Location of Research: Grand Portage National Monument; St. Croix Scenic Riverway visitors' centers

Dates: 05/90—09/92

Funding Source: National Park Service, Midwest Region

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

157

Evaluating Recreation Innovations and Consequences to Management

Dorothy H. Anderson

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St. Paul, MN 55108
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Project Description: Not available at the time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 06/90—09/92

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station

Funding Amount: \$10,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

158

State Forest Programs: Analysis of Policy Options and Program Administration

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St. Paul, MN 55108
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Project Description: The project's overall objective is to define and evaluate forest resource policies and programs, including associated administrative arrangements, that will enable state governments to accomplish their interests in forest resources. Specifically, evaluate incentive and regulatory programs, assess rural government infrastructures, analyze program funding options, investigate

Public Policy

information flows to legislative systems, and undertake comparative program examinations (domestic and foreign).

Location of Research: St. Paul, Minnesota

Dates: Ongoing

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount:

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project:

Related Research Publications:

159

An Analysis of Emerging Issues in National Parks to Aid Planning of Social Science Research

David W. Lime, Leo H. McAvoy, and Dorothy H. Anderson

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St. Paul, MN 55108
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Project Description: This research focuses on the development and implementation of a process that National Park Service planners, resource managers, scientists and other interested clients can identify priority issues and problems worthy of use to research so study results can be offered to users in a timely and effective manner. While the methods developed are intended to aid development of a social science research agenda for the Midwest region, procedures will be applicable to any park service region and to any research discipline. The process to be developed is intended to open systematic dialogue among those who use research and those who conduct research in an effort to identify priority research needs. Barriers to effective transmittal and application of research results by National Park Service planners and managers will also be examined.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 09/91—Ongoing

Funding Source: National Park Service

Funding Amount: \$62,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

160

Research on Public Involvement to Aid Integrated Resources Management and Planning at Mississippi National River and Recreation Area

David W. Lime and Dorothy H. Anderson

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Project Description: This research will aid managers of the newly established Mississippi National River and Recreation Area (MNRRA) in the public involvement components of developing corridor and river management plans. Research results will be used to help identify regional attitudes toward the MNRRA, desired experience opportunities for various park unit clientele groups (e.g., hikers, boaters, bikers), and provide input to selecting corresponding indicators and standards to achieve such goals. Selected studies within the river corridor will be conducted in collaboration with park unit staff to assist the National Park Service in eliminating obstacles to developing and implementing an integrated management plan for the area.

Location of Research:

Dates: 07/91—07/96

Funding Source: Mississippi National River and Recreation Area; National Park Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

161

Feasibility of Linking DUALPLAN and IMPLAN in an Ecological Economic Model

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Project Description: The study will explore possible approaches to combining forest planning/timber supply models and input-output type economic impact models for the purpose of more realistically linking economic activity and ecological impact. DUALPLAN, an advanced timber harvest scheduling model, will be used to study the short- and long-term effects of possible harvest schedules on timber production costs, and on the temporal and spatial distribution of age classes, forest cover types, and ownership. IPASS, a multiple-period version of IMPLAN which in turn is a county-level input-output model of the U.S. economy, would be used to estimate the economic and social impacts of various timber harvest schedules. Linking DUALPLAN with IPASS/IMPLAN will allow us to explore, in a rudimentary fashion, the mutual temporal and spatial interactions between various timber demand scenarios, the direct and indirect economic impacts of these scenarios, and the ecological effects of the associated forest management activities.

Location of Research:

Dates: 08/90—09/91

Public Policy

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount: \$5,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

162

The Historical Use and Potential Role of Regional Economic Impact Estimation Models in the Public Policy Decision-Making Process

Dietmar Rose

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115 Green Hall
1530 N. Cleveland Ave.
St. Paul, MN 55108
(612) 624-3400

Project Description: Study objectives are to: 1) conduct a literature review to assess past uses of input-output models in public forest policy analysis, and 2) include the input-output model IMPLAN in an evaluation of the ability for, and potential use of, various impact models to provide information for forest policy decision-making.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 03/90—06/91

Funding Source: U.S. Department of Agriculture, Forest Service; North Central Forest Experiment Station

Funding Amount: \$5,240

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

163

The Economic Impacts of the Zebra Mussel on Great Lakes (and Mississippi River) Water Users: A Policy Assessment

Barbara J. Kanninen

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Minneapolis, MN 55455
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Project Description: Since its introduction into the Great Lakes region, much has been made of the potential negative impact of the zebra mussel. Several larger scale surveys have been conducted to date; however, none have included the impacts of the zebra mussel below the Great Lakes region. In addition, these surveys have mainly focused on the costs that have resulted due to the zebra mussel. Little has been done in the area of surveying to determine what led to these costs: what sorts of warnings did firms have about the zebra mussel, what kinds of adaptations have firms made, and why did firms choose these forms of adjustment? This project would fill this gap in damage assessment

research by surveying industrial, municipal, and power-generating users of the Great Lakes waterways, as well as the Mississippi River and zebra mussel-affected rivers in Ohio and Illinois.

The survey of the zebra mussel-impacted water users will provide information in several important areas. First, the survey will provide updated and expanded figures on the economic impact of the zebra mussel invasion. Accurate data is crucial to alerting public leaders of the problem and to provide zebra mussel researchers with reliable damage assessments. Second, the survey will help determine whether warnings of the zebra mussel invasion were strong enough and, to the extent that they existed, what level of attention was paid to them. If a warning failure occurred, it should be examined to ensure that it will not be repeated in the future.

Third, an examination of the control strategies used by firms will help establish which control strategies have worked and which have not. The survey will also establish the points at which water-users tend to switch to longer-term control strategies. This information should prove valuable to potentially affected firms. Also, if firms are finding that expensive control strategies have the best long-term results, then it may be in the interest of the government to subsidize those control strategies.

Location of Research: University of Minnesota

Dates: 09/91—Ongoing

Funding Source: Minnesota Sea Grant

Funding Amount: \$12,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

164

The Economics of Alternative Transportation Modes: Measuring the Value of Transportation Characteristics that Affect the Demand for Transportation Modes

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Project Description: The ultimate goal of this research is to better understand the transportation needs and desires of the people in the Twin Cities area and then be able to design a set of transportation alternatives (public transit, semi-private or private commuter services, bicycle or pedestrian systems) that better accommodate the public demand. The first objective is to assess the values that the public places on particular transportation amenities or characteristics, such as travel time, comfort, safety, convenience. By measuring these values, we can define the public's priorities in choosing a transportation mode, and we can attempt to design transportation alternatives that address these priorities. The second objective of the study, to be addressed in subsequent years, is to determine what price will encourage the switch, and how the price incentives can be implemented.

Location of Research: University of Minnesota

Dates: 07/92—07/93

Funding Source: Regional Transit Board

Funding Amount: \$35,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

165

Atlas Services Office

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Project Description: The Atlas Services Office responds primarily to the needs of local government for unbiased geotechnical information. Given the increasing responsibility that local government is expected to take for environmental resources, particularly the preservation or enhancement of groundwater quality and the use of groundwater supplies at a sustainable rate, the need for such assistance is acute. The office builds upon three programs at the Minnesota Geological Survey: county geologic atlas, regional groundwater assessment, and water-well database. There are six completed county geologic atlases by MGS, plus three county geologic atlases and three regional groundwater assessments in progress. The water-well database at MGS, originally started on mainframe to provide automated data for the county geologic atlas program, has evolved into the County Well Index, a county-based listing of water-well records, designed for easy use by individuals on personal computers. The Atlas Services Office provides geotechnical advisory services to counties with completed atlases, those with assessments in progress, and to counties without geologic county maps. Clients are staff of county health and environmental planning agencies, city engineers, well drillers, geotechnical consultants, and individual citizens.

Location of Research:

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$250,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

Wahl, T.E. and R.G. Tipping. 1991. *Groundwater Data Management: The County Well Index*. Minnesota Geological Survey.

166

Factors Influencing Racial Diversity in Environmental Education

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Project Description: This is a qualitative study consisting of in-depth interviews with over 50 people of color working in environmental education, including both formal education and informal community education addressing environmental issues, throughout the United States. The three primary questions asked were: 1) what path led each individual to a career in environmental education, 2) how does each individual define environmentalism, and 3) what are the primary issues this field must address? Identifying the common threads running through the lives of these individuals which pulled them toward environmentalism may facilitate drawing support for environmental issues from a more diverse cross-section of the population. Identifying the barriers these people had to surmount to enter

environmental fields may be a first step toward eliminating these barriers in the future. Finally, broadening the scope of environmentalism may be the key to increasing racial diversity within these fields. The results presented will describe the common experiences promoting interest in environmental concerns, barriers encountered in this field, and goals for environmentalism which emerged in the interviews. Results expected in 1993.

Location of Research: University of Minnesota

Dates: 10/90—01/93

Funding Source: National Wildlife Federation

Funding Amount: \$10,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

James, K. 1990. A philosophy for change. In *1990 National Interpreters Workshop, What's Past is Prologue: Our Legacy, Our Future, November 26-30, 1990, Charlston, South Carolina*, ed. D.I. Kulhavy and M.H. Legg, 63-65. National Association for Interpretation, Fort Collins, CO.

James, K. 1991. Increasing racial diversity: A philosophy for change. *Legacy* 2(2): 16-19.

James, K. 1991. Leveling the barriers: Increasing racial diversity in environmental education. In *Confronting Environmental Challenges in a Changing World. Proceedings from the Twentieth Annual Conference of The North American Association for Environmental Education, September 27-October 2, 1991, St. Paul, Minnesota*, ed. J.H. Baldwin, 63-65. North American Association for Environmental Education, Troy, OH.

For additional research on PUBLIC POLICY, see project numbers 58, 59, 60, 63, 68, 120, 127, 130, 194, 229.

SOIL RESOURCES

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Water Movement in Soils

John L. Nieber and James L. Anderson

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203 Agricultural Engineering
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Project Description: This research is designed to understand how, when and where agricultural chemicals move to groundwater. This requires knowing how water moves in soil, particularly in the unsaturated zone between the topsoil and groundwater. Research objectives include: evaluating the impact of large soil pores (macropores) on movement; characterizing the occurrence and development of macropores; modeling coupled water flow, heat transport, and chemical transport in soils; modeling water flow in heterogeneous soils; and modeling unstable flow of water in soils.

Location of Research:

Dates: 07/91—06/93

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$5,000/year

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 1

Related Research Publications:

Warner, G.S., J.L. Nieber, I.D. Moore, and R.S. Greise. 1989. Characterizing macropores in soil by computed tomography. *Soil Science Society of America Journal* 53: 653-660.

Nieber, J.L. and G.S. Warner. 1991. Soil pipe contribution to steady subsurface storm flow. *Hydrological Processes* 5: 329-344.

168

Sustaining Soil Productivity and Quality Plant Performance via Management of Living and Allelopathic Cover/Companion Crops in Nursery Field Maintenance

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Project Description: Concern about soil erosion, herbicide residue, and weed control costs have spawned considerable interest in new methods of nursery field maintenance such as minimum tillage and cover or companion crops. In the past, cover crops, usually grass, were judged to be too competitive since tree growth was often reduced. With current renewed interest in these techniques, research is needed to better understand the nature of the competition between companion crops and trees so such systems can be managed accordingly. Such research should include the search for materials best suited for use as companion crops as well as the study of the competitive nature of

cover crops. The overall goal of this research is to develop companion crop production systems which result in an acceptable rate of tree growth while being environmentally sound and cost effective.

Location of Research: Teaching, Research and Extension (TRE) Nursery, University of Minnesota

Dates: 04/80—Ongoing

Funding Source: Minnesota Agricultural Experiment Station; Nursery and Landscape Industry

Funding Amount: \$3,000/year

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 2

Related Research Publications:

169

A Site Study of Soil Characteristics and Soil Gas Radon in Rochester, Minnesota

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Newton Horace Winchell School of Earth Sciences
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Project Description: In regional surveys, indoor radon is usually the parameter of interest, but occasionally soil gas radon at depths of 1 meter or less is also measured. At statewide scales, even limited data sets can be used to infer relationships between geology and soil gas or indoor radon. However, predicting the radon potential of a single house or even an area the size of a neighborhood is more difficult. As the potential size of a surveyed area decreases, site-specific variables become more significant.

During 1990 we completed a study of two residential neighborhoods within 7 km of each other near Rochester, Minnesota. Eight holes were augered into glacial sediments to maximum depths of 4.5 m and samples collected for grain-size analysis, measurement of radon parent/daughter nuclides, and radon emanation. A total of sixty-five homes in the area were provided with two alpha-track registration detectors for indoor monitoring between September 1988 and September 1989.

Positive correlations were observed between the average soil radon, the average indoor radon, and the precursor/daughter radionuclides. The study area with the most topographic relief also had the highest radionuclide contents, the most variability with depth, and some variation with time and soil moisture; these results were not observed at the low-relief site. The type of study described would best be applied to site-specific preconstruction screening, rather than to predicting radon in existing structures.

Location of Research: Rochester, Minnesota

Dates: 11/88—11/90

Funding Source: Center for Urban and Regional Affairs, University of Minnesota; Minnesota Geological Survey

Funding Amount: \$20,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Lively, R.S., Steck, D., Brasaemle, B. 1991. *A Site Study of Soil Characteristics and Soil Gas Radon in Rochester, Minnesota*. Center for Urban and Regional Affairs, University of Minnesota, CURA 91-2. 15 pp.

Lively, R.S. and Steck, D. 1991. A Site Study of Soil Characteristics and Soil Gas Radon. In *1991 International Symposium on Radon and Radon Reduction Technology* v. 5, n. 5. 15 pp.

170

Effective Nitrogen and Water Management for Water Quality-Sensitive Areas of Minnesota

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Project Description: The objectives of this study are to: 1) prepare an inventory of soil, climate, and management practices of the Central Sands of Minnesota; 2) evaluate tillage influences on nitrogen available to corn from manure and fertilizer sources as well as nitrate leaching losses on the Central Sand region; 3) monitor soil nitrogen distribution and develop a nitrogen budget for irrigated potatoes; 4) field-test and validate models for nitrate leaching; and 5) develop a network of demonstrations to use as a core for an educational effort.

Location of Research: St. Paul and Staples, Minnesota

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$300,000

Number of Graduates Working with Project: 6

Number of Undergraduates Working with Project: 2

Related Research Publications:

171

Movement of Pesticides Under Irrigated Potato Production

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Project Description: Irrigated sandy soils can have high potential for leaching of agricultural chemicals to ground water. Objectives of this study are to assess the fate of two annual applications of the herbicides metribuzin and metolachlor to a Hubbard loamy sand soil (Udorthentic Haplobrols) under irrigated potato production. Metolachlor and metribuzin absorption through the soil profile were correlated, in order of strength, to organic carbon content, carbon exchange capacity, percent sand and percent clay. Metribuzin degraded and did not build up in soil after two annual applications. Metolachlor dissipated more slowly in year 2 than year 1, significant soil residues remained into the following year, and it remains unclear if metolachlor was building up in the soil from annual use.

Location of Research: St. Paul and Becker, Minnesota

Dates: 01/90—12/92

Funding Source: U.S. Dept. of Agriculture, North Central Region Pesticide Impact Assessment Program

Funding Amount: \$44,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

172

Pesticides and Other Organics in Soil and Their Potential for Groundwater Contamination

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Project Description: The objectives of this study are to: 1) characterize mechanisms and quantify processes by which pesticides and other toxic organics interact with soil and water systems, and 2) develop management strategies and tools to reduce soil and groundwater contamination from pesticides and other toxic organics. Laboratory and field studies will be conducted to examine the fate and behavior of pesticides such as atrazine and other toxic organics such as allelochemicals in the soil environment. Although atrazine has not been extensively studied, its basic chemistry as affected by soil properties has not been clearly elucidated. For instance, how soils affect the kinetics of atrazine hydrolysis and protonation is not well characterized. Studies will concentrate on how the transformations of atrazine will affect its transport in soil columns, especially in the presence of growing plants. Laboratory studies will be correlated with field observations. A systematic sampling and analysis of the Minnesota and Upper Mississippi River waters and sediments will be conducted to document the extent and the fluctuation of atrazine concentrations in these water systems. Models and techniques developed by these studies will be extended to examinations of allelochemicals in the soil.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 10/89—09/94

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS), Regional Research Funds

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

173

Potential Impact of Global Climate Changes on Soils as Sink or Source of Carbon Dioxide in Terrestrial Carbon Cycle

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Project Description: There has been much debate on the relationship between atmospheric CO₂ and global warming. Elucidation of this relationship is complicated by the modifying effect of carbon (C) cycle on atmospheric CO₂ concentration. Although the basic C transformation processes in terrestrial environment are generally understood, reliable data on the magnitude and rate of changes in C transformations under different soil and vegetation regimes in response to temperature changes and moisture availability are lacking. Recent advances in computer-based multi-scale geographic information systems (GIS) are providing opportunities to link imagery obtained from remote-sensing

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techniques and data from soils information base to provide realistic estimates of: 1) terrestrial C status at local, regional, and global scales by integrating data from point locales to larger landscapes, and 2) potential changes in C dynamics at the transition of major ecosystems which are sensitive to climate changes. Minnesota presents an excellent setting to study environmentally-sensitive zones at the transition of different ecosystems where impact of any change in climate would be readily detected. The Soil Science Department at the University of Minnesota possesses one of the most comprehensive soil and climate resources databases that have been digitized for computer access. These databases can be readily used for estimation of C pools and dynamics in various ecosystems. This project intends to establish the methodological guidelines for using the soil and climate database to evaluate the spatial variation and model temporal trends in soil moisture status and C sequestration capacity, and for linking the database to remotely-sensed imagery. A multi-scale GIS will be used to integrate information from point locales to local, regional, and global-scale levels. The methodology will enable us to estimate the rates of C cycling for a broad geographic region and to assess the potential impact of climate changes on the role of soils as sink or source of atmospheric CO₂.

Location of Research: St. Paul Campus, University of Minnesota

Dates: 12/91—06/93

Funding Source: National Aeronautics and Space Administration (NASA)

Funding Amount: \$67,500

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

174

Increasing Usefulness of Soil Survey Information for Environmental Analysis Through Soil Morphology Studies

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Project Description: Soil characteristics as identified in the field are the initial investigation points for determining how various uses of the soil will affect the environment. Understanding exactly how these characteristics can best be identified so they can be monitored over the landscape is the goal of the project.

Location of Research: Greater Minnesota

Dates: 09/88—09/94

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$6,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

175

Trace Metal Movement Through the Soil Profile

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Project Description: The potential for movement of sewage sludge-borne trace metals beyond the zone of soil incorporation poses a real concern for society. To address this concern, we sampled an Aeric Ochraqualf (Blount Series) after 14 years of massive, sludge additions (765 Mg ha^{-1} cumulative sludge applications, dry wt. basis). Cadmium, Zn, and Cu concentrations in each genetic horizon to a depth of 1.0 m were determined by atomic absorption spectroscopic analyses of 4.0 M HNO_3 extracts. In addition, ped surfaces (cutans) and intra-ped materials (s-matrix) from prismatic structural units of the lower B and upper C horizons were analyzed to determine the partitioning of trace metals in this highly structured profile. Cadmium concentrations in the subsoil of sludge-treated areas were consistently and significantly higher ($\sim 0.4 \text{ mg kg}^{-1}$) than levels present in the control areas. Similarly, Zn concentrations in the 0.32 to 0.51 m region (Bt1) were increased ($\sim 12 \text{ mg kg}^{-1}$) with sludge applications; no increases in Cu levels were observed. Significantly more Cd (0.08 mg kg^{-1}) was present in cutans removed from ped surfaces in the upper B horizon than was observed in the s-matrix for sludge-treated areas. Cutans also contained more sludge-borne Zn than the associated s-matrix. The evidence suggests that small amounts of sludge-borne Cd and Zn moved out of the tillage zone into the subsoil of this highly structured agricultural soil over a 14-year period of massive sludge additions.

Location of Research: St. Paul Campus, University of Minnesota; field site in Joliet, Illinois

Dates: 01/83—01/92

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

176

Mercury Distribution in Forest Floor and Surface Mineral Soils Across the Lake States

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Project Description: Mercury (Hg) is a known atmospheric pollutant of anthropic origin. It is also present in the environment as a trace constituent of soil parent materials and geologic materials. Determining the amounts of Hg deposited to soils from atmospheric sources is difficult due to the potential for geologic source contributions and the highly ephemeral nature of most Hg chemical species.

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If atmospheric deposition is an important source of Hg to ecosystems, then geographic patterns in the concentration of Hg in the forest floor (the organic layer at the soil surface) and in the surface mineral soil across the Lake States should reflect patterns of atmospheric deposition. We will test the hypothesis that the concentration of Hg should be higher in the forest floor and surface mineral soil in easternmost forests in the Lake States compared to those in the west. To test this hypothesis the contractor shall analyze and determine the concentration of Hg in forest floor and surface mineral soil samples collected and archived in the studies conducted by David et al., 1988; and Grigal and Ohmann, 1989.

Location of Research: Minnesota, Wisconsin, and Michigan

Dates: 01/89 —12/90

Funding Source: Minnesota Pollution Control Agency, Air Quality Division

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Grigal, D.L. and L.F. Ohmann. 1989. Spatial patterns on the forest floor across the north-central United States. *Journal of Environmental Quality* 18: 368-373.

David, M.B., D.F. Grigal, L.F. Ohmann, and G.Z. Gerpner. 1988. Sulfur, carbon, and nitrogen relationships in forest soil across the northern Great Lakes states as affected by atmospheric deposition and vegetation. *Canadian Journal of Forest Research* 18: 1386-1391.

177

Nitrate Production Across an Acidic Deposition Gradient

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Project Description: There is increasing interest in the role of nitrogen in both forest decline and in negative aquatic effects as related to acidic deposition. The latter interest is especially directed at episodic events, and is tied to aluminum solubility. Systems that are capable of producing nitrate by the linked processes of nitrogen mineralization and nitrification are also systems that have potential to have that nitrate leach from those systems. In addition, the process of nitrification itself produces acidity that mobilizes A1. The nitrate so produced then acts as a mobile anion to move that A1 to aquatic systems.

Our null hypothesis is that nitrate production from forest floor and surface mineral soil is independent of forest cover type, geographic location, and atmospheric deposition. We will test the null hypothesis by using samples of forest floor surface mineral soil collected in 171 forest stands and archived as part of a study of acid deposition gradient across the Lake States.

Our specific objectives are to: 1) determine the nitrification potential of forest floor and surface mineral soil for all stands sampled along the deposition gradient; 2) apply estimation techniques to NADP and other data to develop estimates of wet deposition of nitrogen species (both NO_3^- and NH_4^+) for all stands along the gradient; and 3) relate N_0 to stand production, cover type, N content of soil, N deposition, and location.

Location of Research: Minnesota, Wisconsin, and Michigan

Dates: 01/89—12/91

Funding Source: U.S. Department of Agriculture, Forest Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Grigal, D.L. and L.F. Ohmann. 1989. Spatial patterns on the forest floor across the north-central United States. *Journal of Environmental Quality* 18: 368-373.

David, M.B., D.F. Grigal, L.F. Ohmann, and G.Z. Gerpner. 1988. Sulfur, carbon, and nitrogen relationships in forest soil across the northern Great Lakes states as affected by atmospheric deposition and vegetation. *Canadian Journal of Forest Research* 18: 1386-1391.

178

Impact of Nitrogen and Tillage Management Practices on Potential Nitrate Contamination of Groundwater and Corn Production

Gary L. Malzer, David E. Clay, and Nathan Manjula

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Project Description: Coarse textured soils in central Minnesota are frequently irrigated and fertilized with N to maintain maximum corn (*Zea mays* L.) yields. If excessive N fertilizer or over-irrigation occurs, then NO₃ leaching may be a potential health problem. The objective of this research was to determine the impact of different tillage systems, N rates, and nitrification inhibitor (DCD) on corn yield, N utilization and efficiency. Over the past two years of the study, corn yield and NO₃ concentration in the percolated water increased with N rate. Tillage treatment did not influence corn yield or NO₃ leaching. Nitrification inhibitor reduced NO₃ leaching into the ground water and did not have an impact on corn yields.

Location of Research: West-central Minnesota (Westport)

Dates: 04/82—12/90

Funding Source: Center for Agricultural Impacts on Water Quality, College of Agriculture, University of Minnesota

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 2

Related Research Publications:

179

Nitrogen Specific Management by Soil Condition

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Project Description: Recent advances in technology have brought about considerable interest in developing the methodology for making variable N rate applications within a field. The objectives of this study were to evaluate yield variability within production fields, determine yield responses to

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applied fertilizer N and differential N loss as influenced by soil conditions. Results are being evaluated to determine what measurable soil conditions are best suited for making site specific N recommendations. Experimental locations of 36 and 44 acres were established at Lamberton and Becker, respectively. Different N management treatments were applied in replicated strips across the fields. Yields obtained from segmented harvest areas from control strips (zero N) indicate extreme yield variability. Preliminary results would suggest that variable N rate application can reduce N inputs, maintain or improve yield, and increase net return for the producer.

Location of Research: Central and southwestern Minnesota

Dates: 01/91—Ongoing

Funding Source: Minnesota Agricultural Experiment Station; U.S. Department of Agriculture, Cooperative States Research Service (CSRS); Dow Chemical

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

180

Tillage Induced Microrelief Impact on NO₃ and Atrazine Movement in Soils

Gary L. Malzer and David E. Clay

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College of Agriculture
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Project Description: The objectives of this project are: 1) to determine the impact of tillage induced microrelief on agrichemical movement; 2) to determine the effect of tillage, agrichemical placement, and timing on a) overland and subsurface water, nitrate, and atrazine movement over the entire season, b) agrichemical dissipation, c) fertilizer and herbicide efficiency, and d) corn production; and 3) to develop a database that can be used to validate existing water and solute flow models.

Location of Research: South Dakota and central Minnesota

Dates: 05/91—04/94

Funding Source: Presidential Water Quality Initiative, Cooperative States Research Service (CSRS), U.S. Department of Agriculture

Funding Amount: \$102,710

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

181

Development of the EPPL7 Soil Database for Regional and Environmental Planning

Pierre C. Robert, Chris Cialek, and Dennis Heil

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College of Agriculture
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1991 Upper Buford Circle
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(612) 625-3125

Project Description: The main objective of the project is to develop a detailed soil database for the EPPL7 GIS. Data will come from the State Soil Survey Data Base (3SD) maintained and updated by U.S. Department of Agriculture—SCS. The database will include soil physical and chemical properties, and soil interpretations that can be used for various types of applications.

Location of Research: Minnesota

Dates: 10/90—09/91

Funding Source: Center for Urban and Regional Affairs, University of Minnesota

Funding Amount: \$7,500

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

182

Farm Soil/Crop Information System

Pierre C. Robert

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Project Description: The project objective is to develop a farm geographic system and management tools. The geographic (map-based) crop and soil information system will be developed to help answer the needs of various farm management systems. The user-friendly system will provide easy storage and access to annual field data including: soil records such as fertility data, tillage practices, soil test locations, drainage problems, and soil physical and chemical characteristics; crop records such as seed, planting, fertilizer, chemical, and yield data; climate records such as air temperature, rainfall, and area soil temperature and moisture recharge; cost of production records, and field map records such as new crop boundaries, fertility maps, chemical leaching and runoff susceptibility maps, grass and weed maps, plant disease maps, insect maps, soil moisture maps, tile drainage maps, and yield maps. The software will run on standard microcomputers and will be very easy to use. The data entry procedure will be efficiently designed to minimize the typing and the time required to input or update records. The system will be capable of searching selected records for selected fields and periods of time and print reports in tabular and map formats.

Location of Research: Minnesota

Dates: 09/91—08/93

Funding Source: Agricultural Utilization Research Institute (AURI)

Funding Amount: \$100,000

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Number of Graduates Working with Project: 2
Number of Undergraduates Working with Project: 1
Related Research Publications:

183

Low Input Agriculture

Pierre C. Robert and Wallace W. Nelson

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College of Agriculture
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Project Description: Concerns for the possible movement of agricultural chemicals into surface and ground water and agricultural sustainability has resulted in increased interest in low input agricultural systems. The project will study: 1) the benefit of soil specific management of anhydrous ammonia and nitrification inhibitors on maximizing economic return and minimizing environmental pollution; 2) measure flux of water within the root zone under different input level managements to develop a simulation model predicting deep leaching of solutes; and 3) quantify tile drainage effects under various soil and crop management on soil water regime, water quality, and farm profitability.

Location of Research: Southwest Experiment Station, Lamberton, Minnesota

Dates: 06/91—05/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Funding Amount: \$164,952

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 3

Related Research Publications:

184

Soil Specific Crop Management

Pierre C. Robert and Wallace W. Nelson

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College of Agriculture
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Project Description: Not available at the time of publication. Contact the principal investigator for further information.

Location of Research: Southwestern Minnesota

Dates: 08/90—07/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Funding Amount: \$140,304

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 2

Related Research Publications:

185

A State and Transition Approach to Nitrogen Cycling in Agroecosystem

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Project Description: The project objective is to gain an ecosystem-wide understanding of nitrogen cycling processes at the agricultural landscape level and to model and determine benefits of soil specific rate application of nitrogen, when compared with conventional application, on non-point source pollution.

Innovative simulation modeling techniques will be used to integrate this information into a coherent picture of agrosystem function. The system will be evaluated in light of the 'state and transition' paradigm of ecosystem dynamics. A model of the system will be constructed using a selection of modeling techniques including the artificial intelligence concept of the frame (a data structure used to specify stereotyped situations) to represent the possible states of the system, with qualitative rules governing transitions between states, as well as the simulation of ecosystem components as classes of discrete objects each with its own data and procedures.

Location of Research: Minnesota

Dates: 09/91—08/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Funding Amount: \$130,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

186

A Regional Assessment of Soil Nitrogen Tests in Iowa, Minnesota, and Wisconsin

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Project Description: Fertilizer N recommendations in each of the three states are made using a different soil test/concept. The overall objective of this project is to assess current soil N test concepts in an effort to develop a predictive tool that integrates all potential plant-available N sources to determine the most environmentally and economically sound rate of N application in a site-specific manner over the three-state area. Specific objectives include: 1) determine the applicability of diagnostic soil N tests and develop complementary means for predicting crop N needs which will protect water quality; 2) determine the optimum time(s) and depth(s) of sampling to enable accurate prediction of N needs for corn under various soil/crop/climate conditions; 3) verify the ability of the NLEAP (Nitrogen Leaching and Economic Analysis Package) model or other simple models to predict the effect of using soil N tests to modify fertilizer N rates on potential leaching to the groundwater. These objectives will be met by data collection from 10 to 15 field sites in each state per year.

Location of Research: Southern Experiment Station, Waseca, Minnesota and field sites in 12 counties

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Dates: 05/91—10/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Funding Amount: \$191,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3

Related Research Publications:

187

Decreasing the Threat of Nitrate Pollution

Samuel D. Evans, Michael P. Russelle, and Donald K. Barnes

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Project Description: Weather has an overriding effect on nitrogen (N) cycling. Excessive, insufficient, or untimely rainfall can rapidly negate even the best N management practices by reducing crop yield or enhancing deep nitrate leaching. This project addresses the need for a way to remove leached nitrate before it enters water supplies through the use of deeply-rooted forages.

The objective is to determine the subsoil nitrate removal efficiency of alfalfa, switchgrass, and reed canarygrass in removing large amounts of deeply leached nitrate resulting from long-term manure applications.

Location of Research: West Central Experiment Station, Morris, Minnesota

Dates: 10/89—06/93

Funding Source: West Central Experiment Station; U.S. Department of Agriculture, Agricultural Research Service

Funding Amount: \$20,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

188

Residual Effect of Heavy Applications of Animal Manures on Corn Growth

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Project Description: Large amounts of animal manure were applied in 1970 and 1971. The total manure applications were as follows: solid beef manure—200 tons/acre (wet weight); liquid beef manure—136,000 gallons/acre; liquid hog manure—136,000 gallons/acre. The manure-treated plots were compared to plots receiving recommended amounts of inorganic fertilizer. Over the past 20 years observations have been made on plant nutrient content, corn grain and stover yields, and the leaching of selected nutrients to depths of 20 feet. The manure treatments had a long-term residual which varied with manure source. High rainfall events early in the study resulted in significant nitrate-N

Soil Resources

leaching below the root zone of the corn. Corn grain yields from manure-treated plots were equivalent to those from inorganic fertilizer-treated plots for at least 10 years following the application. There were significant manure effects on corn stover and corn grain elemental composition, but in most cases the materials were still in the range required for animal consumption. By the 1991 crop year any significant effect of residual manurial nitrogen had disappeared.

Location of Research: West Central Experiment Station, Morris, Minnesota

Dates: 10/70—06/93

Funding Source: Minnesota Agricultural Experiment Station; West Central Experiment Station

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

For additional research on SOIL RESOURCES, see project numbers 51, 73, 81, 101, 102, 104, 206, 208, 209, 214, 215, 221, 224.

SUSTAINABLE AGRICULTURE

189

Validation of Weed Management Expert Systems for Corn and Soybeans in Minnesota

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Project Description: This project will improve the predictive power of the corn/soybean models with field studies on weed/crop interactions and weed population dynamics, with emphasis on corn. Educational materials will be developed for use with interdisciplinary teams in other corn belt states, extension agents, and agricultural consultants.

Location of Research:

Dates: 05/91—09/93

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 0

Related Research Publications:

190

Extent of Weed Suppression from Summer and Winter Annual Small Grains

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College of Agriculture
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Project Description: Increase the profitability of small grain production by reducing weed management costs and improving weed control. Assess the impact of winter and summer annual small grains on the suppression of summer annual weeds. Investigate cultural practices that will affect the survival of winter annual crops. Improve our ability to manage summer annual weeds culturally by changing small grain production systems.

Location of Research: Agricultural Experiment Stations at Waseca, Lamberton, and Morris, Minnesota

Dates: 09/90—09/93

Funding Source: Graduate School, University of Minnesota

Funding Amount: \$5,472

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

120

191

Weed Management Strategies for Corn and Soybean Production Systems

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Project Description: Research on the effectiveness of mechanical weed control practices in corn and soybeans is currently under investigation. The research data base that is currently being developed will be used to assess the economic and time management constraints of mechanical weed control. The influence of reduced postemergence soybean herbicide rates on weed control and economic returns is currently under investigation. Results indicate that the following herbicides: bentazon, acifluorfen, and sethoxydim can be used at one-half of label use rates and consistently control weeds if the following procedures are followed: 1) early application, 14 to 21 days after soybean planting; 2) application to weeds approximately 5 cm tall, or less; 3) fields must be cultivated one to two weeks after herbicide application to control weed flushes.

Location of Research: Agricultural Experiment Stations at Rosemount, Waseca, Lamberton, and Morris, Minnesota

Dates: 01/89—Ongoing

Funding Source:

Funding Amount: \$30,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Gunsolus, Jeffrey L. 1990. Mechanical and cultural weed control in corn and soybeans. *American Journal of Alternative Agriculture* 5(3): 114-119.

192

Sustainable Agriculture in Minnesota: A Multidisciplinary Research

Dario Menanteau, Virginia Juffer, and Bruce D. Maxwell

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Project Description: This research analyzes the social, economic, and ecological dimensions of sustainable agriculture and aims to determine the main factors related to sustainable farming practices in Minnesota. The project is being developed in two phases utilizing survey techniques and personal interviews to farmers.

The first phase aims to develop and improve indicators measuring agricultural sustainability and its current levels of acceptance by Minnesota farmers. Two main dimensions of sustainability have been explored: 1) the attitudinal structure of producers towards environmental issues and sustainable practices, and 2) the agronomic dimension which includes land resources, crop systems, and farm management techniques.

Sustainable Agriculture

The second phase deals with the impact of sustainability upon farming operations, labor utilization, agronomic and management practices, as well as the social and economic impacts of sustainable agriculture on rural communities.

Location of Research: University of Minnesota; state of Minnesota

Dates: 12/90—Ongoing

Funding Source: Northwest Area Foundation

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

Menanteau, D., V. Juffer, and B. Maxwell. December 1990. *Sustainable Agriculture Among Minnesota Farmers, A Discussion Paper*. Center for Rural Social Development, University of Minnesota.

Juffer, V., D. Menanteau, and B. Maxwell. April 1991. Sustainable agriculture: Trends among Minnesota farmers. Paper presented at the 1991 Midwest Sociological Society Meeting, Des Moines, Iowa.

Menanteau, D., J. Virginia, B. Maxwell, and R. Kroese. 1991. *Sustainable Agriculture in Minnesota, Report: Phase I*. Center for Rural Social Development, University of Minnesota.

193

Biological Control in Sweet Corn

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College of Agriculture
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1980 Folwell Ave.
St. Paul, MN 55108
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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 06/86—Ongoing

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

194

Exotic Species Invasions

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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research:

Dates: 05/89—Ongoing

Funding Source:

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

195

Natural Enemies of Corn Pests

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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research: Twin Cities metropolitan area

Dates: 09/89—Ongoing

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

Sustainable Agriculture

196

Sustainable Corn Production Systems

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Project Description: Not available at time of publication. Contact the principal investigator for further information.

Location of Research: Goodhue County, Minnesota

Dates: 05/88—06/90

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

197

Pesticide Impact Assessment Program

David M. Noetzel and Subramanyam Bhadriraju

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Project Description: The pollution of the environment with pesticides, and food safety and water quality concerns need to be objectively addressed based on the scientific evidence available about the use, fate, and behavior of pesticides in the environment. In addition, information on the benefits and risks of pesticides is necessary to clearly define the role of pesticides in Minnesota agriculture. The Minnesota Pesticide Impact Assessment Program (MPIAP) efforts are basically directed at providing scientifically-based information on the effects of pesticides in the environment and ways to minimize the impact of these pesticides on humans and the environment. Most of these efforts are accomplished via publications, pesticide applicator training programs, seminars and telephone.

Location of Research: Minnesota

Dates: 01/74—Ongoing

Funding Source: U.S. Department of Agriculture

Funding Amount: \$31,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Subramanyam, Bh. and P.K. Harein. 1990. Accuracies and sample sizes associated with estimating densities of adult beetles (Coleoptera) caught in probe traps in stored barley. *Journal of Economic Entomology* 83: 1102-1110.

Subramanyam, Bh, D.W. Hagstrum, and P.K. Harein. 1991. Upper and lower temperature thresholds for development of six stored-product beetles. In *Proceedings of the 5th International Working Conference on Stored Product Protection, 9-14 September 1990, Bordeaux, France, 2029-2037*.

Subramanyam, Bh. and D.W. Hagstrum. 1991. Quantitative analysis of temperature, relative humidity, and diet influencing development of the larger grain borer, *Prostephanus truncatus* (Horn) (Coleoptera: Bostrichidae). *Tropical Pest Management* 37: 195-202.

198

Action Thresholds for an Aphid Vector of Potato Leafroll Virus in Virus Resistant and Susceptible Potato Cultivars

Edward B. Radcliffe, David W. Ragsdale, and K. Flanders

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(612) 624-9773

Project Description: This project seeks to determine the dynamic economic thresholds that take into account the inherent resistance of potato cultivars to plant potato virus Y.

Location of Research:

Dates:

Funding Source: U.S. Department of Agriculture, Agricultural Research Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

199

Colorado Potato Beetle Resistance Management

Edward B. Radcliffe, David M. Noetzel, and A.M. Fallon

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College of Agriculture
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St. Paul, MN 55108
(612) 624-9773

Project Description: This project investigates the use of natural product insecticides, e.g., neem (a botanical) and *Bacillus thuringiensis* toxin (bacterial product). The insecticides can be used to manage insecticide resistance in the Colorado potato beetle.

Location of Research:

Dates: 01/90—01/92

Funding Source: Agricultural Utilization Research Institute (AURI); Greater Minnesota Corporation (now Minnesota Technology, Inc.); Red River Valley Potato Growers Association (RRVPGA)

Funding Amount: \$60,000

Sustainable Agriculture

Number of Graduates Working with Project: 1
Number of Undergraduates Working with Project:
Related Research Publications:

200

Incorporation of Resistance to Green Peach Aphid

Edward B. Radcliffe, F.I. Lauer, and David W. Ragsdale

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219 Hodson Hall
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St. Paul, MN 55108
(612) 624-9773

Project Description: This project uses exotic potato species in a breeding program to produce potato breeding lines resistant to green peach aphids, the vector of the potato leafroll virus, and also resistant to the virus.

Location of Research:

Dates: 01/89—Ongoing

Funding Source: U.S. Department of Agriculture, Agricultural Research Service

Funding Amount: \$35,000/year

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3-4

Related Research Publications:

201

Spatial Dynamics of Leafhopper Pests and Their Management on Alfalfa

Edward B. Radcliffe

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St. Paul, MN 55108
(612) 624-9773

Project Description: This project investigates how the feeding behavior of the potato leafhopper is influenced by stress.

Location of Research:

Dates:

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

202

Management of Potato Virus Y: Epidemiology and Cultural Control

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Entomology
College of Agriculture
219 Hodson Hall
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(612) 624-6771

Project Description: This project seeks to determine when potato virus Y (PVY) occurs, what aphid species are involved, assess the efficacy of cultural tactics for the management of PVY, and determine if mechanical spread by farm machinery is a factor in the spread.

Location of Research: Research farm owned by the Red River Valley Potato Growers, Grand Forks, ND; farms of 12 cooperating potato seed producers in Minnesota and North Dakota

Dates: 01/91—01/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS); North Central IPM Program; Red River Valley Potato Growers Association; North Dakota Potato Seed Growers Association; Minnesota Potato Seed Growers Association; Minnesota Department of Agriculture

Funding Amount: \$230,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3

Related Research Publications:

203

Environmental Influences on Plant Growth, Performance and Seed Quality

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Project Description: This a component project of USDA/CSRS NE-124 Regional Project: "Genetics and Physiology of Sweet Corn Pest Resistance and Yield." Crosses and plant selections therefrom have been made to combine leaf rust (*Puccinia sorghi*), maize dwarf mosaic virus, European corn borer (*Ostrinia nubilalis*) and Poast herbicide resistance in the quest for improved biocontrol of pests. Genotypes have been developed which may reduce the need for chemical control by 75%. A predictive model for decision making in the chemical control of leaf rust also is being developed for safer more efficient use of fungicides. Also, the Minnesota physical and biological environment frequently is hostile to the successful stand establishment of the new high sugar endosperm mutants of sweet corn. Environmental impact, seed quality factors and seedling vigor are being investigated with the goal of improving stand establishment with minimal use of pesticides.

Location of Research: St. Paul Campus, University of Minnesota; Southern Experiment Station, Waseca, Minnesota; University of Minnesota Landscape Arboretum; Sand Plain Experimental Farm, Becker, Minnesota; Rosemount Experiment Station, Rosemount, Minnesota

Dates: 01/90—01/95

Sustainable Agriculture

Funding Source: U.S. Department of Agriculture, Regional Funds; Midwest Food Processors Association

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

Davis, D.W., C.A. Engelkes, and J.V. Groth. 1990. Erosion of resistance to common leaf rust in exotic-derived maize during selection for other traits. *Phytopathology* 80(4): 339-342.

Fritz, V.A., J.B. Hebel, and A.M. Borowski. 1991. Sweet corn genotypes vs. ethephon in relation to yield components. *Agronomy Journal* 83(6): 991-995.

Rubino, D.B. and D.W. Davis. 1990. Response of a sweet corn x tropical maize composite to mass selection for temperate zone adaptation. *Journal ASHS* 115(5): 848-853.

204

Biological Control of Potato Scab

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314 Stakman Hall
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Project Description: Potato scab is a disease of tubers caused by *Streptomyces scabies*, a gram positive, filamentous, soil inhabiting bacterium. Isolates of *Streptomyces* obtained from a field where the scab disease of potato has declined, are being used in biological control experiments. Ecological studies on both the pathogen and suppressive isolates are being made in an attempt to enhance biological control. The antibiotic produced by the suppressive isolate is being purified and its chemical structure will be determined.

Location of Research: Sand Plains Experiment Station, Becker, Minnesota

Dates: 01/88—Ongoing

Funding Source: U.S. Department of Agriculture; Legislative Commission on Minnesota Resources; Agricultural Utilization Research Institute (AURI)

Funding Amount: \$190,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 3

Related Research Publications:

Liu, D. and N.A. Anderson. 1991. Biological control of *streptomyces scabies*. *International Symposium on Biology of Actinomycetes*. Madison, WI.

Lorang, J.M., N.A. Anderson, F.I. Lauer, and D.K. Wildung. 1989. Disease decline in a Minnesota potato scab plot. *American Potato Journal* 66: 531.

205

Sand Plain Research Farm

Glen O. Titrud

Sand Plain Research Farm
Agricultural Engineering
Institute of Technology
P.O. Box 344
Becker, MN 55308
(612) 261-4063

Project Description: The Sand Plain Research Farm is a service project that provides labor, land and technical support for a large number of cooperating projects. Primary objectives of the research conducted on the farm since 1982 have included: determining possible changes in groundwater quality resulting from use of agrichemicals; increasing water use efficiency and minimize leaching; evaluating efficacy of pesticides for disease control; breeding and propagation of crops uncommonly grown in Minnesota; determining herbicide usage on horticultural crops; and determining appropriate irrigation amounts and timing. Current projects include an evaluation of the impact of using yard wastes (leaves, grass clippings) on agricultural soils, and the impacts and the effects of various tillage methods on nutrient and water movement in soils.

Location of Research:

Dates: 01/82—Ongoing

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount:

Number of Graduates Working with Project: 12

Number of Undergraduates Working with Project:

Related Research Publications:

206

Midwest Initiative on Water Quality: Northern Cornbelt Sand Plains

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Project Description: The primary objective of this project is to put in place an agricultural management system and evaluate its impact on groundwater in a variety of sand plain settings in the four cooperating states of Minnesota, North Dakota, South Dakota and Wisconsin. Research components of the project include: 1) investigating the impacts of ridge-tillage practices in a corn and soybean cropping system on groundwater quality and on the rate of transport of atrazine, alachlor, and metribuzin in the unsaturated and saturated zones; 2) determining the effects of nitrogen management by soil test and plant analysis on groundwater quality; 3) characterizing water flow through various sand plains at project sites and relating these characteristics to the transport and storage of agrichemicals; and 4) determining the relation between groundwater recharge rate and rates of agrichemical loading to groundwater.

Location of Research:

Dates: 07/90—06/94

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Sustainable Agriculture

Funding Amount: \$1,600,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

Anderson, J.L., R.H. Dowdy, and G.N. Delin. Ground water impacts from irrigated ridge-tillage. In *Proceedings of the American Society of Civil Engineers, 1991 Conference on Irrigation and Drainage Engineering, July 23-26, 1991, Honolulu, Hawaii*, ed. W.F. Ritter, 604-610.

207

The Role of Earthworms in Agricultural Chemical Leaching and Sustainable Production Practices

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Project Description: The consequences of preferential flow through earthworm burrows have been well documented, yet the physical processes occurring inside burrows are not well understood. This study was designed to investigate the partitioning of water between bypass flow through burrows and lateral infiltration across burrow walls into the saturated soil matrix. An experiment was carried out using large undisturbed soil cores. These cores were collected from a long-term study comparing tilled and no-till treatments. Two intensities of simulated rainfall were used, the lowest of which did not exceed the saturated hydraulic conductivity. Bromide and dye solutions were applied to the soil surface prior to application of water. Localized leachate volumes were measured with a 36-cell (5 by 5 cm each) grid collection lysimeter at a depth of 25 cm. Bromide concentrations in the leachate were determined as a function of time. Dye remaining in the soil around functional burrows facilitated sampling of water content away from burrow walls. A close-form model based on the boundary layer integral method was also used to calculate lateral infiltration. These enabled us to quantify bypass flow and lateral infiltration independently, and to characterize their interactions with burrow distribution, rainfall intensity, and soil initial conditions.

Location of Research: St. Paul Campus, University of Minnesota; Rosemount Experiment Station, Rosemount, Minnesota

Dates:

Funding Source: U.S. Department of Agriculture, Agricultural Research Service

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 3

Related Research Publications:

Linden, D.R. and M.D. Trojan. 1991. Modeling preferential flow in earthworm burrows. *Preferential Flow: Proceedings of a National Symposium*, 268-277. American Society of Agricultural Engineers.

208

Crop, Soil and Animal Management Systems for Upper Midwest Unglaci-ated Soils

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Project Description: The objectives of this project are to develop, evaluate, and provide on-site examples of soils and crop management practices which conserve and maintain soil and water quality on the loessial soils of the Upper Midwest. The findings from this on-site research will be used to develop profitable and energy-conserving crop and animal production systems which maintain or improve productive capacity of the soils in the area. There are five states cooperating on this project: Iowa, Indiana, Illinois, Minnesota, and Wisconsin.

Location of Research:

Dates: 10/91—10/96

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Funding Amount:

Number of Graduates Working with Project: 5

Number of Undergraduates Working with Project:

Related Research Publications:

209

Assessment and Modeling of Nitrate Leaching under Conventional and Organically Managed Corn

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Project Description: This project is multi-disciplinary and multi-institutional. The Rodale Research Center, Michigan State University (MSU), and the University of Minnesota (U of M) will cooperate to integrate their expertise and facilities. The planned experiment will be performed on the fields of the Rodale Center where yield and soil nitrate data have been collected for the past eight years on the same site for a variety of low and high output cropping sequences. Nitrate leaching as well as levels of the various nitrogenous pools in the soil-plant system will be measured through the use of the isotopic ¹⁵N methodology. This experimental phase of the work will be assumed by MSU. MSU and the U of M will pool their expertise in the area of computer simulation of the soil-plant system to develop and verify a model which will be validated against the ¹⁵N data collected at Rodale. In particular, the U of M will contribute by bringing in the simulation endeavor the concepts which are underlying their models of nitrogen and carbon dynamics in soil (NCSOIL and NCSWAP).

Location of Research: Rodale, Pennsylvania

Dates: 07/90—06/93

Funding Source: U.S. Department of Agriculture, Cooperative States Research Service (CSRS)

Sustainable Agriculture

Funding Amount: \$25,250

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

210

Cultivation and Herbicides for Weed Control in Corn and Soybeans

William E. Lueschen and Jeffrey L. Gunsolus

Southern Experiment Station

Institute of Agriculture, Forestry, and Home Economics

Waseca, MN 56093

(507) 835-3620

Project Description: The objective of this study was to evaluate the effects of bawding postemergence herbicides in corn and soybean on weed control as compared to broadcasting herbicides and cultivating later. Our goal is to evaluate the weed control methods that have the potential to reduce the amount of herbicide used.

Location of Research: Southern Experiment Station, Waseca, Minnesota

Dates: 05/91—10/91

Funding Source: Southern Experiment Station, Waseca, Minnesota

Funding Amount: \$3,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Lueschen, W.E. and T.R. Hoverstad. 1991. Broadcast vs. banding of postemergence soybean herbicides. *North Central Weed Science Society Research Report* 48: 311.

211

Reduced Herbicide Rates, Rotary Hoeing and Cultivation for Weed Control in Soybeans

William E. Lueschen and Jeffrey L. Gunsolus

Southern Experiment Station

Institute of Agriculture, Forestry, and Home Economics

Waseca, MN 56093

(507) 835-3620

Project Description: The objective of this project is to evaluate the use of reduced rates of herbicides in combination with rotary hoeing and cultivation for weed control in soybeans. Our goal is the reduced use of herbicides by using rotary hoeing and cultivation to supplement herbicides. We have evaluated time of herbicide application which is a major factor in the success of using reduced rates.

Location of Research: Southern Experiment Station, Waseca, Minnesota; Southwest Experiment Station, Lamberton, Minnesota

Dates: 03/89—10/91

Funding Source: Southern Experiment Station, Waseca, Minnesota; general grant support

Funding Amount: \$20,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

Schmitt, R.M., J.L. Gunsolus, and W.E. Lueschen. 1989. Reduced herbicide rates in soybeans. Abstract. *North Central Weed Science Society Proceedings* 44: 85.

Schmitt, R. M., W.E. Lueschen, and J.L. Gunsolus. 1990. Influence of time and rate of application of aciflufen, benatzen, and sethoxydim with and without cultivation on weed control in soybeans at Lamberton, MN. *North Central Weed Science Society Research Report* 47: 173-175.

Schmitt, R.M., W.E. Lueschen, and J.L. Gunsolus. 1990. Effects of reduced herbicide rates, rotary hoeing, cultivation and row spacing on weed control in soybeans at Waseca, MN. *North Central Weed Science Society Research Report* 47: 157-159.

Schmitt, R.M., W.E. Lueschen, and J.L. Gunsolus. 1990. Influences of time and rate of aciflufen, benatzen, and sethoxydim with and without cultivation on weed control in soybeans at Waseca, MN. *North Central Weed Science Society Research Report* 74: 173-175.

Schmitt, R.M., W.E. Lueschen, and J.L. Gunsolus. 1990. Rotary hoeing used in conjunction with herbicides. Abstract. *North Central Weed Science Society Proceedings* 45: 111.

Lueschen, W.E., J.L. Gunsolus, and T.R. Hoverstad. 1991. Effects of rotary hoeing and reduced rates on weed control in soybeans. *North Central Weed Science Society Research Report* 48: 262-263.

212

Strip Cropping Systems to Reduce Energy Inputs and Optimize Profitability

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Project Description: Four single crop production components (ridge tillage; 3-crop wheat-corn-soybean rotation; narrow, alternate strips; and legume interseeding) will be integrated into a complete cropping system that should reduce soil erosion, fertilizer N, pesticide, and energy inputs; allow greater crop selection flexibility; reduce potential nematode, weed, and insect incidence; and increase crop yield, land use efficiency and profitability. Ridge tillage should reduce energy (fuel and labor) inputs and soil erosion. The wheat-corn-soybean rotation with interseeded legumes will reduce fertilizer N and pesticide input by interrupting weed, nematode and insect cycles normally associated with monoculture or traditional corn-soybean sequences. The narrow alternate strips of wheat, along with ridge tillage, should enhance wildlife (pheasant) habitat--adding to the aesthetic and recreational dimension of this cropping system. The narrow strips should produce higher yields due to the border effect. Energy use for artificial drying of corn should be reduced because of faster field dry down when in narrow strips. In summary, the goal of this project is to develop a cropping system that requires fewer off-farm purchased inputs, shows greater profitability, and demonstrates improved environmental impact.

Location of Research: Southern Experiment Station, Waseca, Minnesota and field sites in 12 counties

Dates: 10/91—10/93

Funding Source: U.S. Department of Agriculture; Low Input Sustainable Agriculture (LISA)

Funding Amount: \$53,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

213

Koch Farm of Sustainable Agriculture

Wallace W. Nelson

Southwest Experiment Station
Institute of Agriculture, Forestry, and Home Economics
Lamberton, MN 56152
(507) 752-7372

Project Description: Ongoing work funded by the Legislative Commission on Minnesota Resources initiated on the Koch Farm emphasizes the development of farm management alternatives that will take greater advantage of natural processes and beneficial on-farm biological interactions, reduce off-farm inputs, and improve the efficiency of their operations. This will result in decreased production costs and environmental consequences, and maintain profitability.

Farmers around the world are requesting information on how to decrease their use of non-renewable and/or hazardous chemicals. Information already exists, and more research is underway, on reducing nitrogen (N) inputs. There is very little information on reducing phosphorus (P) or potassium (K) applications nor how to manage natural sources of N, P and K in the soil. Experiment stations across the country, as well as virtually all farms in the U.S., have received heavy applications of P and K in the past. If fertilizer application to these soils ceased today, it would be 25 years before native (i.e., Koch Farm) levels of nutrients would return. Koch Farm research can thus begin immediately to investigate how to restrict inputs.

Location of Research: Southwest Experiment Station, Lamberton, Minnesota

Dates: 05/89—Ongoing

Funding Source: Minnesota Agricultural Experiment Station, Legislative Commission on Minnesota Resources

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 4

Related Research Publications:

214

Effects of a Winter Rye Crop System and Available Soil Water on Weed Control and Yield in Corn and Soybeans

Dennis D. Warnes and J. Harlan Ford

West Central Experiment Station
Institute of Agriculture, Forestry, and Home Economics
Morris, MN 56267
(612) 589-1711

Project Description: Concerns about soil erosion, water quality, and the use of synthetic agricultural chemicals have increased interest in the development of more sustainable cultural systems for corn and soybean production. Use of winter rye (*Secale cereale* L.) as a cover crop could help reduce erosion, improve the physical condition of soil, increase water penetration, and help control weeds through competition and allelopathic effects. A limitation of a winter rye cover crop system in Minnesota may be the lack of adequate soil water to support growth of both the cover and the corn and soybean crop. Therefore, the objective of our research was to determine the effects of a fall- or spring-planted winter rye cover crop on weed control, corn and soybean yield, and available soil water.

Location of Research: West Central Experiment Station, Morris, Minnesota and Southwest Experiment Station, Lamberton, Minnesota

Dates: 09/89—08/92

Funding Source: Agricultural Utilization Research Institute (AURI)

Funding Amount: \$32,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Warnes, D.D., J.H. Ford, C.V. Eberlein, and W.E. Lueschen. 1991. Effects of a winter rye cover crop system and available soil and water on weed control and yield of soybeans. *Proceedings, Cover Crops for Clean Water Symposium, April 9-11, 1991, Jackson, Tennessee.*

Warnes, D.D., C.V. Eberlein, J. H. Ford, W.E. Lueschen, and M.W. Seeley. 1989. Effect of precipitation and management on weed control and crop yield with winter rye cover crop system. *American Society of Agronomy Symposium: Mechanisms of Cover Crops Contributing to Low Input Agriculture. Abstracts of 1989 Annual Meeting of American Society of Agronomy*, 296.

For additional research on SUSTAINABLE AGRICULTURE, see project number 183.

WASTE MANAGEMENT

215

Agricultural Waste Management

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Project Description: The purpose of this experiment station project is to study the interactions of waste with the soil-water system. Specific objectives are to: assess the nutrient variability associated with livestock wastes; develop and study runoff control facilities in the problem soils (shallow topsoil and fractured limestone areas); study surface sealing associated with land application of wastes; and determine moisture and nutrient movement beneath earthen storage facilities.

Location of Research:

Dates: Ongoing

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount: \$5,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

216

Economically and Environmentally Sound Management of Livestock Waste

Frederick G. Bergsrud, Tim Wagar, and Michael A. Schmitt

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209 Agricultural Engineering
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(612) 625-2282

Project Description: The purpose of this project is to assist livestock producers in utilizing rather than disposing of their livestock manure. Earlier studies in the area indicated that livestock producers were not properly utilizing their manure, resulting in the potential for nitrate leaching to groundwater, in addition to the economic loss. The project provides a nutrient analysis of manure, guidelines for its application, and methods for developing utilization plans. The variability in nutrient content is being compared to tabled average values. Sampling methods to assure representative samples are also being investigated.

Location of Research: Farms in southeastern Minnesota

Dates: 04/90—06/92

Funding Source: Sustainable Agriculture Grant, Minnesota Department of Agriculture

Funding Amount: \$17,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

217

Waste Management: Mercury Behavior in a Wastewater Sludge Incineration Process

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Project Description: The Western Lake Superior Sanitary District (WLSSD) in Duluth, Minnesota utilizes solid waste as fuel to incinerate wastewater treatment sludge. The wastewater treatment sludge is incinerated with refuse-derived fuel in a fluidized bed reactor. The objective of this research was to determine mercury partitioning between the gas and water phases. This information would then be utilized in the development of a mercury removal process for the WLSSD facility.

Mass balance calculations indicated that approximately 50% of the total mercury left the process in the gas stream and approximately 50% was contained in the wastewater effluent at a concentration of 100-400 ng/L. The scrubbing system was identified as a critical area for heavy metal accumulation based on the process flow stream evaluation. Initial laboratory tests indicated a high percentage of the mercury associated with the particulates on fly ash and three primary methods of mercury removal were considered for application in this process: removal of solids with absorbed mercury, precipitation, and absorption. Precipitation and coagulation were subsequently tested for mercury removal efficiency with a series of chemicals and coagulants including lime, alum, ferric sulfate, ferric chloride, cationic polymer, and anionic polymer. The removal of solids with absorbed mercury appeared to be the most efficient method with over 90% removal of total mercury.

Initial plant tests have been run using alum and anionic polymer resulting in a mercury removal efficiency of 84%. Plant tests with lime are also planned because of the anticipated benefit in terms of reducing corrosivity and phosphorus control in other process streams.

Location of Research: Western Lake Superior Sanitary District

Dates: 07/89—03/91

Funding Source: Western Lake Superior Sanitary District (WLSSD); University of Minnesota, Duluth; National Science Foundation

Funding Amount: \$50,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 3

Related Research Publications:

Dorland, D. and J. Stepun. 1991. Mercury behavior in a wastewater sludge incinerator. In *Air-Water Mass Transfer*, ed. S.C. Wilhelms and J.S. Gulliver, Selected Papers from the Second International Symposium on Gas Transfer at Water Surfaces, ASCE, New York.

218

Paper Science and Engineering

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Project Description: Conduct research and education in paper science and recycling to help meet the needs for knowledge and trained professionals in these areas. This research is intended to help extend Minnesota's timber supply, improve industry competitiveness and ameliorate environmental problems.

Develop production and process control technology to permit increased recycling of current paper and fiber products. Examine possibilities for redesign of paper and fiber products for purposes of enhancing recycling potential.

Location of Research: Kaufert Laboratory, University of Minnesota

Dates: 07/91—06/93

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$392,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Allan, G. and Muvundamina, M. 1991. Processability of composite materials containing chitosan. *Proceedings of the Materials Research Society: Symposium on Materials Synthesis Based on Biological Processes*, v. 218.

Muvundamina, M. 1991. Recycling of wastepaper: Opportunities and problems. *Proceedings of the Materials Research Society, Anaheim, April 29 to May 3, 1991*.

219

Performance Characteristics of Fibers Recovered from Mixed Household Waste

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Project Description: Mixed household paper constitutes a large fraction of the municipal solid waste stream. Significant barriers presently exist to recycling mixed household paper. Currently, there are no efficient processes for reclamation of fibers from this grade of waste paper. There are also technical reasons that prevent industries from investing in the utilization of mixed paper as a source of fibers in manufacturing. Some of these are the absence of data on performance characteristics of fibers recovered from mixed household paper, and the lack of information on the mechanical behaviors of pulp prepared from recycled mixed fibers.

The directed research/feasibility study will evaluate the performance characteristics of fibers recovered from mixed household paper and define and develop processes for the production of a market pulp from mixed household paper. Components of the study will include: characterization of

the contaminants present in the fiber furnish; investigation of cleaning techniques; characterization of the waste materials generated during the recycling process; and a determination of the distribution of fibers of different size and morphology as a basis for investigation of the mechanical techniques of fiber separation or fractionation.

The study will develop the information and data necessary to move towards utilization of mixed household wastepaper by the pulp and paper industry.

Location of Research: Kaufert Laboratory, University of Minnesota

Dates: 10/91—09/92

Funding Source: Minnesota Office of Waste Management

Funding Amount: \$68,430

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

220

Feasibility Study: Recycling Mixed Wastes

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Project Description: The project is part of a feasibility study on the modification of the Waldorf Corporation's St. Paul boxboard mill to accept up to several hundred tons per day of mixed office and household waste papers. This material is post consumer-waste, much of which is currently land disposed or utilized in waste-to-energy facilities. In addition to evaluating the proposed Waldorf capital project, this study would refine the methods used for evaluation and thus provide transferable technology which may be used to improve the evaluation of other projects. The proposed directed research/feasibility study would be in support of an ongoing Waldorf effort to investigate new equipment configurations that would allow for the use of locally collected mixed waste paper. The complex recirculated piping of a secondary fiber preparation system makes it very difficult to predict the performance of the individual process units with a particular fiber furnish. Only full mass and energy balances, based on the performance curves developed in the laboratory and in pilot trails, can provide such information. Such a study is normally a prerequisite to an intelligent investment decision.

The University of Minnesota study will develop data/information crucial to predicting the performance of the new equipment configuration and intermediate scenarios being investigated by Waldorf to use mixed paper.

Location of Research: Kaufert Laboratory, University of Minnesota; Waldorf Mill, St. Paul

Dates: 10/91—10/92

Funding Source: Minnesota Office of Waste Management

Funding Amount: \$95,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

221

Minnesota Power Hibbard Plant Ash Project

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Institute of Agriculture, Forestry, and Home Economics
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(218) 384-3511

Project Description: The objective of this project is to investigate the agronomic and environmental effects of land application of wood waste/coal ash from the Hibbard Power Plant in Duluth, Minnesota, operated by Minnesota Power. The plant produces about 14,000 tons of ash per year from a fuel mixture consisting of wood waste and coal in a 4 to 1 ratio by weight. Included in the wood waste portion of the fuel mixture is sludge from nearby Lake Superior Paper Industries plant. Presently, the ash is being placed in a landfill. Land application of this ash would help extend the useful life of the landfill while also providing farmers with lower cost source of lime and fertilizer needed for crop production. To investigate effects of land application, test plots were established at a farm near Barnum, Minnesota in October, 1991. Experimental design is a randomized block with four replications. Treatments consisting of three ash rates (5, 10, and 20 tons per acre as received from the plant), a lime/fertilizer treatment consisting of 5 tons per acre of lime from the Cutler plant in Duluth and phosphorus (P) and Potassium (K) as per soil test recommendations, and an untreated check. Ash and lime were applied and incorporated at the time of the plot establishment. Fertilizer will be applied and incorporated in the spring of 1992 prior to seeding of all plots to alfalfa. Comparisons will be made of soil pH, concentrations of P, K and other elements including heavy metals in both soil and plant tissue, plant stands after the first winter, and yields.

Location of Research: Reuben Westendorf Farm, Barnum, Minnesota

Dates: 10/91—12/93

Funding Source: Minnesota Power

Funding Amount: \$7,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

222

A Project to Demonstrate the Feasibility of Composting Fish Waste in Northern Minnesota

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Minnesota Sea Grant College Program
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Project Description: Small resort and marina operators can save hundreds to thousands of dollars per year by composting fish waste instead of hauling it to landfills. The composting system uses sphagnum peat moss and wood chips. The resulting compost contains plant nutrients and can be used as a soil amendment for gardens and lawns.

Location of Research: Knife River, Leech Lake, Bass Lake, and Lake Vermillion, Minnesota

Dates: 02/90—09/91

Funding Source: Minnesota Sea Grant; Minnesota Extension Service; Itasca County; St. Louis County

Funding Amount: \$12,850

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

223

Recycling Attitudes and Behavior

Eugene Borgida, Mark Snyder, and Brian A. Kojetin

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Project Description: Our investigation has been examining the factors that predict people's recycling behavior. Although most people in Hennepin County support recycling, many fail to participate actively in their local recycling programs. In our research we have found that people's attitudes about recycling, intentions to recycle, awareness of local recycling programs, and knowledge about recycling are important influences on their recycling behavior. However, some people are more likely to act on their intentions than others. People who claim they do things based on their values or say that they are civic-minded are more likely to follow through on their intentions more often than other people. We have also found that habit also appears to play an important role in people's recycling behavior. People who feel that recycling is a habit recycle more frequently. Helping people get into the habit of recycling, perhaps by showing them how to structure their environments to make recycling fast and easy, may be an important goal for further information and persuasion campaigns.

Location of Research: Hennepin County, Minnesota

Dates: 04/88—Ongoing

Funding Source: Center for Urban and Regional Affairs, University of Minnesota; Hennepin County Board of Commissioners

Funding Amount: \$10,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 2

Related Research Publications:

Kojetin, B.A., E. Borgida, and M. Snyder. 1991. Recycling attitudes and behavior. *CURA Reporter* 21(4): 11-15.

224

Land Spreading of Yard Waste

Thomas R. Halbach, Carl J. Rosen, and Jean A.E. Molina

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College of Agriculture
216 Soils
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(612) 625-3135

Project Description: Research with yard wastes has focused on demonstration type experiments with little quantitative potential. Land spreading of yard wastes has been shown to be feasible both here and in Wisconsin. High rates of leaves have also been shown to generate severe nitrogen deficiency for some types of agricultural crops. Yet these same leaves may contain large amounts of nitrogen which may be released as decomposition becomes nearly complete. When fully decayed, excess nitrogen from these yard wastes has the potential to pollute groundwater. Thus, the process of management of yard wastes, particularly in terms of nitrogen management, must be better understood. Appropriate application rates of yard wastes and supplemental nitrogen under varying soil and meteorological conditions in Minnesota have not been precisely determined.

The objectives of this project are: 1) to evaluate different application rates of yard waste applied and directly incorporated into agricultural soils, and to identify rates of nitrogen required to accelerate the decay of yard wastes that can be actively decomposed without reducing agricultural crop yields or presenting an unacceptable environmental threat to the soil, and 2) to develop a prediction model so others can forecast the rate of yard waste decomposition under varying soil, climatic and tillage conditions.

Location of Research: Agricultural Experiment Station, Becker, Minnesota

Dates: 07/91—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$100,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

225

Land Application and Agricultural Utilization of Urban Wastes

Carl J. Rosen

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Project Description: Disposal of urban wastes is a major social and environmental issue as landfills are being closed and costs for using the remaining landfills continue to increase. Recycling the wastes based on the potentially useful materials they contain may be an alternative to traditional landfilling. The focus of our research is to determine whether the wastes can be used as a nutrient source or soil amendment for plant growth without adverse effects on the environment.

Field, greenhouse, and laboratory experiments are being conducted to determine the effects of waste products such as sewage sludge, incinerator ash, yard waste, municipal solid waste

Waste Management

compost, and municipal solid waste incinerator ash on growth and elemental composition of crops and movement of added elements in the environment. Elements of specific concern include nitrogen (nitrate), phosphorus, cadmium, lead, zinc, copper, and molybdenum. Some specific projects include modeling of nitrogen transformations following application of yard waste and chemical speciation of trace metals in soil solutions following amendment with sewage sludge incinerator ash.

Location of Research: Westport and Becker, Minnesota; St. Paul Campus, University of Minnesota

Dates: 01/87—Ongoing

Funding Source: Metropolitan Waste Control Commission; Legislative Commission on Minnesota Resources; Minnesota Office of Waste Management

Funding Amount:

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 2

Related Research Publications:

For additional research on WASTE MANAGEMENT, see project numbers 5, 135, 138, 256.

WATER RESOURCES

226

Modeling the Hydrology and Water Quality of Small Watersheds

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205 Agricultural Engineering
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St. Paul, MN 55108
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Project Description: This project will result in the development of physically-based models to represent hydrologic and contaminant transport processes. In addition, improved methods will be developed for predicting catchment runoff and the representation of three-dimensional terrain in hydrologic and water quality modeling. The effects of land management practices on runoff, water quality and vegetal (forest or crop) environment will also be studied.

Location of Research:

Dates: 07/88—09/92

Funding Source: Minnesota Agricultural Experiment Station

Funding Amount:

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

Related Research Publications:

227

Weed Management Systems to Reduce Ground Water Contamination with Herbicides

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College of Agriculture
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Project Description: The overall objectives of this research are to: 1) determine the bases for weed management systems that reduce the adverse environmental impacts of weed management in corn and soybean production, and 2) evaluate the leaching and degradation of agricultural herbicides as influenced by environment and crop management practices.

Objective 1 will be approached by: a) developing and testing integrated weed management systems for corn and soybean production, b) determining the influence of weed management systems on weed population dynamics and the weed seed bank in the soil, and c) determining the interaction between weed population dynamics and herbicide bioactivity. Objective 2 will be approached by: a) measuring the leaching and degradation of atrazine and alachlor as influenced by tillage systems at three locations with different soil types and environments, and b) determining the influence of herbicide management practices on herbicide runoff and movement into soil following simulated rainfall.

Location of Research: St. Paul Campus, University of Minnesota; several out-state field sites

Dates: 03/89—Ongoing

Funding Source: U.S. Department of Agriculture, Agricultural Research Service; University of Minnesota; U.S. Environmental Protection Agency

Funding Amount: \$150,000/year

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 2

Related Research Publications:

228

Mercury Pollution

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Project Description: Mercury contamination of the fishery affects hundreds of lakes and rivers in the Upper Midwest and around the Great Lakes. In Minnesota, fish consumption advisories restricting full utilization of the resource because of elevated levels of mercury have been issued for 355 water bodies compared to the limited database of 22 water bodies ten years ago. This project has extensively monitored mercury concentrations in precipitation, lake water and sediment, zooplankton and fish throughout many lake and river watersheds in northern Minnesota and Wisconsin. Results to date have shown the primary source of mercury to be of atmospheric origin, from both remote and local sources of mercury emissions. Additional research on source identification, source-receptor relationships, and bioavailability is needed to determine the cause and extent of contamination in aquatic resources.

Location of Research: Limnological Laboratory, Duluth; Environmental Research Lab, U.S. Environmental Protection Agency

Dates: 07/87—06/93

Funding Source: Minnesota Pollution Control Agency

Funding Amount: \$664,000

Number of Graduates Working with Project: 6

Number of Undergraduates Working with Project: 2

Related Research Publications:

Glass, G.E., J.A. Sorensen, K.W. Schmidt, and G.R. Rapp, Jr. 1990. New source identification of mercury contamination in the Great Lakes. *Environmental Science and Technology* 24(7): 1059-1069.

Sorensen, J.A., G.E. Glass, K.W. Schmidt, J.K. Huber, and G.R. Rapp, Jr. 1990. Airborne mercury deposition and watershed characteristics in relation to mercury concentrations in water, sediments, plankton, and fish of eighty northern Minnesota lakes. *Environmental Science and Technology* 24(11): 1716-1727.

Glass, G.E., J.A. Sorensen, K.W. Schmidt, G.R. Rapp, Jr., D. Yap, and D. Fraser. 1991. Mercury deposition and sources for the upper Great Lakes region. *Water, Air and Soil Pollution* 56: 235-249.

Water Resources

229

State/Tribal Relations in Area of Water Resources in the Western United States

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Project Description: The newly developing relationships between state governments and American Indians in the critical area of water management and use are being examined. Experiences in two states will be studied: Minnesota and New Mexico. These states have a large and diverse Indian population which has been involved in important ways in the questions of management and use of water resources. Work will be carried out in cooperation with water resources research centers in the two states.

Location of Research: Minnesota, New Mexico

Dates: 10/92—12/93

Funding Source:

Funding Amount: \$25,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project:

Related Research Publications:

230

Environmental Inventory of the Mississippi River and Its Basin

William J. Craig

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Project Description: The purpose of this project was to produce an atlas showing the environmental status of the Mississippi River and its basin for the McKnight Foundation. The foundation is beginning a new geographically focused environmental initiative. The 38-page document, *Environment and River: Maps of the Mississippi*, by William J. Craig and William S. Anderson, provides a background of the status and future potential of that area. Maps are small scale and each presents an overview of a given topic on a single page. Three general topic areas are covered using maps about specific topics: 1) status of the river—suspended sediments, nutrient loads, insecticide residue in carp, and recreation sites; 2) insults to the river—soil erosion, fertilizer use, pesticide use, wetlands losses, direct release of industrial toxins, and spills; and, 3) coping capacity—income levels, government management balkanization, and environmental organizations.

Location of Research:

Dates: 03/91—10/91

Funding Source: McKnight Foundation

Funding Amount: \$18,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

Craig, William J. and William S. Anderson. 1991. *Environment and the River: Maps of the Mississippi*. Report to the McKnight Foundation. Center for Urban and Regional Affairs, University of Minnesota.

231

Toxics in the St. Louis River System: A White Paper

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Project Description: The Great Lakes Basin ecosystem has been the focus of environmental recommendations and legislation over the past eighteen years. The St. Louis River system has been designated as an Area of Concern (AOC) through Great Lakes policy mechanisms. The Remedial Action Plan (RAP) process was initiated for the St. Louis River Systems Area of Concern in 1978 by the International Joint Commission. The original AOC designation was based on significant adverse effects from large suspended loads, nutrients, and biochemical oxygen demand. Current concerns include water and sediment contamination by organic chemicals and heavy metals.

In response to the St. Louis River AOC designation, a citizens advisory committee was formed in 1989 to work with the Minnesota Pollution Control Agency (MPCA) and the Wisconsin Department of Natural Resources (WDNR) in the development of a RAP. A primary task in the preparation of the RAP involves the review of existing information to aid in the identification of the causes and sources related to the impaired beneficial uses of the AOC. Technical advisory committees (TAC) were identified to assist in this task. The results from the TACs were combined with other agency technical input which resulted in a problem identification document. Evaluation of the identified information will be used in the development of recommendations that aim to restore the beneficial uses and prevent further degradation of the area.

Location of Research: University of Minnesota, Duluth

Dates: 06/90—05/91

Funding Source: Center for Urban and Regional Affairs, University of Minnesota

Funding Amount: \$20,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

232

The Acidification of Little Rock Lake

Patrick L. Brezonik and James A. Perry

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Project Description: This multi-year whole-ecosystem acidification project currently is in its eighth year. Through acidification, lake pH was manipulated from 6.1 to 4.5 and is currently undergoing "recovery." The study has shown that acidification has caused an increase in levels of metals, including aluminum. Mercury levels have risen sharply in yearling yellow perch, a game fish and food source for walleye. About 30 percent of plankton species have been lost, which simplifies the food web and tends to destabilize the ecosystem. In addition, the effects of acidification on nutrient cyclings,

Water Resources

decomposition, leaf litter inputs to the lake, and microbial community variables as indicators of system response have also been studied.

Location of Research:

Dates: 01/83—Ongoing

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$933,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Brezonik, P.L., L.A. Baker, J. Eaton, T. Frost, P. Garrison, J. Magnuson, J.A. Perry, W. Rose, B. Shepard, W. Swenson, C. Watras, and K. Webster. 1986. Experimental acidification of Little Rock Lake. *Water, Air, and Soil Pollution* 31: 115-122.

Brezonik, P.L., K.E. Webster, and J.A. Perry. 1989. Effects of acidification on benthic community structure and benthic processes in Little Rock Lake, Wisconsin. *Triannual Meeting, International Society of Theoretical and Applied Limnology, Munich, West Germany.*

233

Liming of Thrush Lake as an Acid Precipitation Mitigation Strategy: Effects on Biogeochemical Cycles and Ecosystem Processes

Patrick L. Brezonik and James A. Perry

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500 Pillsbury Drive S.E.
Minneapolis, MN 55455
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Project Description: Thrush Lake is a small, brown-water lake in northeastern Minnesota. Lime was added to the lake to raise the pH and increase the productivity, as a measure of an acid precipitation mitigation technique.

Location of Research: Thrush Lake, Minnesota

Dates: 01/89—12/91

Funding Source: Minnesota Pollution Control Agency

Funding Amount: \$48,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

234

Development of a Similitude Criteria for the Model/Full-Scale Comparison of Oxygen Transfer in Auto-Venting Hydraulic Turbines

John S. Gulliver

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Project Description: An important freshwater quality parameter is dissolved oxygen. The level of oxygen concentration in surface waters is a prime indicator of the quality of that water for human use as well as by the aquatic biota. The impact of hydropower facilities on dissolved oxygen levels can be severe. At the turbine intake level, often located at the bottom of the reservoir, dissolved oxygen concentrations tend to be low and little aeration occurs during intake. If dissolved oxygen concentrations fall below about 2 ppm, nutrients, metals, toxins and other sediment materials are released. These emissions from the sediment can create a negative impact for tens of river miles downstream from the facility. A technology that has the potential of significant cost savings is the development or retrofit of an auto-venting turbine. While there are a few such turbines in existence, there has been little research that can measure their effectiveness of enhancing oxygen transfer. The development of a similitude criteria is a key to this cooperative research effort that is directed at improving the design and reliability of auto-venting turbines. This project is part of a federal agency cooperative research group consisting of the Tennessee Valley Authority Engineering Laboratory, the U.S. Army Engineer Waterways Experiment Station, and the U.S. Bureau of Reclamation Engineering Laboratory.

Location of Research:

Dates: 10/90—10/91

Funding Source: U.S. Army Corps of Engineers

Funding Amount: \$20,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

235

The Potential for Biological Control of Eurasian Water Milfoil with Native and Naturalized Invertebrates

Raymond M. Newman and James A. Perry

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Project Description: Eurasian water milfoil is a rapidly invading noxious plant that colonizes and disrupts Minnesota lakes. This project will determine if, when and where recognized biological control agents occur as well as other potential biological control invertebrates. An extensive survey of about 50 lakes will be conducted and the results will be used in a correlational analysis of factors affecting occurrence of potential control agents, milfoil density, and occurrence and damage. This information will be used to guide detailed preference studies. Further, laboratory feeding results will identify those invertebrates with a potential for

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biological control of milfoil and minimal impact on desirable plants. In addition, these results will provide an estimate of the density of invertebrates needed for milfoil control.

Location of Research: Lake Minnetonka, Minnesota

Dates: 04/92—06/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$55,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 3

Related Research Publications:

236

Nemadji Watershed Project

Kenneth N. Brooks

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Project Description: The project is evaluating erosion-sedimentation relationships of the Nemadji Watershed. The focus is on land use and vegetative changes and conditions that can cause accelerated erosion rates.

Location of Research: Nemadji Watershed, Carlton County, Minnesota

Dates: 03/91—12/91

Funding Source: Minnesota Pollution Control Agency; Carlton County and Water Conservation District

Funding Amount: \$6,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

237

Effects of Experimental Acidification on Leaf Litter Decomposition in Northern Lakes

James A. Perry

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(612) 624-9796

Project Description: Leaf litter from riparian trees serves as a food resource for microbial and macroinvertebrate organisms in the lake, and as a source of nutrients for plants and animals in the lake. Acid deposition reduces pH of lakes and changes many lake-water chemistry variables. This project is part of the larger project "The Acidification of Little Rock Lake" (number 232), which involves experimentally reducing the pH of one-half of a divided lake. Leaf litter decomposition, leaf litter microbial populations, and leaf chemistry are measured in Little Rock as well as five to nine other neighboring lakes.

Location of Research:**Dates:** 06/84—Ongoing**Funding Source:** U.S. Environmental Protection Agency; Minnesota Agricultural Experiment Station; McIntire Stennis Cooperative Forestry Program**Funding Amount:** \$350,000**Number of Graduates Working with Project:** 4**Number of Undergraduates Working with Project:** 2**Related Research Publications:**

Perry, J.A., N.H. Troelstrup, Jr, M. Newsom, and B. Shelley. 1987. Results of recent whole ecosystems manipulations: The search for generality. *Water Science Technology* 19: 55-71.

Perry, J.A. and N.H. Troelstrup, Jr. 1988. Whole ecosystem manipulation: A productive avenue for test system research? *Environmental Toxicology and Chemistry* 7: 941-951.

Perry, J.A., R. Zeyen, M. Newsom, and G. Ahlstrand. 1989. X-ray microanalysis of leaf litter decomposing in lakes. *Bioscience* 39: 260-263.

238**Effects of Liming on Thrush Lake****James A. Perry**

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115 Green Hall
1530 N. Cleveland Ave.
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Project Description: Acid deposition lowers the pH of lakes and impairs the ecological function of impacted lake ecosystems. Addition of lime is seen as a way of mitigating acidified lake ecosystems. In this project, leaf litter inputs and decomposition rates in limed Thrush Lake and nearby Thrasher Lake were analyzed. Leaf litter weight losses, chemistries and microbial communities are compared through time. Results of these analyses are combined with chemistry models developed by other investigators to develop geo-chemical models of ways the lake has responded to liming and thus, the implications of liming as a mitigation strategy. See also project number 233.

Location of Research: Thrush Lake and Thrasher Lake, northeastern Minnesota**Dates:** 06/89—07/92**Funding Source:** U.S. Fish and Wildlife Service; Minnesota Pollution Control Agency**Funding Amount:** \$100,000**Number of Graduates Working with Project:** 1**Number of Undergraduates Working with Project:** 0**Related Research Publications:**

Holm, C.E. and J.A. Perry. 1992. *Litter, Carbon and Element Loading to Thrush Lake, Minnesota: A Component of an Empirical Model to Predict Lake Response to Lime Treatment*. Department of Forest Resources, University of Minnesota. Staff paper.

Holm, C.E. and J.A. Perry. 1990. Effects of liming on terrestrial fungal colonizers of leaf litter in Thrush Lake. Presented at University of Minnesota/3M Research Conference.

Holm, C.E., N.H. Troelstrup Jr., and J.A. Perry. 1990. Effects of liming on leaf litter decomposition and microbial dynamics in a brown water lake: Thrush Lake, Minnesota. Presented at 52nd Annual Midwest Fish and Wildlife Conference, Minneapolis, Minnesota.

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Holm, C.E., J.A. Perry, and N.H. Troelstrup Jr. 1991. Coniferous litter decomposition in a lime-treated Minnesota lake. Presented at the 39th Annual Meeting of the North American Benthological Society, Santa Fe, New Mexico.

239

Land Use Impacts on Southeastern Minnesota Streams

**James A. Perry, Nels H. Troelstrup, Jr., and
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Project Description: As part of the Lanesboro Watershed Project, this study focuses on the impacts of land management practices on surface and ground water quality. Researchers have measured variables such as nutrient cycling rates; decomposition; benthic macroinvertebrate, macrophyte and microbial structure and function; whole ecosystem production and respiration; community diversity and pesticide and other water quality attributes as functions of land use.

Location of Research: Southeastern Minnesota

Dates: 01/85—12/92

Funding Source: Legislative Commission on Minnesota Resources; Minnesota Agricultural Experiment Station; College of Natural Resources

Funding Amount: \$300,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 1

Related Research Publications:

Bartodziej, W. and J.A. Perry. 1989. Litter processing in diffuse and conduit springs. *Hydrobiologia* 206: 87-97.

Perry, J.A., N.H. Troelstrup Jr., W. Bartodziej, and T.F. Wilton. 1988. *Risks to Surface Water Quality in the Lanesboro Watershed: Southeastern Minnesota*. Department of Forest Resources, University of Minnesota, Staff Paper 63, 112 pp.

Perry, J.A., and W.H. Clark. 1990. Groundwater classification through spring chemistry: The Lower Portneuf River, Idaho. *Journal of the Idaho Academy of Science* 26: 55-71.

Troelstrup, N.H., Jr., and J.A. Perry. 1989. Impacts of land management practices on water quality in southeastern Minnesota streams. *Journal of the Minnesota Academy of Science* 55: 6-13.

Troelstrup, N.H., Jr., and J.A. Perry. 1990. Interpretation of scale dependent inferences from water quality data. *Proceedings of the 1990 Midwest Pollution Control Biologists Meeting*. U.S. Environmental Protection Agency 905/9-90-05: 64-86.

240

Leaf Litter Inputs to Northern Lakes

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Project Description: Riparian trees surrounding lakes shed their leaves into the lake water. That leaf material serves as a food resource for microbial and macroinvertebrate organisms in the lake, and as a source of nutrients for plants and animals in the lake. The landscape characteristics that influence the rate, timing, and chemistry of that leaf material are poorly understood. We have measured leaf litter inputs to one lake for nearly ten years and to six other neighboring lakes during one year in order to develop an understanding of the year-to-year variation in leaf litter inputs and the similarities among lakes in a given year. Questions posed include the relationship between "position in the landscape" (e.g., on the groundwater divide) and "leaf litter quality or volume."

Location of Research:

Dates: 06/84—Ongoing

Funding Source: U.S. Environmental Protection Agency; National Science Foundation; Minnesota Agricultural Experiment Station; McIntire Stennis Cooperative Forestry Program

Funding Amount: \$300,000

Number of Graduates Working with Project: 4

Number of Undergraduates Working with Project: 2

Related Research Publications:

Rudensky, K. and J.A. Perry. 1985. Quantification of allochthonous organic matter inputs to Little Rock Lake. Wisconsin Water Resources: Atmospheric, Surface, and Groundwater. LaCrosse, Wisconsin.

Rudensky, K. and J.A. Perry. 1985. Allochthonous organic carbon dynamics of Little Rock Lake. Presented at the Annual Meeting of the Ecological Society of America.

241

Management Implications of Exotic Species Invasions: Use of GIS to Assess Effects of Harvesting Water Milfoil in Lake Minnetonka

James A. Perry and Lloyd P. Queen

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Project Description: Lake Minnetonka is a large, shallow lake in south-central Minnesota. The lake receives a large amount of recreational use and is heavily impacted by Eurasian water milfoil. A geographic information system is being developed that addresses plant occurrence, water quality in and near plant beds, and the effects and effectiveness of harvesting and other treatment practices. Ecological variables such as water clarity, nutrients, sediment quality, and associated plants allow prediction of other areas where milfoil invasions might be expected.

Location of Research: Lake Minnetonka, Minnesota

Dates: 01/89—12/91

Water Resources

Funding Source: Freshwater Foundation

Funding Amount: \$35,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

Crowell, W., N.H. Troelstrup, Jr., L. Queen, and J.A. Perry. 1991. *Lake Minnetonka Milfoil Geographic Information System Project: Final Report*. Department of Forest Resources, University of Minnesota.

242

Land and Water Resource Management of the Lower St. Croix Riverway

Nels H. Troelstrup, Jr. and James A. Perry

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Project Description: The Lower St. Croix Riverway was one of the nation's first designated Wild and Scenic Rivers. During its twenty-year history, numerous changes have taken place in the land use of the watershed and in the quality of the river water. Those changes are regulated and managed by a series of environmental policies. As part of a larger project (Pitt, Number 244), this effort examines land use changes in the watershed since the late 1930s, historical water quality changes, and biological measures of the "health" of the riverine systems today. Measures include analyses of mussel beds and the chemistry of individual animals, chemical and physical quality of the river water, and contributions from various land use activities.

Location of Research: eastern Minnesota

Dates: 07/91—07/93

Funding Source: Legislative Commission on Minnesota Resources; Minnesota Agricultural Experiment Station; McIntire Stennis Cooperative Forestry Program

Funding Amount: \$150,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

243

Environmental Assessment of Lac qui Parle Lake Watershed

James B. Van Alstine

Geology
College of Science and Engineering
University of Minnesota, Morris
Morris, MN 56267
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Project Description: The environmental assessment of the Lac qui Parle Lake Watershed will be conducted in three phases. In phase 1, information will be gathered to determine sources of nutrient and sediment loading in tributaries to the lake. This will include determining the land use patterns and nonpoint source pollution potential of selected areas within the watershed. In phase 2, the water quality

of selected tributaries entering the lake will be assessed, including various chemical and physical measurements. The final phase will focus on lake monitoring and assessment. This will include measuring sedimentation rates as well as chemical testing of water and sediments to determine lake water quality trends.

Location of Research: Lac qui Parle Lake, Lac qui Parle County, Minnesota

Dates: 07/91—Ongoing

Funding Source: Lac qui Parle Lake Association

Funding Amount: \$33,800

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 3

Related Research Publications:

244

Land Use Management and the Effectiveness of Policies on the Lower St. Croix National Scenic Riverway

David G. Pitt, Lloyd P. Queen, Nels H. Troelstrup, Jr., and James A. Perry

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Project Description: The Lower St. Croix is a National Scenic River and a valuable resource. A master plan, implemented in 1968, provides the policy environment for river-way management. A multi-disciplinary team is measuring changes in land use and water quality that have occurred since the inception of the master plan and the relationships between those changes and management policies.

Location of Research: St. Croix River in Minnesota and Wisconsin

Dates: 01/91—12/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$241,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Troelstrup Jr., N.H. and J.A. Perry. 1991. Examination of change in the lower St. Croix National Scenic Riverway: Water quality and ecology. Presented at the St. Croix Rendezvous Research Meeting, Wilder Forest.

245

Effects of Navigation-Induced Shear and Turbulence on the Upper Mississippi River System

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Project Description: The U.S. Fish and Wildlife Service's Long Term Resource Monitoring Program supports studies that provide information about sedimentation, navigation, and water level fluctuations on the Mississippi River. Areas of research needed for resource management include investigations of navigation-induced shear and turbulence on larval fish and invertebrates in the Upper Mississippi River System (UMRS). Egg and larval stages of fish are responsible for annual fish production under natural circumstances and their high mortality rates greatly affect year-class strength. Therefore, navigation-related factors that influence egg and fry mortality may exacerbate the existing problems of habitat degradation and contaminants for fish populations in the UMRs.

The objectives of this research are: 1) to review and assemble existing data concerning pertinent physical force impacts on early developmental stages in fishes, 2) to evaluate the accuracy of existing methods of impact simulation based on newest data available, 3) to test methods regarding selected UMRs species to compare results for other species in other river systems, and 4) to develop and perform preliminary tests on a new prototype system to simulate vessel passage impacts on early life stages of ichthyoplankton.

To date, an extensive literature search of the effects of navigation-induced shear and turbulence on early life stages of fishes has been initiated. One feature of the literature reviewed highlights the lack of post-exposure observation of eggs or larvae. In addition, the impact of multiple shear force events upon fish egg and larvae has not been researched. Additional steps have been taken to compile current information on the natural history parameters of the species of interest in this study: walleye (*Stizostedion vitreum*), sauger (*Stizostedion canadensis*), freshwater drum (*Aplodinotus grunniens*), and gizzard shad (*Dorosoma cepedianum*).

Location of Research: University of Minnesota, Duluth; National Fisheries Research Center, LaCrosse, Wisconsin

Dates: 08/90—02/93

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Environmental Contaminant Threats of Irrigation Drainwater Materials

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Project Description: The discovery of deformities, reproductive failures, and mortality in fish and wildlife at Kesterson National Wildlife Refuge in California was one of the first events to suggest that irrigation drainwater may be hazardous to living organisms. Irrigation drainwater at some western sites has been shown to contain elevated concentrations of selenium, boron, arsenic, mercury, and organochlorine pesticides. Subsequent research shows that irrigation related contaminants negatively affect reproduction, development, and growth in fish and wildlife. In 1985, the Department of Interior initiated the Irrigation Drainwater Program in 1985 to investigate the potential impacts on fish and wildlife of contaminants associated with departmentally operated or sponsored irrigation programs.

The objectives of this project are: 1) to develop toxicity tests as methodologies to be used by environmental contaminants (EC) specialists in field and laboratory settings for reconnaissance screening; 2) to develop approaches for using MICROTOX[®] in environmental assessments; 3) to develop a comparative toxicity database for water- and sediment-associated contaminants collected from seven irrigation drainwater projects sites across the country; 4) to aid EC specialists in using biological tools, as well as residue data, to determine initial areas of concern deserving more in-depth contaminant assessment.

No significant reduction in mobility or mortality was observed in the *D. magna* or the fathead minnow toxicity tests. In all cases MICROTOX[®] did not indicate toxicity when exposed to 100% sample water or dilutions. Toxicity was indicated by the EC50 values recorded in the midge tests at two of the project locations. The sites with toxicity indicated in the midge tests showed no toxicity in the other three tests. Thus, the sediments at these sites may be more toxic than the water to the test organisms.

Location of Research: Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota; seven environmental contaminant field station assessment locations

Dates: 06/89—10/91

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Water Resources

247

Long Meadow Lake Bioassessment

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Project Description: Long Meadow Lake, on the Minnesota Valley National Wildlife Refuge (NWR), is an important mallard and wood duck production area. In the opinion of refuge personnel, however, the 1,375-acre shallow, backwater lake does not produce waterfowl broods commensurate with its apparent capacity. In 1988, a survey of sediments near the mouths of nine Long Meadow Lake storm water outfalls was conducted. One outfall had particularly high sediment concentrations of heavy metals. Previous limited sampling in that area leads us to believe that total polycyclic aromatic hydrocarbon (PAH) concentrations will also be high. Such a sediment environment is intuitively undesirable. However, there is no hard information available to demonstrate whether the sediment is chronically affecting benthic organisms or whether it is acutely toxic to some of these sensitive organisms indigenous to the system.

The objective of this study is to determine the toxicity of the water from Long Meadow Lake to several aquatic organisms. This information will provide the refuge manager with a perspective from which to decide whether or not to vigorously pursue measures to mitigate the storm water discharge.

Long Meadow Lake surface sediments were collected from two locations, one within the area of stormwater impact and one from an area determined to be uncontaminated. The sediments will be analyzed for heavy metal and PAH contamination and three toxicity tests will be performed. Partial life cycle toxicity tests using *Chironomus tentans* and *Hexagenia limbata* will be performed on sediment, sediment pore water, and elutriate. In addition the MICROTOX[®] bacterial toxicity test will be performed on the sediment pore water and the elutriate.

Location of Research: Minnesota Valley National Wildlife Refuge; Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota

Dates: 07/90—06/91

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

248

A Geographic Information System for Water Resources Management in Beltrami County, Minnesota

Lloyd P. Queen and James A. Perry

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College of Natural Resources
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Project Description: Beltrami County is a large, diverse county in northern Minnesota. The county has a variety of land uses and a variety of designated uses for its surface and groundwaters. This

geographic information system will assist county officials in making decisions about groundwater sensitivity, surface water quality, and land use impacts. The GIS will serve as a model for application in other counties with similar issues of concern.

Location of Research: Beltrami County, Minnesota

Dates: 01/89—12/92

Funding Source: Beltrami County, State of Minnesota

Funding Amount: \$40,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

249

Assessment of Phytoplankton Nutrient Deficiency in Northern Minnesota Acid-Sensitive Lakes

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Project Description: In addition to the more publicized effects of acid deposition on softwater lakes, indirect effects associated with increased algal growth due predominately to nitrate and ammonium contaminants are also possible in less productive lakes. Previous studies of northern Minnesota lakes have emphasized the importance of phosphorus in regulating lake productivity, but depleted levels of inorganic nitrogen during the growing season suggest that sources of nitrogen may also be important. As part of the Minnesota Pollution Control Agency's Stream/Lake Water Analysis Study and the Minnesota Department of Natural Resources' Thrush Lake Liming Study, this project will provide an assessment of the potential for nitrogen deposition to be a significant non-point source of pollution to many unproductive lakes.

Location of Research:

Dates: 07/89—06/91

Funding Source: Minnesota Pollution Control Agency

Funding Amount: \$15,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 1

Related Research Publications:

An Assessment of Phytoplankton Nutrient-deficiency in Northern Minnesota Acid-Sensitive Lakes. Technical Report NRR/IR-91/18. Natural Resources Research Institute, University of Minnesota-Duluth. 114 pp.

250

Lake and Stream Water Analysis

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University of Minnesota, Duluth
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Project Description: Northern lakes and streams may be subject to declines in pH and alkalinity brought about by acid rain and spring snowmelt. The NRRI Central Analytical Laboratory is assisting the Minnesota Pollution Control Agency (MPCA) by analyzing water samples taken from lakes in Pine, Carlton, Itasca, St. Louis, Lake, and Cook counties, and from four North Shore streams. Lake water data will be used by the MPCA to expand a data base of acid-sensitive lakes. Data on stream water chemistry has been used by the MPCA to select two study streams displaying acid sensitivity. These sites have been monitored intensively during the project. Data from these sites and from analysis of snow will be used to assess long-term water chemistry trends and to determine the importance of spring snowmelt as a potential contributing factor to acidic conditions.

Location of Research:

Dates: 07/89—06/92

Funding Source: Minnesota Pollution Control Agency

Funding Amount: \$96,200

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 3

Related Research Publications:

251

Aquatic-based Toxicological Assessment of Contaminated Freshwater Sediments

Keith B. Lodge
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Project Description: The part that contaminated sediments play in the general assessment of the health of an ecosystem is coming under increasing scrutiny. Possible consequences of sediment contamination are the incidence of tumors in fish and deformities in birds in certain regions of the Great Lakes. However, the link between anthropogenic contamination in sediments and effects in higher organisms is tenuous at best. Regulatory agencies require detailed knowledge of the transport processes in order to make decisions regarding the clean-up of sediments, which require huge expenditures. This research will investigate how hydrophobic organic chemicals are transferred from contaminated sediments to biota, and thereby, to relate laboratory-observed toxic effects to conditions in the field.

Location of Research:

Dates: 10/90—09/93

Funding Source: U.S. Environmental Protection Agency

Funding Amount:

Number of Graduates Working with Project:
Number of Undergraduates Working with Project:
Related Research Publications:

252

Predictive Modeling and Experimental Design of Lotic Mesocosms

Gerald J. Niemi, James A. Perry, and Michael C. Swift

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Project Description: This project will develop a database on information gathered at the Monticello Ecological Research Station (MERS) over the past 10-15 years and use this information to better understand the effects of chemicals on streams. The project will also develop an ecological model of the station's associated streams. A summarization of the data gathered at MERS indicates that macroinvertebrate population data are very good and will be the focus of further efforts on understanding how chemicals, especially in sediments, affect the functions of the streams.

Location of Research: Monticello, Minnesota

Dates: 04/90—04/93

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$618,000

Number of Graduates Working with Project: 2

Number of Undergraduates Working with Project: 1

Related Research Publications:

253

Biological Characteristics of the Saginaw River Watershed

Carl Richards, George Host, and John Arthur

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Project Description: Biological, physical, and chemical characteristics of streams in Saginaw Bay watershed will be assessed to identify major trends in these parameters. A series of streams in agricultural, forested, and mixed watersheds will be examined to quantify important environmental gradients.

Location of Research:

Dates: 07/90—06/91

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$38,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 2

Related Research Publications:

Water Resources

254

Development of Biocriteria for Regional Watersheds Through Integrated Landscape and Reach-Scale Analyses

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Project Description: Land use and landscape characteristics of the Saginaw River watershed in Michigan will be described using a geographic information system. This database will be used to identify factors that influence water quality and biological communities in associated streams. Biocriteria that can be used to assess stream conditions in monitoring programs will be developed from this information.

Location of Research:

Dates: 08/91—07/94

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$248,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 4

Related Research Publications:

255

Factors Influencing Algal Production in the Minnesota River Watershed

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Project Description: Several mainstem and tributary locations on the Minnesota River will be examined to determine the influence of nutrient availability on the algal growth. In situ bioassays will be used to assess the relative influence of several nutrients in relation to other physical characteristics in the streams.

Location of Research: Minnesota River

Dates: 07/90—06/91

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$19,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

256

Fish Community Analysis in an Effluent Mixing Zone

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Project Description: Fish communities in the St. Louis River estuary will be surveyed in the vicinity of the Western Lake Superior Sanitary District effluent plume. Surveys will be conducted during winter conditions to determine fish utilization of the area.

Location of Research: St. Louis River Estuary

Dates: 11/91—07/92

Funding Source: Western Lake Superior Sanitary District (WLSSD)

Funding Amount: \$22,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

257

Influence of Habitat and Water Quality on Algal Community Structure

Carl Richards

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Project Description: A series of small agricultural streams in the Minnesota River watershed will be examined to determine the relationships between physical and chemical characteristics of the streams and algal community structure. Groups of species will be identified that may serve as biological indicators of stream conditions.

Location of Research: Minnesota River watershed

Dates: 08/91—02/93

Funding Source: Legislative Commission on Minnesota Resources

Funding Amount: \$32,000

Number of Graduates Working with Project:

Number of Undergraduates Working with Project: 1

Related Research Publications:

Water Resources

258

Pollutant Delivery Evaluation System for Urban Watersheds

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North Central Soil Conservation
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Project Description: As an outcome from this research project, a methodology will be developed for analyzing the development of pollutants including the movement of organic matter, sediment, and nutrients from urban and suburban land uses. The methodology will be able to function independently in strictly urban watersheds or be integrated into Agricultural Non-point Source Pollution Model (AGNPS) for watersheds where both agricultural and urban land uses exist.

Location of Research:

Dates: 03/87—03/92

Funding Source: U.S. Department of Agriculture

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

259

The Secondary Metabolites of Eurasian Water Milfoil and Their Relation to Potential Control Agents

Florence K. Gleason and Raymond M. Newman

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College of Biological Sciences
220 Biological Sciences
1445 Gortner Ave.
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(612) 625-4275

Project Description: Eurasian water milfoil is a major nuisance plant throughout North America. With increased efforts to control it, more information about its competitive and anti-herbivore abilities are needed. There is little ecologically relevant information on aquatic macrophyte secondary metabolites. This project will characterize the biologically active secondary metabolites of Eurasian water milfoil and their effects on competitors and potential biological control agents. The attractant, deterrent, and toxic effects of milfoil on other plants and selected aquatic invertebrates will be tested. The plant or animal showing the most pronounced effects will be selected for further testing and characterization of the inhibitory metabolites. The most active component of the inhibitory metabolites will then be isolated and chemically characterized. The results can suggest approaches for biocontrol that may save management time and money and be more ecologically sound.

Location of Research:

Dates: 01/92—12/93

Funding Source: Minnesota Sea Grant

Funding Amount:

Number of Graduates Working with Project:
Number of Undergraduates Working with Project:
Related Research Publications:

260

Global Climate Change Impacts on Lake and Stream Environmental Conditions

Heinz G. Stefan and John G. Eaton

St. Anthony Falls Hydraulic Laboratory
Civil and Mineral Engineering
Institute of Technology
Mississippi River at Third Ave. S.E.
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Project Description: The effect of global climate was projected on the distribution and growth potential of common freshwater fishes in 5 streams and 27 classes of lakes in Minnesota. The method developed for this analysis uses laboratory growth and mortality data, and a stream temperature-fish distribution database, to define temperature responses for 32 warm and coldwater fish species. In general, warmwater fishes will gain good growth habitat in lakes and streams. Coldwater and some coolwater fish species will be eliminated in unshaded streams but will have a chance for continued existence in shaded streams. In lakes, coldwater fishes will have a chance to survive if the lakes are deep and located in the northern half of the state, but there will be a loss in habitat for good growth conditions.

Location of Research: St. Anthony Falls Hydraulic Laboratory, University of Minnesota

Dates: 09/90—09/91

Funding Source: U.S. Environmental Protection Agency

Funding Amount: \$70,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 0

Related Research Publications:

Hondzo, M. and H.G. Stefan. 1991. Three case studies of lake temperature and stratification response to warmer climate. *Water Resources Research* 27(8): 1837-1846.

Stefan, H.G., M. Hondzo, B. Sinokrot, X. Fang, J.G. Eaton, B.E. Goodno, K.E.F. Hokanson, J.H. McCormick, D.G. O'Brien, and J.A. Wisniewski. 1991. *A methodology to estimate global change impacts on lake and stream environmental conditions and fishery resources with application to Minnesota*. Project Report No. 323, St. Anthony Falls Hydraulic Laboratory, University of Minnesota, Minneapolis, MN. 141 pp.

For additional research on WATER RESOURCES, see project numbers 32, 46, 53, 66, 90, 93, 94, 99, 105, 106, 107, 108, 112, 113, 114, 115, 121, 136, 151, 180, 184, 186, 197, 207, 208, 212, 265, 266.

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Management Implications of Exotic Species Invasions: Nutrient Cycling in the Cattail and Purple Loosestrife Wetlands

James A. Perry

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Project Description: Purple loosestrife is an exotic plant that is "taking over" many wetlands in the northern United States. As part of a larger effort, this research is assessing the impacts of loosestrife on phosphorus throughput from the watershed to a downstream lake. This project involves artificial wetlands in the greenhouse and a series of field plots in which decomposition and nutrient cycling is measured.

Location of Research: Twin Cities metropolitan area

Dates: 01/89—12/91

Funding Source: Minnesota Department of Natural Resources

Funding Amount: \$30,000

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project: 0

Related Research Publications:

Emery, S., J.A. Perry, and N.H. Troelstrup, Jr. 1990. Dynamics of phosphorus and biomass among wetlands undergoing transition from cattail (*Typha* spp) to purple loosestrife (*Lythrum salicarium*). Presented at the 52nd Annual Midwest Fish and Wildlife Conference, Minneapolis.

262

Wetland Conservation: The Effectiveness of Restoration

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Project Description: Wetlands are under constant pressure from development and developers are often required to restore and/or replace damaged wetlands. In this project, we are developing a new monitoring technique, based on the population dynamics of adult dragonflies, to assess the "quality" of natural versus restored wetlands.

Location of Research: Twin Cities metropolitan area

Dates: 01/89—12/91

Funding Source:

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

Bioassessment of Prairie Pothole Wetlands for Impacts from Insecticides and Herbicides**Mary G. Henry, Michael W. Tome, and Stanley L. Smith**

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200 Hodson Hall
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Project Description: Most prairie potholes important to waterfowl occur in an agricultural landscape and are subject to inputs of pesticides. Recent U.S. Fish and Wildlife Service research detected duckling mortality and reductions in aquatic vertebrate populations in wetlands after normal application of agricultural insecticides to the surrounding cropland (Grue et al. 1988, Tome in prep.). The objectives of this research are to: 1) evaluate the usefulness of toxicity tests in measuring pesticide toxicity common in wetlands adjacent to crops sprayed with insecticides, 2) evaluate the impact of insect pest control using esfenvalerate (Asana[®]) on aquatic invertebrate populations important in diets of breeding waterfowl, and 3) determine how much drift of pesticide occurs.

In 1990 invertebrates were sampled in wetlands adjacent to fields sprayed with Asana[®], in wetlands adjacent to fields not sprayed with Asana[®], and in wetlands within waterfowl production areas where spraying is prohibited. Invertebrates were sampled with sweep nets and core samplers on the day before spraying, the day after spraying, and once a week for 28 days after spraying. One toxicity test, MICROTOX[®], suggested the presence of a contaminant in samples from two of the sampling stations in wetlands adjacent to agricultural fields that were not sprayed. These samples are undergoing further chemical analysis. Preliminary analysis of the invertebrate data characterizes communities in these Type II-III wetlands but indicates that due to no wind and very accurate aerial application, little pesticide drift occurred. Follow-up studies are being conducted to examine Asana's[®] impact when the pesticide does enter the wetland.

Location of Research: Morris, Minnesota; Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota; Patuxent Wildlife Research Center, Maryland; and U.S. Fish and Wildlife Service Fish and Wildlife Enhancement, St. Paul, Minnesota

Dates: 06/90—09/93

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

Grue, C.E., M.W. Tome, G.A. Swanson, S.M. Borthwick, and L.R. DeWeese. 1988. Agricultural chemicals and the quality of prairie-pothole wetlands for adult and juvenile waterfowl: What are the concerns? In *Proceedings of the National Symposium on Protection of Wetlands from Agricultural Impacts*, ed. P.J. Stuber, 55-64. USDI Fish and Wildlife Service Biological Report 88(16).

264

Biological and Chemical Effects of Snowmelt on Wetlands on the Upper Midwest

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Project Description: Acid deposition is one of a number of problems threatening the quality of aquatic resources. As the quality and quantity of Minnesota's wetlands decrease each year, it is critical that existing habitat is capable of supporting waterfowl populations. The need for investigation into acid deposition effects on wetlands is two-fold. First, the degree and extent of acid deposition occurring across waterfowl habitat and its influence on wetland chemistry needs to be determined. Second, there is a need to determine whether the acidification of wetlands results in a reduction in the invertebrate food base that is essential to egg-laying female waterfowl.

This study is being conducted on seventeen seasonal wetlands located in central, western and northwestern Minnesota on U.S. Fish and Wildlife Service Waterfowl Production Areas. Seasonable wetlands are used extensively by waterfowl in early spring, before most of the larger, more permanent wetlands have lost their ice. Also, seasonal wetlands typically dry up in late summer. Therefore, there is no water present to dilute the pulse of water entering the wetland during the spring snowmelt.

Snow and water samples were collected during 1990 and analyzed for a variety of chemical parameters. There were a few depressed pH values for snow from the eastern portion of the study area. Unfortunately, no corresponding water samples were collected due to drought conditions last spring. Snow samples were collected again in 1991. Laboratory microcosm experiments will be conducted to assess the effect of snowmelt on invertebrate community diversity, abundance and emergence.

Location of Research: Western Minnesota; Minnesota Cooperative Fish and Wildlife Research Unit, University of Minnesota

Dates: 06/89—03/92

Funding Source: U.S. Fish and Wildlife Service

Funding Amount:

Number of Graduates Working with Project: 1

Number of Undergraduates Working with Project:

Related Research Publications:

265

Assessing Recovery of Freshwater Wetland Water Quality Status

Naomi E. Detenbeck

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University of Minnesota, Duluth
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(218) 720-4279

Project Description: Despite existing state and federal regulations to protect wetlands from further loss, wetland loss and degradation of wetland water quality continues. Wetland managers and regulatory agencies need additional information to quantify the values of wetlands with respect to their water quality functions, the response of those functions to physical and chemical disturbances, and the rate of recovery of wetland water quality status and function. Under previous funding from the

EPA, 55 wetland sites were exposed to a variety of physical and chemical disturbances like dredging, wetland fill, pesticide applications, draining, and stormwater or pumped groundwater inputs. The impact of these disturbances on wetland water quality status and function were monitored. In this follow-up study, the recovery of wetland water quality status and function is being assessed.

Location of Research:

Dates: 06/91—05/92

Funding Source: U.S. Environmental Protection Agency

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

266

Development of Macroinvertebrate Indicators for Monitoring Effects of Nonpoint Source Pollution in Wetlands

Naomi E. Detenbeck and Anne Hershey

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: Aquatic insect communities have traditionally been used as indicators of the ecological health of stream ecosystems, but their utility as indicators of the health of wetland systems is unknown. This research will collect and analyze macroinvertebrate data for wetlands that have been exposed to a range of levels of urban or agricultural nonpoint source pollution to identify suitable indicators specific to wetland systems.

Location of Research:

Dates: 06/91—06/92

Funding Source: U.S. Environmental Protection Agency

Funding Amount:

Number of Graduates Working with Project:

Number of Undergraduates Working with Project:

Related Research Publications:

267

Evaluation of the Effects of Methoprene and BTI in Metropolitan Mosquito Control District Wetlands

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Lyle J. Shannon, and Melbourne C. Whiteside**

Natural Resources Research Institute
University of Minnesota, Duluth
5013 Miller Trunk Highway
Duluth, MN 55811
(218) 720-4279

Project Description: This project will determine whether use of methoprene and BTI for mosquito control causes any long-term disruption to predator-prey interactions in wetland ecosystems. Any direct effect these chemicals may have on non-target species, such as zooplankton, aquatic insects, and bird populations, and any indirect effect their use may have on integrated food webs of wetland ecosystems, are the focus of this study. Research is continuing in 27 wetland sites included in the treatment.

Location of Research: Wright County, Minnesota—27 wetland sites in western part of county

Dates: 04/86—03/95

Funding Source: Metropolitan Mosquito Control District

Funding Amount: \$700,000

Number of Graduates Working with Project: 3

Number of Undergraduates Working with Project: 2

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Numbers refer to project numbers

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Extensive cross references lead the reader to broader, narrower, and related keywords through *See* and *See also* references. Access to research on very specific subjects is provided by over 290 keywords that have been used for only one or two entries. Geographic names, when significant to a research project, are included as keywords.

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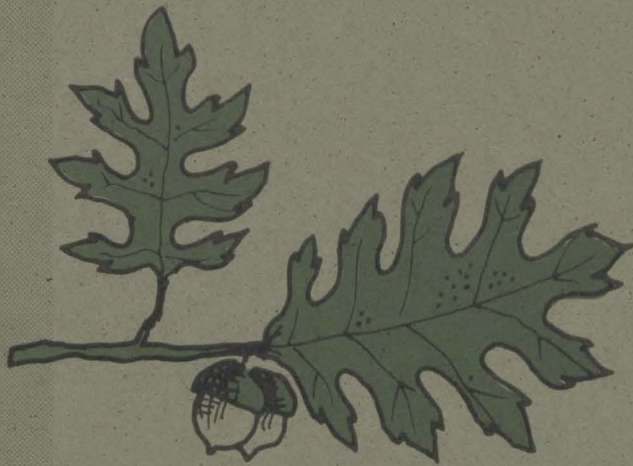
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