



## **Biennial Report**

**January 1999 through December 2000**

Minnesota Cooperative Fish and Wildlife Research Unit  
Biennial Report  
January 1999 – December 2000

U.S. Geological Survey – Biological Resources Division  
Minnesota Cooperative Fish and Wildlife Research Unit  
Department of Fisheries, Wildlife, and Conservation Biology  
200 Hodson Hall  
1980 Folwell Avenue  
St. Paul, MN 55108  
Phone: (612) 624-3421  
Fax: (612) 625-5299

Unit Cooperators:  
University of Minnesota  
U.S. Geological Survey  
Minnesota Department of Natural Resources  
The Wildlife Management Institute  
U.S. Fish and Wildlife Service

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# INTRODUCTION

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The Cooperative Fish and Wildlife Research Units Program was established to facilitate cooperation among the U.S. Department of the Interior (currently through the U.S. Geological Survey-Biological Resources Division), universities, state fish and wildlife agencies, and private organizations, by developing and conducting programs of research and education related to fish and wildlife resource conservation. The Minnesota Cooperative Fish and Wildlife Research Unit emphasizes research on impacts of human activities on aquatic and terrestrial ecosystems that are of state, regional, and national significance. Our research program addresses not only the biological, but also social and economic aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems.

The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987, and staffed beginning in 1988. This is the 6<sup>th</sup> biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 1999 and 2000. This period has been one of relative stability for our Coop Unit, in that there have been no major structural reorganizations within the federal system that directly affected the Unit Program. However, in 1999, Gerda Hagen retired from her position as Unit secretary/office manager. Gerda had been with the Unit since 1988. Fortunately, Teri Kanikula filled the vacancy left by Gerda's retirement and has kept the Unit running smoothly.

Over the past two years, support for the Unit program in general, and for our Unit in particular, has been as strong as it has ever been. We have worked with a wide range of cooperators, outstanding graduate students, and many university and federal scientists and resource managers to further our research, teaching, and technical assistance mission. We invite you to review the summary of our Unit's accomplishments and to contact us with comments or to request additional information. Thanks to our many partners!

Sincerely,

Dr. David E. Andersen, Leader  
Minnesota Cooperative Fish and Wildlife Research Unit

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# TABLE OF CONTENTS

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INTRODUCTION .....	i
PERSONNEL AND COOPERATORS .....	iv
Unit Personnel .....	iv
Unit Coordinating Committee .....	vii
Unit Cooperators.....	viii
COMPLETED RESEARCH.....	1
Applied Ecology .....	1
Age and Growth of Lake Herring in Lake Superior.....	2
Fall Local Movements, Foraging, and Population Dynamics of Tundra Swans on the Upper Mississippi River.....	3
Microhabitat Selection, Spawning Behavior, and Growth of Three Trout .....	5
Review of Research Pertaining to Northern Goshawk ( <i>Accipiter gentilis</i> ) in the Western Great Lakes Region and Ontario.....	7
Human Activities, Management, and Conservation.....	8
Assessing Human Dimensions Research Needs: a Workshop and Pilot Project Initiation on the Human Dimensions of Natural Resources.....	9
Breeding Ecology of Forest-nesting Birds in North-Central Minnesota.....	10
Citizen Monitoring: Can Widely-used Protocols Discriminate Benthic Communities in Relation to Land Management Changes? .....	11
Data Acquisition, Analysis, and Presentation in Support of Comprehensive Management Planning.....	12
Development of a Research and Monitoring Framework for Northern Goshawks in the Western Great Lakes Region.....	13
Evaluation of the Effects of the Grass Lake Wetland Restoration on Migratory Birds .....	14
Foraging Behavior of California Sea Lions at San Miguel Island, California.....	15
Larval Fish Populations on Tributaries of the Red River.....	16
Stream Fish Distribution and Habitat in Relation to Land Use, Geology, and Geomorphology in Southeastern Minnesota .....	17
Winged Mapleleaf Mussel ( <i>Quadrula fragosa</i> ) Host Fish Experiments, Phase II ....	18
ONGOING RESEARCH.....	19
Applied Ecology .....	19

Eastern Prairie Population Canada Goose Breeding Ecology.....	20
Ecology of Oak Savanna Birds at Sherburne National Wildlife Refuge .....	21
Fall Movements, Habitat Use, and Survival of the American Woodcock in the Western Great Lakes .....	22
Great Lakes Colonial Waterbird Survey .....	23
Home Range and Habitat Use of Breeding Northern Goshawks in North-central Minnesota.....	24
Inventory of Northern Goshawks on the Superior National Forest .....	25
Modeling the Environmental Impacts of Farming Systems in Two Watersheds in Minnesota.....	26
Review of Research Pertaining to Double-crested Cormorants in the Eastern U.S...	27
Trophic Cascade Interactions in a Coldwater Stream .....	28
Human Activities, Management, and Conservation.....	29
Assessing Social-psychological Aspects of Deer Management in Cuyahoga Valley National Recreation Area.....	30
Assessment of Use and Benefits of Waterfowl Production Areas in Minnesota.....	31
Breeding Biology and Management of the Great Lakes Piping Plover Population 2000-2002.....	32
Constraints and Opportunities for Quality Trout Angling Experiences in Southeastern Minnesota.....	33
Evaluating Decision-Processes: Case Studies of Fisheries Issues in Minnesota .....	34
Geospatial Technologies for National Wildlife Refuge Planning and Management.	35
Inventory of Heather Vole and the Northern Bog Lemming on the Superior National Forest .....	36
Minnesota Waterfowl Hunter Survey .....	37
Trends on Fisheries Issues in Minnesota.....	38
Understanding Visitor Uses, Motives, and Benefits at Sherburne National Wildlife Refuge .....	39
ACTIVITIES.....	40
PUBLICATIONS .....	41
COMPLETED THESES AND DISSERTATIONS OF MINNESOTA COOP UNIT STUDENTS .....	44
PRESENTATIONS .....	49
HONORS AND AWARDS .....	52
UNIT NEWS.....	53

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# PERSONNEL AND COOPERATORS

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## Unit Personnel

UNIT STAFF – U. S. GEOLOGICAL SURVEY - BIOLOGICAL RESOURCES DIVISION  
COOPERATIVE RESEARCH UNITS

Dr. David E. Andersen, Unit Leader

Dr. Bruce Vondracek, Assistant Leader-Fisheries

Dr. David C. Fulton, Assistant Leader-Wildlife

UNIT STAFF – UNIVERSITY OF MINNESOTA

Dr. Clint W. Boal, Postdoctoral Research Fellow

Gerda Hagen, Principal Secretary (January 1999 through April 1999)

Teri Kanikula, Principal Secretary (May 1999 through December 2000)

Ted Dick, Research Associate

Dr. David Plumpton, Research Associate

Beau Liddell, Research Associate

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UNIT STUDENTS

Leakhena Au, M.S. (Andersen)  
Kristen L. Blann, Ph.D. (Vondracek)  
Leigh Currie, M.S. (Fulton)  
Erin Dougherty, M.S. (Fulton)  
John Epton, M.S. (Fulton)  
Julia A. Frost, Ph.D. (Vondracek)  
Gerold C. Grant, Ph.D. (Vondracek; graduated 1999)  
Julie Henry, Ph.D. (Vondracek)  
James C. Manolis, Ph.D. (Andersen and Cuthbert; graduated 1999)  
Maija Meneks, M.S. (Vondracek; graduated 2000)  
Robert Nack, M.S. (Andersen)  
Fiona Nagle, M.S. (Vondracek and Fuitak)  
Brian A. Nerbonne, M.S. (Vondracek; graduated 1999)  
Aimee Roberson, M.S. (Andersen)  
Jon Rosales, Ph. D. (Fulton and Spangler)  
Carl R. Ruetz, Ph.D. (Vondracek)  
John Sammler, M.S. (Andersen)  
Grant Spickelmier, M.S. (Fulton)  
Elizabeth Weaver, M.S. (Fulton and Cuthbert)

UNIT AFFILIATED STAFF AND STUDENTS

Allison B. Coffin, M.S. (Spangler)  
Samantha Hayes, M.S. (Anderson)  
Mark Hove (Kapuscinski)  
Sharon Melin, M.S. (Siniff)  
Anup Joshi (Cuthbert)  
Jennifer Hathaway-Stucker (Cuthbert)  
Erik Thorson, M.S. (Cooper)  
Dale Trexel, M.S. (Cuthbert)  
Lauren Wemmer, Ph.D. (Cuthbert)  
Stephanie West Todhunter, M.S. (Spangler)  
Linda Wires (Cuthbert)

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### UROP RECIPIENTS AND FACULTY SPONSORS

The Undergraduate Research Opportunity Program (UROP) is a University-wide competitive program that supports undergraduate research projects. Twice a year, students may apply by writing a proposal with the assistance of a faculty advisor.

<b>Name</b>	<b>Year</b>	<b>Title of Project</b>	<b>Faculty Sponsor</b>
Paul Mastbaum	2000	Dietary information of goshawks as it relates to habitat and reproduction	D. Andersen
David Schrader	2000	A test of the predation-risk hypothesis: addition of benthic predators	B. Vondracek

### LIFE SCIENCE SUMMER UNDERGRADUATE RESEARCH PROGRAM PARTICIPANTS AND FACULTY SPONSORS

The Life Science Summer Undergraduate Research Program is a program that supports undergraduate research projects in the life sciences.

<b>Name</b>	<b>Year</b>	<b>Title of Project</b>	<b>Faculty Sponsor</b>
Amy Hurford	2000	Tropic interactions in a small, coldwater Minnesota stream	B. Vondracek

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## Unit Coordinating Committee

### **University of Minnesota**

Dr. Jim Perry, Interim Department Head  
Department of Fisheries and Wildlife  
200 Hodson Hall, 1980 Folwell Avenue  
St. Paul, MN 55108  
(612) 624-4228

Dr. Al Sullivan, Dean  
College of Natural Resources  
235 NRAB, 2003 Upper Buford Circle  
St. Paul, MN 55108  
(612) 624-1234

### **MN Department of Natural Resources**

Tim Bremicker, Chief of Wildlife  
500 Lafayette Road, Box 7  
St. Paul, MN 55155  
(651) 296-3344

Ron Payer, Chief of Fisheries  
500 Lafayette Road, Box 12  
St. Paul, MN 55155  
(651) 296-3325

Lee Pfannmueller, Chief of Ecological  
Services  
500 Lafayette Road, Box 25  
St. Paul, MN 55155  
(651) 296-6157

Mr. Paul J. (Jack) Wingate  
Fisheries Research Manager  
500 Lafayette Road, Box 12  
St. Paul, MN 55155  
(651) 296-0793

Mr. Blair Joselyn (1999)  
Mr. Mike DonCarlos (2000)  
Wildlife Research Manager  
500 Lafayette Road, Box 12  
St. Paul, MN 55155  
(651) 296-0706

### **Wildlife Management Institute**

Dr. Rollin Sparrowe, President  
1101 14th Street N.W., Suite 801  
Washington, D.C. 20005  
(202) 371-1808

Rob Manes, Midwest Field Representative  
10201 S. Hwy 281  
Pratt, KS 67124  
(316) 672-5650

### **USGS - Biological Resources Division**

Dr. Michael W. Tome, Eastern Region  
Supervisor  
Cooperative Research Units  
Leetown Science Center  
1700 Leetown Road  
Kearneysville, WV 25430  
(304) 715-8461 Ext. 297

Dr. Byron Ken Williams, Division Chief  
Cooperative Research Units  
12201 Sunrise Valley Drive, MS 303  
Reston, VA 20192  
(703) 648-4260

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# Unit Cooperators

## UNIVERSITY OF MINNESOTA, DEPARTMENT OF FISHERIES AND WILDLIFE FACULTY

Ira R. Adelman	Kristen Nelson
Yosef Cohen	Raymond M. Newman
James A. Cooper (emeritus)	Andrew M. Simons
Francesca J. Cuthbert	J. L. David Smith
Peter A. Jordan	Peter W. Sorensen
Anne R. Kapuscinski	George R. Spangler
James R. Kitts (retired)	
John Loegering	

## ADJUNCT FACULTY IN THE DEPARTMENT OF FISHERIES AND WILDLIFE

Charles Anderson	Richard Kimmel
Glenn DelGiudice	L. David Mech
Alan Franklin	Donald L. Pereira
David Garshelis	Carl Richards
Frederick J. Jannett	Edward Swain

## DEPARTMENT OF FISHERIES AND WILDLIFE COOPERATING FACULTY WITH APPOINTMENTS OUTSIDE OF THE DEPARTMENT

Jay Hatch  
Donald Siniff  
Anthony Starfield

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FACULTY AS PRINCIPAL INVESTIGATOR IN UNIT RESEARCH

Dorothy Anderson

Paul Bolstad

Thomas E. Burk

James A. Cooper

Francesca J. Cuthbert

Susan M. Galatowitsch

Jay Hatch

Frederick Jannett

Anne R. Kapuscinski

David Lime

Raymond M. Newman

Donald L. Pereira

Donald B. Siniff

George R. Spangler

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COOPERATING UNIVERSITY OF MINNESOTA ACADEMIC UNITS

College of Natural Resources  
Conservation Biology Graduate Program  
Department of Ecology, Evolution, and Behavior  
Department of Fisheries and Wildlife  
Department of Forest Resources  
Fisheries Graduate Program  
Minnesota Institute for Sustainable Agriculture  
College of Agricultural, Food, and Environmental Sciences  
Wildlife Conservation Graduate Program  
Water Resources Graduate Program

COOPERATING STATE AND FEDERAL AGENCIES

Michigan Department of Natural Resources  
Minnesota Department of Natural Resources  
National Park Service  
    Voyageurs National Park  
National Fish and Wildlife Foundation  
National Science Foundation  
University of Minnesota  
University of Wisconsin-Madison  
U.S. Geological Survey-Biological Resources Division  
    Upper Mississippi Science Center  
U.S. Environmental Protection Agency  
U.S. Fish and Wildlife Service  
    Sherburne National Wildlife Refuge  
    Upper Mississippi River National Wildlife and Fish Refuge  
U.S. Forest Service  
    Chippewa National Forest  
    Superior National Forest  
    North Central Forest Experiment Station  
Wisconsin Department of Natural Resources

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# COMPLETED RESEARCH

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## Applied Ecology



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**Project Title: Age and Growth of Lake Herring in Lake Superior**

Investigators: George R. Spangler and Donald L. Pereira

Students: Stephanie West Todhunter, M.S. (Fisheries) and Allison B. Coffin, M.S. (Fisheries)

Duration: September 1993 to December 1998

Funding Source: Minnesota Department of Natural Resources

Project Location: Lake Superior  
University of Minnesota, St. Paul

We constructed environmental growth histories, termed biochronologies, for lake herring (*Coregonus artedii*) from western Lake Superior using scale samples from historical collections. We created chronologies using a linear growth model to describe individual somatic growth. This model decomposes growth (as recorded on a scale or other calcified structure) in to two distinct components, the portion of growth due to intrinsic factors (age effect), and the portion due to environmental factors (year effect). We built a master chronology using all possible scale samples age five or younger, then examined subsets of the data according to collection site (Bayfield

Wisconsin, Black Bay Ontario, French River Minnesota, and Thunder Bay Ontario). The linear growth model best fit the site-specific data, indicating statistically different stock-specific growth rates. These differences were primarily due to environmental growth, as age effects were similar across sites. Our findings demonstrate that the stocks at these four sites are growing at different rates and therefore require different management strategies according to the unit stock concept. Further refinement of these chronologies and coupling with abundance data may allow managers to determine the degree of stock rehabilitation.

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**Project Title: Fall Local Movements, Foraging, and Population Dynamics of Tundra Swans on the Upper Mississippi River**

Investigator: James A. Cooper

Student: Erik Thorson, M.S. (Wildlife Conservation)

Funding Sources: U.S. Fish and Wildlife Service  
Upper Mississippi Science Center  
Upper Mississippi River National Wildlife & Fish Refuge  
Wisconsin Department of Natural Resources  
Minnesota Department of Natural Resources

Project Location: Upper Mississippi River  
University of Minnesota, St. Paul

The Upper Mississippi River (UMR) is one of the most important fall stopover sites in North America for the Eastern Population (EP) of the tundra swan (*Cygnus columbianus*). The UMR has held nearly 30,000 swans at peak population or nearly one-third of the EP. Tundra swan use of this reach of the Mississippi River has increased dramatically over the past decade. The study area, Pools 4 through 9, includes approximately 180 km of river between Wabasha, MN and Harpers Ferry, IA. The UMR is currently managed for commercial navigation, which has created a series of pools. In general, the upper portions of the pools are similar to the river before impoundment. They contain a complex of bottomland forest and backwater sloughs, with relatively small ponds, lakes, and streams. The lower portion of the pools resembles shallow reservoirs. They consist of large open expanses of water, with scattered small wooded islands. This reach lies within the boundaries of the Upper Mississippi River National Wildlife and Fish Refuge (UMRNW&FR) and Trempealeau National Wildlife Refuge (TNWR). The refuges contain administrative closed areas, which are subject to regulations that restrict fall hunting and trapping. A survey, telemetry, and banding study were conducted in 1998 and 1999 to investigate swan population dynamics, local movements, home range size, habitat use, weights, and measurements in fall.

Thirty-seven University of Minnesota (UM) and U.S. Fish and Wildlife Service/ Wisconsin Department of Natural Resources (FWS/DNR) aerial surveys were completed on a biweekly basis to record swan numbers. In addition to recording total swan numbers, UM surveys also estimated cygnet numbers through ocular estimates and videography. Analog video (S-VHS) was converted to digital video (DV format), and then saved as adjacent digital still images. Each of these 1,615 images were interpreted and the total number of swans, number of cygnets, and family sizes of isolated family groups were determined. Immature to adult ratios and swan use-days were calculated. Forty-three adults were captured and radio-marked in the fall of 1998 and 1999. Forty-nine adults were tracked with telemetry equipment. The 49 swans tracked included 6 swans radio-marked in 1998 that returned in 1999. These radio-marked swans were tracked from aircraft and ground vehicles. Each swan was relocated every 2 to 3 days. During the study period, 1,333 point locations, including 1,278 locations with an estimate of error, were gathered on these marked swans. Point locations were used to estimate length of stay in the study area, describe daily and seasonal movements, and determine home range sizes. Locations with an estimate of error, home ranges, and study area boundaries were used to describe habitat use and availability. Compositional analysis was used to determine habitat

selection at 2 levels. Forty-nine adults and 22 cygnets were weighed and measured.

Survey results indicated numbers peaked during late November and swans were present on the river in substantial numbers for over a 2-month period. Peak populations were 20 to 30% of the EP. Swan use-days in the study area were between 0.75 and 1.0 million each year. The average length of stay for radio-marked birds was over 1 month. Use-day and length of stay data indicate a very low turnover rate; so peak populations and number of swans using the river were similar. The age ratios increased from  $< 0.1$  in mid-October to almost 0.3 in mid-November, and then remained stable for the remainder of the stopover period. The average immature to adult ratio in the study area was 0.25 in 1999 compared to 0.12 on the wintering grounds. At peak population, the study area held over 50% of the cygnets in the EP. Average family size was 1.9 in 1999, which is intermediate to family sizes on the breeding and wintering grounds. Radio-marked birds moved extensively using almost 40 km of river, 2 pools, and  $>3$  survey areas on average. Some showed a southward movement within the study area throughout the fall. Night-time use of open areas was significantly greater for the last 3 seasonal periods (5 Nov – 31 Dec), but day-time use of open areas did not increase significantly until the last seasonal period (5 Dec – 31 Dec). During the 2 intermediate periods (5 Nov – 4 Dec), most of the radio-marked swans moved from closed areas into open areas shortly after dark. These movement and use patterns were probably related to human disturbance and food availability. Radio-marked swans had large seasonal home range sizes,  $>5,000$  ha. The fall seasonal home ranges were much larger

than those reported for late summer and breeding territories. Non-breeding swans had seasonal home ranges that were twice as large as breeder home ranges. Swans selected aquatic vegetation, shallow water depths, water, smaller islands, aquatic areas with flow, and administrative closed areas. Swans avoided developed land, deep water, larger land masses, channels, and administrative open areas. Males were larger than females and adults were larger than cygnets. Adults and cygnets on the UMR appear to be in better condition than birds on the wintering grounds based on weights and condition indices. Condition of adults and cygnets on the UMR appears to improve throughout the fall, although this trend was non-significant and based on small samples.

Based on these data, high quality tundra swan stopover habitat consists of large wetland complexes including an abundance of aquatic vegetation in shallow water depths ( $<1.2$  m) interspersed with small islands ( $<5$  ha) within a large open aquatic area, protected from human disturbance. The UMR fall stopover site is vitally important to energetically stressed cygnets. It, along with other fall stopover sites, allows cygnets to rest, feed, and develop, so they can complete their first migration to the wintering grounds. The current high cygnet mortality would likely increase and possibly limit population growth, if some fall stopover sites were eliminated or their quality was diminished. These sites can support large portions of the population for substantial periods of time and may be worthy of more management and research emphasis.

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**Project Title: Microhabitat Selection, Spawning Behavior, and Growth of Three Trout**

Investigator: Bruce Vondracek

Student: Gerold Grant, Ph.D. (Fisheries)

Duration: September 1992 to June 1999

Funding Sources: Cargill Fellowship  
Kalamazoo Chapter of Trout Unlimited  
Sigma Xi  
Special Projects Foundation of the Big Game Club

Project Location: Valley Creek, Washington County, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

To determine if there was niche partitioning that limited interspecific competition for food or space between sympatric brown and rainbow trout, we investigated diet, microhabitat use, and feeding behavior in Valley Creek, Minnesota. Yearling trout of both species relied primarily on drifting prey; age-1 brown and rainbow trout made an average of 84.7% and 88.6% of their feeding forays in the water column, respectively. Benthic organisms comprised 40.2% of age-1 brown trout prey biomass and 24.9% of age-1 rainbow trout prey mass. Adult brown trout consumed progressively more benthic items as they grew older. Benthic prey accounted for 56.4% and 52.4% of age-2 and 3+ brown trout prey biomass, respectively. Age-2 rainbow trout made 90.6% and age-3+ rainbow trout made 82.1% of feeding forays in the water column and benthic taxa accounted for 23.9% and 25.9% of their prey biomass, respectively. These different feeding strategies suggest mechanisms for reduced interaction between brown and rainbow trout.

We quantified habitat availability and developed site-specific predictions of microhabitat use. We quantified microhabitat use of brown and rainbow trout from direct underwater observation using video cameras. Trout of both species used progressively deeper and slower microhabitats as they grew. Smaller trout

used locations towards the head and tail of the pool or closer to the stream margins while the largest trout used the deepest habitat available in Valley Creek. This ontogenetic habitat shift resulted in drift-feeding models predicting feeding locations more accurately for some age groups than others. The fact that both species chose similar habitats despite having different feeding strategies suggests other factors play a role in microhabitat selection. Thus, drift-feeding models based on energetics may not be useful in testing mechanisms of species replacement.

We characterized spawning behavior and diurnal activity patterns in sympatric populations of native brook and introduced brown trout in a Minnesota stream to examine potential reproductive isolating mechanisms. There was no indication of any isolating mechanisms that might prevent interspecific courtship and hybridization between these species. We observed hybridization during four of ten spawning events in the main creek channel. Hybridization occurred both by interspecific pairing between male brown trout and female brook trout, and by sneaking of male brook trout. Male brook and brown trout spent similar amounts of time courting females of both species. Thus, there was no evidence of isolating mechanisms preventing males from courting heterospecific females. Female spawning

behaviors did not differ when courted by heterospecific males. Spawning behaviors appear identical between species, except the method by which females cover eggs, which occurs after fertilization. Both species were active on spawning redds throughout the day and night, and spawning occurred

throughout the day. Male brown trout may be more successful at pairing with females of both species due to their larger size. Interspecific spawning interactions and hybridization probably play a role in the replacement of native brook trout by introduced brown trout.

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**Project Title: Review of Research Pertaining to Northern Goshawk (*Accipiter gentilis*) in the Western Great Lakes Region and Ontario**

Investigator: David E. Andersen

Students: Ted Dick, M.S. (Wildlife Conservation) and David L. Plumpton, Ph.D. (Wildlife Conservation)

Duration: May 1997 to December 1998

Funding Source: U.S. Fish and Wildlife Service

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Northern goshawks (*Accipiter gentilis*) have been the subject of considerable conservation concern, especially in the southwestern U.S., the Pacific Northwest, and southeast Alaska. Several petitions for listing under the federal Endangered Species Act have been filed. In the western Great Lakes Region, northern goshawks are considered a sensitive species by the U.S. Forest Service, and have been considered by several states for listing as species with special status. This project provided an overview of research activities past and present related to northern goshawks in the western Great Lakes Region, and serves as a summary of existing region-specific information on the forest-nesting raptor.

Conclusion: Historical research and results of past and ongoing research provide some basic information concerning goshawk ecology in the western Great Lakes Region. However, there are no data that address many aspects of goshawk ecology (e.g., population dynamics, food habits, habitat associations) at a regional scale. This research review is available as a project report for the Minnesota Cooperative Fish and Wildlife Research Unit and is also scheduled for release as a U.S. Fish and Wildlife Service report

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# COMPLETED RESEARCH

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## Human Activities, Management, and Conservation



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**Project Title: Assessing Human Dimensions Research Needs: a Workshop and Pilot Project Initiation on the Human Dimensions of Natural Resources**

Investigators: David C. Fulton, David Lime, and Dorothy Anderson

Duration: March 1999 to December 2000

Funding Source: U.S. Fish and Wildlife Service  
U.S. Geological Survey – Biological Resources Division

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

During the past 30 years, there has been a growing interest in the “human dimensions” of natural resources. For example, fish and wildlife managers face an increasingly complex management environment that now includes many diverse public stakeholders who demand an active role in fish and wildlife decision-making. For such reasons, most managers are now aware that solving natural resource issues requires understanding the socio-political environment as well as understanding biological and ecological principles.

Despite the recognition that human dimensions information is important to managing natural resources, most natural resource professionals still lack specific answers to the practical question, “What can human dimensions information and research do for me?” A workshop was conducted to address this question and identify management issues and problems that could

benefit from human dimensions research. The primary purpose of the assessment was to gain input from stakeholders (land managing agencies in the USDI), identify and prioritize resource management issues that could benefit from human dimensions research, and initiate new studies to address human dimensions of fisheries and wildlife management issues with the U.S. Fish and Wildlife Service.

Conclusion: A workshop was conducted in February 2000 that provided a forum to identify and discuss resource management issues that could benefit from human dimensions research. The workshop was organized around two themes: visitor use issues and community issues. A summary of the workshop has been published that includes review articles of speaker sessions and summaries of small group exercises designed to identify research needs.

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**Project Title: Breeding Ecology of Forest-nesting Birds in North-central Minnesota**

Investigator: David E. Andersen

Students: James C. Manolis, M.S./Ph.D. (Conservation Biology); Ethan Perry, M.S. (Wildlife Conservation)

Duration: May 1997 to June 2000

Funding Sources: U.S. Global Climate Change Research Program  
U.S. Geological Survey – Biological Resources Division

Project Location: Chippewa National Forest (North-central Minnesota)  
Minnesota Cooperative Fish and Wildlife Research Unit

Considerable concern exists regarding the status and population trends of nongame birds, especially in the eastern U.S. However, little information is available regarding nesting success and productivity for many species, and the impacts of forest management practices on nesting birds in predominantly forested landscapes is not well understood. From 1992 through 1998, we monitored nesting and reproduction of forest-nesting birds on from 4-6 40-50 ha plots on the Chippewa National Forest in north-central Minnesota. Northern Minnesota is thought to serve as an important source area for many forest-nesting birds, as it remains predominantly forested. As an extension of a previous study, we located and monitored 1,673 nests of 47 species over a 7-year period. We also conducted 2-4, 100 m fixed radius counts annually at permanent point count stations from the beginning of June to mid-July each year. Vegetation and habitat variables were

measured at all nest and point count locations. Fractional nesting success estimates (data pooled across years) were 0.55 for all species combined ( $n = 1,231$ ) and 0.42 for neotropical migrants ( $n = 927$ ). Mayfield estimates of nesting success were 0.48 for least flycatchers ( $n = 643$ ), 0.45 for ovenbirds ( $n = 326$ ), 0.38 for red-eyed vireos ( $n = 129$ ), 0.23 for hermit thrushes ( $n = 45$ ), and 0.94 for yellow-bellied sapsuckers ( $n = 242$ ). Ovenbirds and yellow-bellied sapsuckers exhibited low annual variation in nesting success and least flycatchers exhibited high annual variation in nesting success. Nest predation was the primary cause of nest failure on the plots. As components of this project, we also investigated the occurrence of edge effects in a predominantly forested landscape, factors affecting aggregated nesting in least flycatchers, and methodological issues related to estimating nesting success in forest-nesting birds.

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**Project Title: Citizen Monitoring: Can Widely-used Protocols Discriminate Benthic Communities in Relation to Land Management Changes?**

Investigator: Bruce Vondracek

Student: Julia Frost, M.S. (Fisheries)

Duration: June 1997 to June 1999

Funding Sources: National Fish and Wildlife Foundation  
Department of Fisheries and Wildlife

Project Location: Goodhue County, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

In the past ten years, biological monitoring has become a popular way to identify pollution problems and to categorize stream quality as poor, fair, good, or excellent. Invertebrate metrics have given researchers the ability to compare the relative health of different streams and to understand how the biotic community responds to changes in land use. Our objectives were: 1) survey the macroinvertebrate community in a small, diversely utilized watershed in southeastern Minnesota to determine whether there were differences in the macroinvertebrate community within the range of different types of current land use, and 2) investigate the ability of existing national monitoring protocols to serve the needs of farmers and citizen volunteers.

Conclusions: Objective 1) Macroinvertebrate community metrics were not significantly different among riparian management practices but were affected by microhabitat conditions. Macroinvertebrates may not be an appropriate monitoring tool for assessing the effects of local management practices at the scale of a single farm, rather they should be used on a broader temporal and spatial scale in the context of a whole watershed. Objective 2) Tolerance values for the

Save our Streams (SOS) method indicated lower water quality than family-level or species-level tolerance metrics. The SOS may not be precise enough to detect differences in macroinvertebrate community composition or associated habitat quality. In addition, we found that monitoring is challenging for untrained volunteers. Volunteers were biased during sorting a sub-sample of organisms, selecting larger organisms more often than trained biologists. Untrained volunteers were not able to consistently identify organisms correctly. If macroinvertebrate monitoring programs are to be effective, significant time must be devoted to training volunteers. Locally developed keys should be made available. We conclude that for volunteer macroinvertebrate monitoring to be an effective tool, we must focus on helping volunteers produce accurate results that will keep these programs active over a long period of time. To address problems encountered with the SOS protocol we created a new monitoring protocol, specific to the SE Minnesota region, that will be better serve local communities.

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**Project Title: Data Acquisition, Analysis, and Presentation in Support of Comprehensive Management Planning**

Investigator: Thomas E. Burk

Duration: May 1998 to September 2000

Funding Source: U.S. Fish and Wildlife Service

Project Location: Minnesota Valley, DeSoto, Ottawa Complex, Shiawassee, Swan Lake, and Squaw Creek National Wildlife Refuges  
University of Minnesota, St. Paul

As a public land managing agency, the U.S. Fish and Wildlife Service (FWS) policy is to manage its lands in accordance with an approved Comprehensive Management Plan (CMP). The FWS is expanding its efforts to complete CMPs for its lands within Minnesota, Wisconsin, Michigan, Iowa, Illinois, Indiana, Ohio, and Missouri. To ensure that FWS lands contribute to the conservation of biological diversity and to the structure and function of the ecosystem in which they are located, it is necessary to acquire, analyze, and present data in a geo-referenced system. Much data exist, but they are commonly not organized in a way that is useful for specific study areas. In some cases data are available, but not in digital form. In those instances, data must be converted into a digital format. Once the data are

organized in a compatible system, they must be further manipulated so that their presentation is understandable to managers and the public. This project was designed to facilitate acquisition and management of these data.

The objective of this cooperative research was to develop a prototype geographic information system to aid the CMP process on national wildlife refuges. The objective was successfully met by developing and implementing components of a system as they applied to six different national wildlife refuges: Minnesota Valley, DeSoto, Ottawa Complex, Shiawassee, Swan Lake, and Squaw Creek. GIS development and example implementation are described in the six-paper final report for this project.

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**Project Title: Development of a Research and Monitoring Framework for Northern Goshawks in the Western Great Lakes Region**

Investigators: David E. Andersen and Patricia L. Kennedy (Colorado State University)

Duration: May 1998 to April 1999

Funding Sources: U.S. Fish and Wildlife Service  
Minnesota Department of Natural Resources  
National Council of the Paper Industry for Air and Stream Improvement  
College of Natural Resources (University of Minnesota)  
Minnesota Cooperative Fish and Wildlife Research Unit  
U.S. Forest Service  
Wisconsin Department of Natural Resources  
Michigan Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Northern goshawks have been the subject of considerable conservation concern, especially in the southwestern U.S., the Pacific Northwest, and southeast Alaska. Several petitions for listing under the federal Endangered Species Act have been filed. In the western Great Lakes Region, northern goshawks are considered a sensitive species by the U.S. Forest Service, and have been considered by several states for listing as a species with special status. This project provided a framework for research and monitoring of northern goshawks in the western Great Lakes region. The resulting

protocol and project report can be downloaded at [www.fw.umn.edu/CO-OP/Co-op.html](http://www.fw.umn.edu/CO-OP/Co-op.html).

Conclusion: Currently, no data exist or are being collected to estimate goshawk population size or trends at the scale of the western Great lakes Region. In the final project report, we evaluate the utility of existing data and data collection efforts in a regional context and suggest approaches to coordinate and develop regional assessment and monitoring of northern goshawks.

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**Project Title: Evaluation of the Effects of the Grass Lake Wetland Restoration on Migratory Birds**

Investigators: David E. Andersen, James A. Cooper, Francesca J. Cuthbert, and Susan Galatowitsch

Student: Beau Liddell, M.S. (Wildlife Conservation)

Duration: September 1997 to January 1999

Funding Source: U.S. Fish and Wildlife Service

Project Location: Grass Lake, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

One of the primary justifications for restoring wetlands through the North American Waterfowl Management Plan program is to provide benefits to migratory birds and other wildlife. However, there is currently not a plan in place to monitor use of these, or most other, restored wetlands by migratory birds, or to evaluate the effects of restoration on birds and other wildlife. Wetland restoration at Grass Lake and the Eagle Lake wetland complex in northern Iowa affords a unique opportunity to

evaluate and monitor response of migratory birds to wetland restoration. The purpose of this initial project was to develop research protocols and plans to evaluate the effects of these restorations and to collect baseline data prior to lake restoration. Initial surveys for breeding birds were established and conducted at the Grass Lake site in 1998, and a final report was submitted to the U.S. Fish and Wildlife Service for this portion of the project. Delays in the restoration of Grass Lake have postponed further work.

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**Project Title: Foraging Behavior of California Sea Lions at San Miguel Island, California**

Investigator: Donald B. Siniff

Student: Sharon Melin, M.S. (Conservation Biology)

Duration: September 1996 to June 2000

Funding Sources: National Marine Mammal Laboratory, Seattle, Washington

Project Location: University of Minnesota, St. Paul  
San Miguel Island, California

The at-sea distribution and diving behavior of lactating California sea lions were studied during the non-breeding season, 1992-1996 and breeding season in 1995. Satellite Linked Time-Depth Recorders (SLTDRs) were used to determine locations of females while at-sea and SLTDRs and TDRs were used to obtain diving information. Females made 20-44 trips to sea during the 6-month non-breeding seasons and 8 trips during the 1-month breeding season. Annual average traveling distances ranged from 77.7 to 194.3 km from San Miguel Island. Females foraged northwest of San Miguel Island along the coast in the breeding season. During the non-breeding season, the at-sea distribution was more random in both directions from and distance west and northward from San Miguel Island. Females showed a range of foraging distance patterns: some consistently foraging close, some far away, and some both close and far from San Miguel Island. Dive depths were generally shallow, <75 m, and short duration,

<2 min. The maximum depth was 536 m and the maximum dive duration was 15 min, considerably deeper and longer than previously reported. Approximately 13% of the dives exceeded the estimated aerobic dive limit (ADL). Annual difference in diving behavior were not significant except that females dove deeper and had longer dives during the springs of the 1992-93 El Niño event that during the non-El Niño year. Females rarely used the proposed ATOC ZOI area off Pt. Sur, California during the non-breeding season. Fifty-percent of the females instrumented in 1993 used the area compared to 25% and 16.7% in other years. The increased use of the area in 1993 was probably due to prey distribution during the El Niño conditions in 1993. Less than 25% of all locations for each female using the area occurred in the ATOC ZOI area, indicating that this area is not a primary foraging area for lactating California sea lion females.

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**Project Title: Larval Fish Populations on Tributaries of the Red River**

Investigators: Bruce Vondracek and Jay Hatch

Student: Maija Meneks, M.S. (Fisheries)

Duration: January 1998 to June 2000

Funding Source: Minnesota Department of Natural Resources

Project Location: Polk, Norman, Clay, and Wilkin Counties, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

Information on early life stages of fishes in tributaries of the Red River of the North is needed for policy recommendation in relation to extensive alteration of streams and land use practices within the watershed. The extent to which these changes have affected fish production in the tributaries is unknown. This study addressed questions about the distribution of larval fishes as related to available habitat, chronology of reproduction of each species, and effects of stream alteration on fish communities. Specifically, we compared larval fish assemblage and abundance in relation to tributary characteristics, degree of alteration, availability of habitats, and described

phenology of larval fish production in tributaries. Study sites include channelized and unchannelized reaches of the Buffalo and Sandhill Rivers, major tributaries to the Red River.

Conclusions: We found a higher number of species and a higher percentage of larval fish in unchannelized stream within both river basins. Fathead minnows (*Pimephales promelas*) dominate samples from channelized sites. A higher percentage of species tolerant of habitat degradation, especially fathead minnows and carp (*Cyprinus carpio*), are found in channelized reaches.

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**Project Title: Stream Fish Distribution and Habitat in Relation to Land Use, Geology, and Geomorphology in Southeastern Minnesota**

Investigator: Bruce Vondracek

Student: Kristen Blann, M.S. (Conservation Biology)

Duration: September 1997 to August 1999

Funding Source: Minnesota Department of Natural Resources

Project Location: Root, Zumbro, and Cannon River Watersheds  
Minnesota Cooperative Fish and Wildlife Research Unit  
Minnesota Department of Natural Resources

Stream ecologists stress the need to understand the relative influences on stream processes of effects at different scales. Concern over the alarming rate of habitat alteration and increasing pressure on aquatic systems has translated into primarily site-level restoration and management strategies, while larger-scale processes (at the watershed or subwatershed level) that may account for many of the observed habitat losses at a site are left unresolved or remain poorly understood. Existing data on hydrology and hydrography, geology, stream morphology, and land use were combined in a geographic information system (GIS) with Minnesota Department of Natural Resources stream survey data regarding physical habitat, presence/absence and relative abundance of stream fish, and patterns of assemblage structure in fish communities in three major watersheds in southeastern Minnesota. We analyzed stream survey data in relation to topography, land use, geology, and soil type at a watershed and a 100 m riparian scale to identify patterns in the distribution of fish, but specifically focused on brook and brown trout and sculpin. Our objectives were to a) identify landscape-level patterns in fish

species distributions, b) characterize relationships between drainage basin variables and instream fish habitat, and c) develop a model for identifying and classifying southeastern Minnesota streams according to their potential for rehabilitation, maintenance, protection, or restoration based on fish community composition.

Conclusions: Geology and topology govern stream characteristics, but land uses such as forest cover affect thermal regimes, which in turn influence the suitability of streams for aquatic life. Landscape characteristics at the watershed and buffer scale accounted for 20-40% of the variance in fish metrics using redundancy analyses. Land use variables explained only a small portion of variance in ordinations where topographic and geologic variables were included. Percent deciduous forest, slope, stream gradient, and bedrock associations were positively correlated with fish distributions, especially for age-1+ brook and brown trout. Cultivated land use was negatively correlated at both scales, but notably at the buffer scale using logistic regression.

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**Project Title: Winged Mapleleaf Mussel (*Quadrula fragosa*) Host Fish Experiments, Phase II**

Investigators: Anne Kapuscinski and Mark Hove

Student: Jennifer Kurth (undergraduate)

Duration: December 1998 to July 2000

Funding Source: U.S. Fish and Wildlife Service, Region 3

Project Location: St. Croix River  
University of Minnesota, St. Paul

The winged mapleleaf [*Quadrula fragosa* (Conrad, 1835)] historically occurred in rivers across eleven U.S. states but now only occurs in a small portion of a few rivers. The glochidial host(s) for this federally endangered species are unknown, which makes it nearly impossible to determine the viability of imperiled mussel populations either in degraded habitats, where they now occur, or in habitats being considered for translocation of mussels. We studied brooding winged mapleleaf in the St. Croix River and in laboratory facilities at the University of Minnesota. Suitable glochidial hosts were determined using a standard artificial infestation protocol. During the brooding period a swollen excurrent aperture was observed among brooding and some non-brooding individuals. Glochidia were released as individuals or in

conglutinates. None of the 48 trials conducted on 28 fish species facilitated glochidia metamorphosis, although two juvenile winged mapleleaf excysted from a channel catfish during a concurrent study. Unfortunately, several catfish succumbed to 'Ich' prior to the end of the study and may have compromised our ability to identify additional suitable hosts. Juvenile mussels were collected from St. Croix River fishes naturally infested with glochidia but none of the recovered mussels were winged mapleleaf. Additional work is needed to determine the function of the swollen excurrent aperture displayed during the brooding season and to verify that catfishes serve as glochidial hosts under artificial and natural conditions.

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# ONGOING RESEARCH

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## Applied Ecology



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**Project Title: Eastern Prairie Population Canada Goose Breeding Ecology**

Investigator: David E. Andersen

Students: John E. Sammler, M.S. (Wildlife Conservation) and Robert R. Nack, M.S. (Wildlife Conservation)

Duration: August 1999 to December 2002

Funding Sources: U.S. Geological Survey – Biological Resources Division,  
Cooperative Research Units  
Mississippi Flyway Council, EPP Canada Goose Technical  
Committee (through the Wildlife Management Institute)  
Manitoba Department of Natural Resources  
Minnesota Department of Natural Resources  
U.S. Fish and Wildlife Service  
Iowa Department of Natural Resources  
Missouri Department of Conservation  
Arkansas Game and Fish Commission  
Canadian Wildlife Service

Project Location: Cape Churchill, Manitoba  
Minnesota Cooperative Fish and Wildlife Research Unit

Eastern Prairie Population (EPP) Canada geese (*Branta canadensis*) breed in the Hudson Bay Lowlands in northeastern Manitoba. This group of birds migrates through southern Manitoba and western Minnesota, and historically wintered in Missouri and Arkansas. Because they nest in the sub-Arctic, EPP geese exhibit wide variation in productivity and recruitment, and annual information regarding breeding ecology and population status is required to effectively manage harvest.

Research on breeding ecology of this population of Arctic-nesting geese has continued since the 1960s, and information from these studies has been used to develop management and harvest strategies. Long-term monitoring of breeding density, nesting success, gosling production, and other breeding population parameters has resulted in information useful in modeling this population. These monitoring efforts occur in close proximity to the La Perouse Bay snow goose (*Anser caerulescens caerulescens*) colony, and over the past 20

years, snow goose use of the study area has increased dramatically. During the same period, breeding densities of Canada geese have dropped dramatically, and snow geese now dominate numerically in historic Canada goose brood-rearing areas. Beginning in 1999, we initiated field work on a project designed to investigate the relationship between Canada and snow geese on the breeding grounds. Adult female geese were radio-marked prior to hatch, and subsequently monitored from the ground and air to document habitat use and interactions with snow geese during the brood-rearing period. In addition, surveys for nesting songbirds and shorebirds were conducted in 1998, 1999, and 2000, and these data will be compared to survey data collected in 1984, prior to significant use of the study area by snow geese. Field activities in 1999 and 2000 also included monitoring Canada goose breeding density, nesting success, and other breeding population parameters at the Cape Churchill study area.

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**Project Title: Ecology of Oak Savanna Birds at Sherburne National Wildlife Refuge**

Investigator: David E. Andersen

Student: Leakhena Au, M.S. (Wildlife Conservation)

Duration: September 2000 to December 2002

Funding Sources: U.S. Fish and Wildlife Service  
Sherburne National Wildlife Refuge  
National Science Foundation

Project Location: Sherburne National Wildlife Refuge  
Minnesota Cooperative Fish and Wildlife Research Unit

Oak savanna habitats are one of the most endangered habitats in the Upper Midwest and relatively little is known regarding the ecology of birds that occupy these habitats. Habitat management activities at the Sherburne National Wildlife Refuge in east-central Minnesota emphasize maintaining, restoring, and enhancing oak savanna, yet few data exist regarding occurrence of breeding birds at this site and their response to management activities. Effects of habitat changes on breeding birds in landscapes dominated by oak savanna are likely to be different than in landscapes dominated by

forest or grassland habitats, where fragmentation is generally thought to have negative consequences. In contrast, oak savanna habitats are naturally heterogeneous, and birds that breed and persist in these habitats may not be affected in the same manner by habitat fragmentation as birds in other landscapes. This project will summarize and review existing data on oak savanna birds, conduct surveys for these birds at Sherburne National Wildlife Refuge, and evaluate habitat relations and effects of habitat management.

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**Project Title: Fall Movements, Habitat Use, and Survival of the American Woodcock in the Western Great Lakes**

Investigator: David E. Andersen

Student: To be selected

Duration: September 2000 to December 2003

Funding Sources: U.S. Fish and Wildlife Service  
Minnesota Department of Natural Resources  
U.S. Geological Survey – Biological Resources Division

Project Location: Minnesota study site not yet selected

Little is known regarding fall movements, habitat use, and survival of American woodcock, particularly in the Central Management Unit. As part of a regional study to investigate these aspects of woodcock ecology, and to understand the impact of harvest on fall woodcock survival, we have initiated a 3-year study of fall woodcock ecology in Minnesota. This study is in parallel with studies in Wisconsin and Michigan. Specific project objectives include: (1) Identify a pair of study sites in close geographic proximity in Minnesota, where woodcock habitat and population sizes are expected to be similar. One of these areas would be open to woodcock hunting, and the other would be closed to woodcock hunting; (2) Capture and equip

woodcock with radio transmitters on both study sites (n = 30 - 60 per site per year) in late summer and early fall, prior to the initiation of the woodcock hunting season; (3) Monitor survival and habitat use of radio-marked woodcock on both study sites through the hunting season or until surviving woodcock migrate from the study sites; (4) As much as possible, make the study protocol compatible with data collection in the Eastern Management Unit, and any concurrent studies of woodcock survival and fall movement in the Central Management Unit. The majority of funding for the Minnesota portion of this study has been identified, site evaluation is currently underway, with the objective of initiating field work in the fall of 2001.

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**Project Title: Great Lakes Colonial Waterbird Survey**

Investigator: Francesca Cuthbert

Student: Dale Trexel, M.S. (Conservation Biology)

Duration: May 1997 to March 2002

Funding Source: U.S. Fish and Wildlife Service

Project Location: Michigan, Upper Peninsula  
University of Minnesota, St. Paul

Colonial waterbirds are a significant biological resource in the Great Lakes ecosystem. Information on their distribution and abundance is essential for implementing effective conservation and management strategies.

Comprehensive surveys of colonial waterbirds in the U.S. portion of the Great Lakes were conducted in 1976-77 and 1989-91. Results from these efforts documented significant population increases (especially ring-billed gulls and double-crested cormorants), monitored species with small populations, and identified critical breeding habitat for colonial waterbirds in the Great Lakes. The 1997-99 survey attempts to duplicate surveys conducted in the two previous decades. Analysis of these 3 data sets will provide the first comprehensive picture of 20 year

population trends including identification of historically stable colony sites, species-specific habitat requirements, and issues of conservation and management concern.

During June-July 2000, surveys were made of double-crested cormorant colonies in northern Lake Michigan, Lake Huron and the lower St. Mary's River. This region was divided into four study areas based on natural island groups. All islands within these study areas were surveyed by airplane for active double-crested cormorant colonies. Islands with nesting double-crested cormorants were visited by plane or boat for total ground counts of nests. These data, along with past colony survey data, are being incorporated into a GIS database to analyze colony establishment and growth.

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**Project Title: Home Range and Habitat Use of Breeding Northern Goshawks in North-central Minnesota**

Investigators: David E. Andersen, Clint Boal, and Patricia L. Kennedy (Colorado State University)

Student: Aimee Roberson, M.S. (Conservation Biology)

Duration: July 1999 to December 2001

Funding Sources: U.S. Forest Service  
Chippewa National Forest  
Superior National Forest  
National Council of the Paper Industry for Air and Stream Improvements  
Potlatch Corporation  
Leech Lake Band of Chippewa  
Minnesota Department of Natural Resources  
Minnesota Falconer's Association  
U.S. Fish and Wildlife Service

Project Location: Chippewa and Superior National Forests and surrounding  
northcentral and northeastern Minnesota

In the western Great Lakes Region, the population status of goshawks is largely unknown. Existing information on goshawk population ecology in this portion of their range is limited to long-term monitoring of nest sites and scattered information on food habits and movements from studies of individual nests or birds. Only recently have efforts been undertaken to quantitatively describe nest sites and assess breeding population status beyond single study sites. The objective of this cooperative study is to begin to address this information gap by collecting data on habitat use, home range, and habitat requirements for goshawks in Minnesota, with potential for direct application toward conservation and management of goshawks throughout the Laurentian Mixed Forest Province. From

1998 through 2000, we captured and radio-equipped 33 breeding northern goshawks in northern Minnesota, and monitored their movements from the ground and air (1998) or exclusively from the air (1999 and 2000) through the fledgling-dependency period (mid-August). In addition, we measured structural habitat characteristics at a subset of locations for each male goshawk, and in 2000, placed video cameras and recording equipment at 3 nests to document food habits. In 1999 and 2000, we also established fixed stations at active nest sites, and evaluated call broadcasts for potential use as a survey technique in the western Great Lakes region. Data are currently being analyzed for all components of this project.

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**Project Title: Inventory of Northern Goshawks on the Superior National Forest**

Investigators: David E. Andersen and Clint Boal

Student: Aimee Roberson, M.S. (Conservation Biology)

Duration: August 2000 to September 2001

Funding Sources: U.S. Forest Service  
Superior National Forest

Project Location: Superior National Forest (Northeast Minnesota)  
Minnesota Cooperative Fish and Wildlife Research Unit

The Superior National Forest encompasses over 12,000 km<sup>2</sup> and is one of the largest areas of forested public land in the western Great Lakes Region. Considerable concern exists regarding northern goshawk populations in this region, yet few efforts to systematically survey potential breeding habitat for goshawks have been completed. Recent research on goshawk survey

techniques in Minnesota suggests that conducting broadcast surveys during the courtship period increases the probability of a response by breeding goshawks, and also facilitates location of nesting attempts prior to potential nest failure. This project will apply these survey techniques at the landscape level on the Superior National Forest in 2001.

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**Project Title: Modeling the Environmental Impacts of Farming Systems in Two Watersheds in Minnesota**

Investigator: Bruce Vondracek

Student: Julie Henry, Ph.D. (Fisheries)

Duration: September 2000 to June 2001

Funding Source: Land Stewardship Project

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

A multi-disciplinary team has been established to investigate the multiple benefits that farming provides to citizens in Minnesota. The team is interested in developing policy that rewards farmers for producing multiple benefits, especially in the transition to integrated, sustainable farming systems. Most analyses have focused on farm profitability, but have included cost-benefit analyses of trade-offs between water quality improvements or other environmental gains on on-farm profitability. However, these have not reported economic values for other ecosystem impacts, such as flood control or production of wild plants and animals in the landscape. Other team members are developing detailed computer simulation

models to examine the relationship between farming systems and the physical outputs (sediment, nitrogen) that emanate from the landscape. This project will conduct a literature review to examine multiple benefits from agriculture and quantify environmental impacts, such as improved water quality and effects on biodiversity, to understand the links between the physical outputs from the computer models and the resulting ecological effects. Although the literature search will be broadly based, the computer models will focus on the physical and ecological conditions present in two watersheds: the Wells Creek watershed and a sub-watershed of the Chippewa River watershed.

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**Project Title: Review of Research Pertaining to Double-crested Cormorants in the Eastern U.S.**

Investigator: Francesca Cuthbert

Student: Dale Trexel, M.S. (Conservation Biology)

Duration: September 1998 to September 2000

Funding Source: U.S. Fish and Wildlife Service

Project Location: University of Minnesota, St. Paul

In this project we reviewed existing information on double-crested cormorants (DCCO) in eastern North America and assessed the status of the species in this portion of its range. Maps were created showing current breeding and winter distributions, and changes in populations over time at local and regional levels were graphed. We summarized information on species

taxonomy and life history, reviewed diet studies and created diet tables for specific regions, and also reviewed population modeling efforts, management options, and studies investigating impacts of DCCOs on biodiversity. Lastly, we included available information on current DCCO research/monitoring efforts and priority research needs.

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**Project Title: Trophic Cascade Interactions in a Coldwater Stream**

Investigators: Bruce Vondracek and Raymond Newman

Student: Carl Ruetz, Ph.D. (Fisheries)

Duration: September 1997 to August 2002

Funding Source: Cargill Fellowship

Project Location: Valley Creek, Washington County, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

A four-year study to examine the effects of fish on benthic macroinvertebrates, benthic algae, and leaf litter processing is underway. This study will provide an understanding of multiple trophic level interactions in streams. Enclosure/exclosure experiments during summer 1998 and 1999 assessed top-down effects of slimy sculpin (*Cottus cognatus*) on grazing invertebrates and periphyton in six riffles. Each riffle contained an enclosure (three sculpin), an exclosure (fishless), and control (downstream sides open). In 1998, total grazer density (*Glossosoma* spp. and *Baetis* spp.) on ceramic tiles was significantly higher in exclosures, whereas individual grazer taxa density did not differ among treatments. Periphyton biomass (ash-free-dry-mass and chlorophyll a) did not differ among fish treatment levels, although a significant negative correlation existed between total grazer density and periphyton biomass. In 1999, a subset of tiles was treated with a vaseline barrier that excluded *Glossosoma*. Periphyton biomass was higher on tiles that excluded *Glossosoma*, but did not differ among fish treatments. *Glossosoma* were significantly more abundant in the presence of fish. Macroinvertebrate drift rates and density in

the substrate are forthcoming and should help elucidate mechanisms by which fish influence their prey. Thus, slimy sculpin may affect grazer abundance, but fish effects may not cascade down to primary producers even when grazers control periphyton biomass. In a separate experiment, indirect effects of fish (slimy sculpin, and rainbow, brown, and brook trout) on leaf litter decay were investigated during winter 1998-99 in three riffles. Our hypothesis was that fish would decrease shredders associated with leaf packs and thus reduce leaf litter processing rates. Willow leaves (*Salix* spp.) were fastened into leaf packs (-3 g dry mass) and placed in 10 cm<sup>2</sup> cages that either excluded fish or were accessible to fish. Two replicates of each treatment were collected after 0, 14, 31, 55, and 112 days. Linear regression of the proportion of leaf mass ( $\log_{10}$ ) remaining in relation to time was used to calculate leaf decay rates. Decay rates were significantly different among treatments and riffles, suggesting that fish exclusion had an effect on decay rates that varied among riffles. Shredder abundance was greater for leaf packs in cages that excluded fish. Thus, fish may affect benthic macroinvertebrates associated with leaf packs and affect leaf litter decay rates.

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# ONGOING RESEARCH

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## Human Activities, Management, and Conservation



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**Project Title: Assessing Social-psychological Aspects of Deer Management in Cuyahoga Valley National Recreation Area**

Investigators: David C. Fulton, David Lime, Dorothy Anderson

Student: Erin Dougherty, M.S. (Conservation Biology)

Duration: May 1999 to June 2001

Funding Source: National Park Service, Cuyahoga Valley National Recreation Area

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This study is being conducted to assess the positive and negative social consequences of various potential deer management alternatives in Cuyahoga Valley National Recreation Area (CVNRA). This information will be used to help the staff at CVNRA develop a deer management strategy that considers public desires and concerns relating to management of the CVNRA. The following specific study objectives were identified: 1) determine the acceptability and preferences among the local public for deer management activities, the perceived positive and

negative consequences of deer management activities, and deer population levels; 2) identify and determine the intensity of the psychological and emotional impacts among the local public served by CVNRA due to various deer management actions; 3) determine the effect of deer management activities on local public attitudes toward the park, its services, and park staff; 4) determine the degree to which deer management activities may affect park visitation patterns among the local public.

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**Project Title: Assessment of Use and Benefits of Waterfowl Production Areas in Minnesota**

Investigators: David C. Fulton and Dorothy Anderson

Student: Samantha Hayes, M.S. (Forest Resources)

Duration: September 1999 September 2002

Funding Source: U.S. Fish and Wildlife Service, Region 3

Project Location: Wetland Management Districts, Minnesota, USFWS  
University of Minnesota

Although information concerning public visitation and the factors affecting public support of Waterfowl Production Area (WPA) management are essential to effective WPA management strategies, at the present time little is known about the level of public use on WPAs or the value and benefits of the WPAs to users. The purpose of this study is to develop a scientific methodology for accurately estimating the level of public use on small, dispersed recreation areas such as WPAs and to identify the types of benefits provided by WPAs and the value and importance of those benefits to the

public. Specific study objectives are to: 1) develop a valid and reliable methodology for estimating visitation rates at WPAs within each of the 5 Wetland Management Districts (WMDs) within Minnesota (estimates at the WMD level); 2) identify the level of use for different activities at WPAs; 3) develop and assess a social psychological framework for identifying and measuring the non-economic benefits that WPA users receive from WPAs; and 4) determine the influence of non-economic benefits on user support for federal ownership and management of WPAs.

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**Project Title: Breeding Biology and Management of the Great Lakes Piping Plover Population 2000-2002**

Investigator: Francesca Cuthbert

Staff: Jennifer Hathaway-Stucker

Duration: April 2000 to April 2002

Funding Source: U.S. Fish and Wildlife Service, Region 3

Project Location: Upper Peninsula Michigan  
University of Minnesota, St. Paul

The Great Lakes population of the piping plover (*Charadrius melodus*) was given federal endangered status in 1986. At that time, the only remaining breeding areas in the Great Lakes region were located within the state of Michigan. The islands of northern Lake Michigan (Charlevoix County) and shoreline of Emmet, Leelanau, and Cheboygan counties are historically important breeding sites for Piping Plovers in Michigan's Lower Peninsula. Since the mid-1980s, nesting sites have been located and monitored in the Lower Peninsula of Michigan in Benzie, Charelvoix, Emmet, Leelanau, and Cheboygan counties. In the Upper Peninsula, nests have been located in Mackinac, Chippewa, Luce and Alger counties. During 1998, a pair of plovers

hatched at different Michigan sites dispersed to Long Island (Ashland County, Wisconsin), successfully fledged young, and expanded the recent breeding range of the Great Lakes population. Objectives of this study are to continue to locate and monitor breeding plovers in the Great Lakes population, coordinate nest protection efforts, and estimate population parameters important for conservation. Results of this study will include information on the size of the breeding population, locations of nest sites, breeding chronology (nest initiation, hatching, fledging) and reproductive success, and assessment of failures. Additional analyses will include assessment of lifetime reproductive success.

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**Project Title: Constraints and Opportunities for Quality Trout Angling Experiences in Southeastern Minnesota**

Investigators: David C. Fulton and Bruce Vondracek

Students: Kristen Blann, Ph.D. (Conservation Biology) and Jon Rosales, Ph.D. (Conservation Biology)

Duration: August 2000 to December 2002

Funding Source: Minnesota Department of Natural Resources

Project Location: Southeast Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

Management of quality trout fishing opportunities in the state of Minnesota has been a contentious issue for several years. Much of the conflict focuses on the competing demands of anglers who have different beliefs about the size and quantity of fish that can be produced by various streams in the region. Managers are challenged with identifying the demands of the trout angling public as well as developing regulations that attend to these various demands while adhering to the available scientific knowledge of resource conditions and capabilities. This project will develop an outcomes-based management system designed to improve the quality of the trout fishing experience in southeastern Minnesota. We will accomplish this goal through seven objectives: 1) identify differences in the biological productivity (e.g., species and size class abundance, growth rates and growth potentials) of diverse trout streams in southeast Minnesota; 2) determine the factors affecting stream productivity such as physical habitat measures and habitat suitability, habitat improvement activities, land use practices, food availability, fishing pressure, and supplemental fish stocking (brown and indigenous brook trout), 3) assess trout angler knowledge of factors

affecting trout populations and stream quality, and 4) define public preferences for angling experiences, activities, settings and benefits associated with these trout waters. To integrate the biophysical and social information we will 5) use general linear, structural equations, and multinomial logit modeling to define the social and biophysical variables that most influence production of desired stream and fisheries benefits (e.g., angler satisfaction levels) at the individual, community, and environmental levels. Based upon variables identified through modeling the fishery's benefit production, we will then develop 6) commensurate angler classification and stream classification systems using cluster and principal components analyses that will form the basis for a "Trout Angling Opportunity Spectrum," and 7) angler demand and participation models incorporating biological, social, and economic (e.g., travel cost and willingness-to-pay) variables to estimate the demand for various trout angling opportunities identified by the "Trout Angling Opportunity Spectrum." The demand and participation models will allow managers to determine the most appropriate mix of trout angling opportunities.

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**Project Title: Evaluating Decision-processes: Case Studies of Fisheries Issues in Minnesota**

Investigator: David C. Fulton

Student: John Epton, M.S. (Conservation Biology)

Duration: August 1999 June 2001

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

The purpose of this study is to improve the understanding of decision-processes for addressing contentious fisheries-related issues and develop practical, theory-based guidelines for designing and participating in decision-processes. Although numerous studies identify general factors associated with successful collaborative decision-making, few studies systematically examine the role that these factors play in affecting the relative success or failure of collaborative decision-processes. There is also a need to develop a theory of decision-process success that integrates the literature in alternative dispute resolution with the theoretical and experimental literature concerned with factors affecting perceptions of justice and fairness in decision-making and factors affecting the quality and technical competency of decisions made within a group context.

Ultimately, a better understanding of collaborative decision processes will allow the Minnesota Department of Natural Resources (MNDNR) to participate more effectively in such processes and improve the quality of decisions made through such processes. The objectives of this study are to 1) improve the basic understanding of factors influencing the success or failure of collaborative decision-processes related to fisheries management in Minnesota by testing current theories about decision-processes and generating new theory grounded in the experiences from Minnesota; 2) develop and assess a model, or strategy, for improving the quality of participation by the MNDNR in such decision-processes. Case studies have been identified and interviews from two case studies have been completed.

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**Project Title: Geospatial Techniques for National Wildlife Refuge Planning**

Investigator: Thomas E. Burk

Duration: August 2000 to September 2002

Funding Source: U.S. Fish and Wildlife Service, Region 3

Project Location: University of Minnesota, St. Paul

A Geographic Information System (GIS), with accompanying relational database management system, for managing, manipulating, and analyzing spatial data will be derived and illustrated. This GIS will build on the basic framework begun in previous cooperative work related to data acquisition, analysis, and presentation related to comprehensive management planning. The use of remote sensing technology for acquiring habitat data will be examined. Approaches utilizing aerial photography, airborne multi-spectral scanners, as well as their satellite counterparts will be considered, though it is anticipated that the extent of possible comparisons will be limited to available or readily obtainable data. Resolution (or

scale), timing (season) of acquisition, and the correspondence between spectral and biophysical characteristics will be the foci of study. The advantages and disadvantages of each remote sensing approach for the various important aspects of habitat identification and description will be tabulated and illustrated where possible. For example, only large scale, color infrared aerial photography obtained at high and low water stages may possess vegetation interpretation characteristics necessary for identification of an important habitat type. Gaps where a significant field data collection component is required for adequate characterization of features of interest will be identified.

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**Project Title: Inventory of Heather Vole and the Northern Bog Lemming on the Superior National Forest**

Investigator: Frederick Jannett

Duration: August 2000 to December 2001

Funding Source: U.S. Forest Service

Project Location: Superior National Forest

The eastern heather vole has been categorized as a rare species that is not commonly secured in trapping. The northern bog lemming is similarly rare and few specimens are known from Minnesota. The southern limit of both species' ranges occur in northern Minnesota. Both species are designated as Sensitive Species by the U.S. Forest Service and Species of Special Concern by the State of Minnesota. The distribution and abundance of these species

are largely unknown in Minnesota, and this project is designed to ascertain their occurrence and habitat relations on the Superior National Forest. Information about the occurrence and habitat relations of heather voles and northern bog lemmings will be used to develop management strategies by the U.S. Forest Service and other land management agencies in the western Great Lakes Region.

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**Project Title: Minnesota Waterfowl Hunter Survey**

Investigator: David C. Fulton

Student: Elizabeth Weaver, M.S. (Conservation Biology)

Duration: December 2000 September 2001

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota has the largest number of waterfowl hunters of any state in the United States, yet quantitative information about this important clientele is limited. Hunter numbers and harvest are estimated annually by the U.S. Fish and Wildlife Service (Federal Harvest Estimates) and the Minnesota Department of Natural Resources [MNDNR] (Small Game Hunter Survey). Minnesota participated in the North American Duck Hunter Survey (Ringelman 1997), and Minnesota hunter responses have been compared to those the in rest of the United States (Lawrence, unpubl). Hunter satisfaction is important, and while the Minnesota Department of Natural Resources (MNDNR) is primarily a regulatory agency, maintaining waterfowl hunter numbers over the long term will depend upon a satisfied clientele.

The objectives of this studies are 1) to provide baseline information on waterfowl hunter demographics in Minnesota 2) identify hunter preferences/opinion on various waterfowl hunting, management, and regulations issues and 3) measure hunter satisfaction. Development of annual waterfowl hunting regulations must be within the frameworks established by the U.S. Fish and Wildlife Service, yet there is some latitude within those frameworks to adjust season structure based upon unique state characteristics and hunter preference. A Saturday opening day, youth waterfowl hunt, or customized regulations are examples of regulations that could be modified by hunter preference. Also, hunter responses will provide a better understanding of where the MNDNR Division of Wildlife needs to focus information and education efforts.

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**Project Title: Trends on Fisheries Issues in Minnesota**

Investigator: David C. Fulton

Student: John Epton, M.S. (Conservation Biology)

Duration: January 2000 to December 2001

Funding Source: Minnesota Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

The purpose of this study is to develop a better understanding of anglers' perceptions of fisheries management issues and to initiate a long-term research program that will assist the Minnesota Department of Natural Resources with tracking trends in public perception of fisheries management issues. The objectives of this study are to 1) determine anglers' attitudes toward and support for various fishing regulations in the state including regulations pertaining to the size and number of fish that can be retained; 2) assess anglers' perception of the effect of fishing regulations on the fishing experience; 3) develop a battery of items based on research studies in Minnesota and other states that will be used to track trends in anglers' preferences and attitudes on key issues and perceptions including satisfaction with the general fishing experience, satisfaction with the number and size of fish caught, perceptions of crowding, and other key indicators of the quality of fishing experiences.

survey is being designed and implemented in Spring 2001.

Data have been collected via a public survey focused on perceptions and preferences for bag limits in the state of Minnesota. There were four targeted populations in the study: 1) Minnesota anglers in the Twin Cities metro region; 2) Minnesota anglers residing elsewhere in the state; 3) Non-resident anglers; and 4) Resort owners in Minnesota. Data are being analyzed and a project report is forthcoming. A second resident angler

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**Project Title: Understanding Visitor Uses, Motives, and Benefits at Sherburne National Wildlife Refuge**

Investigators: David C. Fulton and Dorothy Anderson

Student: Erin Dougherty, M.S. (Conservation Biology)

Duration: September 2000 to September 2002

Funding Sources: U.S. Fish and Wildlife Service  
U.S. Geological Survey

Project Location: Sherburne National Wildlife Refuge  
Minnesota Cooperative Fish and Wildlife Research Unit

This project will focus on developing information concerning refuge visitors' motivations for visiting Sherburne National Wildlife Refuge (NWR) and their perceptions of management issues at the refuge including issues involving visitor-visitor interactions, visitor-resource interactions and impacts, and visitor-management structure interactions. The research will be directed primarily by current ideas and theory concerning outcomes-based management (experience and benefits-based) of natural resource use. This approach to managing recreational use of natural resources is a relatively new area of research focus. One key aspect of this approach will be the development of a system of indicators and standards for specifying management objectives that will facilitate the integration of biophysical and social information in the Comprehensive Conservation Planning (CCP) process, as well as serve as a basis for quantitative evaluation of planning decisions and actions. This research will improve the scientific understanding of the relationship between recreational experiences and long-term social and psychological benefits associated

with recreation participation as well as providing guidance in development of a CCP for the Sherburne NWR. The proposed study will be coordinated with a larger effort to develop a foundation for accomplishing CCP in the refuge system. A series of studies with a focus of integrating biophysical and social information for refuge planning are being developed in Region 3 and Region 6 U.S. Fish and Wildlife Service. This study will be fully integrated with those research efforts and substantial funding for this effort will be contributed by U.S. Geological Survey. Specific study objectives are to:

1. Identify visitor motivations for visiting Sherburne NWR,
2. Identify the desired experiences and benefits that visitors receive from Sherburne NWR,
3. Identify objectives preferred by various visitor segments interested in the management of Sherburne NWR,
4. Develop a system of biophysical and social indicators to facilitate long-term monitoring of whether or not desired management objectives are being achieved for Sherburne NWR.

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# ACTIVITIES

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# PUBLICATIONS

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### 1999

- Anderson, D.J. and **B. Vondracek**. 1999. Insects as indicators of land use in three ecoregions in the Prairie Pothole Region. *Wetlands* 19:648-664
- Garshelis, D.L., R. L. Sikes, **D.E. Andersen**, and E.C. Birney. 1999. Landowner's perceptions of crop damage and management practices related to black bears in east-central Minnesota. *Ursus* 11:219-224.
- Hochachka, W.M., T.E. Martin, V. Artman, C.R. Smith, S.J. Hejl, **D.E. Andersen**, D. Curson, L. Petit, N. Mathews, T. Donovan, E.E. Klaas, P.B. Wood, J.C. Manolis, K.P. McFarland, J.V. Nichols, J.C. Bednarz, D.M. Evans, J.P. Duguay, S. Garner, J. Tewksbury, K.L. Purcell, J. Faaborg, C.B. Goguen, C. Rimmer, R. Dettmers, M. Knutson, J.A. Collazo, L. Garner, D. Whitehead, and G. Geupel. 1999. Scale dependence in the effects of forest coverage on parasitization by brown-headed cowbirds. *Studies in Avian Biology* 18:80-88.
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- Manolis, J.C., **D.E. Andersen**, and F.J. Cuthbert. 2000. Patterns in clearcut edge and fragmentation effect studies in northern hardwood-conifer landscapes: retrospective power analysis and Minnesota results. *Wildlife Society Bulletin* 28:1088-1101.
- Pothoven, S.A., **B. Vondracek**, and D.L. Pereira. 1999. An evaluation of the indirect effects of floundone on the fish communities of two Minnesota lakes. *North American Journal of Fisheries Management* 19:748-757
- Sovell, L.A. and **B. Vondracek**. 1999. Evaluation of the fixed count method for Rapid Bioassessment Protocol III with benthic macroinvertebrate metrics. *Journal of the North American Benthological Society* 18: 420-426.

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- Andersen, D.E.** and D. L. Plumpton. 2000. Urban landscapes and raptors: a review of factors affecting population ecology. Pages 435-445. In R.D. Chancellor and B.-U. Meyburg, eds., Raptor World Working Group on Birds of Prey and Owls. *Proceedings of the 5<sup>th</sup> World Conference on Birds of Prey and Owls*. Hancock House Publishers, Blaine, WA.
- Bright, A.D., M.J. Manfredo, and **D.C. Fulton**. 2000. Segmenting the public: an application of value orientations to wildlife planning in Colorado. *Wildlife Society Bulletin* 28(1):218-

Manolis, J.C., **D.E. Andersen**, and F.J. Cuthbert. 2000. Uncertain nest fates in songbird studies and variation in Mayfield estimation. *Auk* 117:615-626.

McLeod, M.A., B.A. Belleman, **D.E. Andersen**, and G. Oehlert. 2000. Red-shouldered hawk nest site selection in north-central Minnesota. *Wilson Bulletin* 112:203-213.

#### In Press

**Andersen, D.E.**, T.R. Laurion, J.R. Cary, R.S. Sikes, M.A. McLeod, and E.M. Gese. *In Press*. Aspects of swift fox in southeastern Colorado. *Proceedings of the First North American Swift Fox Symposium*.

Sovell, L.A., **B. Vondracek**, J.A. Frost, and K.G. Mumford. *In Press*. Impacts of rotational grazing and riparian buffers on physiochemical and biological characteristics of southeastern Minnesota streams. *Environmental Management*.

#### NON-REFEREED

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Dougherty, E.M. and **D.C. Fulton**. 2000. Understanding values and attitudes related to deer management in Cuyahoga Valley National Recreation Area. *Book of Abstracts of the 8<sup>th</sup> International Symposium on Society and Resource Management*.

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#### TECHNICAL AND SEMI-TECHNICAL

#### 1999

Boal, C.W., D.E. Andersen, and P.L. Kennedy. 1999. Home range and habitat use of breeding northern goshawks in north-central Minnesota. 1998 Progress Report. Minnesota Cooperative Fish and Wildlife Research Unit. St. Paul, MN.

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**Fulton, D.C.** 1999. Evaluating preferences and willingness-to-pay for activities at Potter Marsh Nature Center: assessment of demand and preferences for center activities and services. Report to Alaska Department of Fish and Game, Division of Wildlife Conservation, Region II. Anchorage, AK. Minnesota Cooperative Fish and Wildlife Research Unit. St. Paul, MN.

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## 2000

**Andersen, D.E.** 2000. Canada Goose brood movements and habitat use in relation to snow geese at Cape Churchill, Manitoba. Annual progress report to U.S. Geological Survey—Biological Resources Division. Minnesota Cooperative Fish and Wildlife Research Unit. St. Paul, MN.

Blann, K.A. and **B. Vondracek**. 2000. Landscape scale influences on coldwater streams and stream fish in southeastern Minnesota: a GIS application. Final Report to Minnesota Department of Natural Resources. St. Paul, MN.

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## COMPLETED THESES AND DISSERTATIONS OF MINNESOTA COOP UNIT STUDENTS

1999

**Blann, Kristen L.** 1999. Catchment and riparian scale influences on coldwater streams and stream fish in southeastern Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 117 pp.

Abstract: The structure of the terrestrial landscape at multiple scales influences the baseline potential habitat quality of streams. Geology and topology govern stream characteristics, but land uses such as forest cover affect thermal regimes, which in turn influence the suitability of streams for aquatic life. We analyzed Minnesota Department of Natural Resources stream survey data in relation to topography, land use, geology, and soil type at a watershed and a 100 m riparian scale to identify patterns in the distribution of fish, but specifically focusing on brook and brown trout and sculpin. Landscape characteristics at the catchment and buffer scale accounted for 20-40% of the variance in fish metrics using redundancy analyses. Land use variables explained only a small portion of variance in ordinations where topographic and geologic variables were included. Percent deciduous forest, slope, stream gradient, and bedrock associations were positively correlated with fish distributions, especially for age-1+ brook and brown trout. Cultivated land use was negatively correlated at both scales, but notably at the buffer scale using logistic regression.

**Nerbonne, B.A.** 1999. Effects of land use and sediment on the distribution of benthic invertebrates and fish in the Whitewater River Watershed of Minnesota. M.S. Thesis, University of Minnesota, St. Paul. 69 pp.

Abstract: The Whitewater Watershed Project is interested in assessing benefits of best management practices (BMPs) for reducing non-point-source pollution, particularly sediment. I compared instream physical habitat, invertebrate, and fish communities from farms with BMPs and conventional practices within the Whitewater Watershed in 1996 and 1997. Invertebrate communities were assessed using the rapid bioassessment protocol (RBP) (USEPA 1989), and fish communities were assessed with an index of biotic integrity (IBI). Sites were classified by upland land use (BMP or conventional) and riparian management (grass, grazed, or wooded buffer). Comparisons across land use were made using an analysis of covariance, with buffer width and stream as covariables. The relationship between fish and invertebrate communities was examined using redundancy analysis, a method of comparing two set of multivariate data, and with linear regression.

Physical habitat characteristics differed across buffer types, but not upland land use. Buffer width was negatively correlated with percent fines and embeddedness. Grass buffers had significantly lower percent fines, embeddedness, and streambank bare soil, and higher percent cover and pool area. RBP and IBI scores were not significantly different across land uses, but did show correlations with instream physical habitat. RBP and IBI scores were both negatively correlated with percent fines and embeddedness, and positively correlated with width-to-depth ratio.

Results suggest that grass buffers may be a viable alternative for riparian management. At the local scale, upland land use was not as important as riparian management or buffer width, but upland land use may be important at broader scales. The lack of difference in RBP or IBI scores across buffer types, given that physical habitats were different, suggests that biotic indicators may not respond to local changes, instead relying on broader scale factors that influence them.

**Grant, G. C.** 1999. Microhabitat selection, spawning behavior, and growth of three trout. Ph.D. Dissertation, University of Minnesota, St. Paul. 121 pp.

Abstract: Chapter One: Recently developed fluorescence techniques were used to quantify RNA-DNA ratios in white epaxial muscle tissue biopsies taken from live adult brown trout. RNA-DNA ratios from small biopsies (4-24 mg wet weight) were measured concurrently with growth over five weeks in two groups of brown trout fed different rations, 5% body weight/day (reference) and 1% body weight/week (treatment). Reduced rations had significant effects on RNA-DNA ratios in muscle tissue biopsies. The treatment group had significantly lower mean RNA-DNA ratios than the reference group after the first week. After five weeks of treatment the mean RNA-DNA ratios of the treatment and reference groups were 1.98 and 4.31, respectively. RNA-DNA ratios from muscle tissue biopsies reflected recent growth rates in the two groups of fish. This technique allows a biochemical measurement of growth rates in adult fish without mortality.

Chapter Two: To determine if there was niche partitioning that limited interspecific competition for food or space between sympatric brown and rainbow trout, we investigated the diet, microhabitat use and feeding behavior of these species in Valley Creek, Minnesota. We collected stomach contents concurrently with stream drift approximately every two weeks from May through August to determine if brown and rainbow trout consumed non-drifting prey, and observed their feeding behavior using submerged video cameras. Yearling trout of both species relied primarily on drifting prey; age-1 brown and rainbow trout made an average of 84.7% and 88.6% of their feeding forays in the water column, respectively. Benthic prey (caddisfly larvae, gastropods, isopods and annelids) comprised 40.2% of age-1 brown trout prey biomass and 24.9% of age-1 rainbow trout prey mass. Adult brown and rainbow trout used different feeding strategies. Brown trout consumed progressively more benthic items as they grew older. Age-2 brown trout made an average of 46.3% of feeding forays toward the bottom and age-3 brown trout were rarely observed feeding in the water column during the day. Benthic prey accounted for 56.4% and 52.4% of age-2 and 3+ brown trout prey biomass, respectively. Rainbow trout were commonly observed feeding in the water column during the day and relied more on drifting prey throughout their life, with only a small increase in benthic prey and feeding for the largest individuals. On average, age-2 rainbow trout made 90.6% and age-3+ rainbow trout made 82.1% of feeding forays in the water column and benthic taxa accounted for 23.9% and 25.9% of their prey biomass, respectively. Adult rainbow trout also consumed filamentous algae which comprised 47.7% and 58.2% of the weight of stomach contents for age-2 and age-3+ fish, respectively. Rainbow trout apparently ingested algae incidentally while feeding on insects from the vegetation; age-3+ rainbow trout made 10 % of feeding forays towards epibenthic algae. These different feeding strategies suggest mechanisms for reduced interaction between brown and rainbow trout.

We tested the predictions of two drift-feeding models to determine if they were applicable to adult stream trout and would be useful in explaining aspects of species replacement. We quantified habitat availability and developed site-specific predictions of microhabitat use based on the Hughes & Dill and Hill & Grossman models. We quantified microhabitat use of brown and rainbow trout from direct underwater observation using video cameras. Trout of both species used progressively deeper and slower microhabitats as they grew. Smaller trout used locations towards the head and tail of the pool or closer to the stream margins while the largest trout used the deepest habitat available in Valley Creek. This ontogenetic habitat shift resulted in drift-feeding models predicting feeding locations more accurately for some age groups than others. The Hughes and Dill model predicted the most profitable positions for all age groups were in the deepest available habitat in the center of the stream and appeared to accurately predict microhabitat use of the largest trout. However, deeper habitats generally had lower velocities,

which were probably not optimal for drift-feeding, and the model predicted that smaller trout, which relied more on drift than adults, were using less favorable drift-feeding locations. The Hill and Grossman model predicted the optimal velocity for drift-feeding fish was 34 cm/s for all age groups. Most fish we observed used velocities lower than those predicted by the Hill and Grossman model, but smaller trout used more profitable drift-feeding locations than large trout according to this model. Neither model predicted a shift in microhabitat use for different age fish. These conclusions probably resulted from varying degrees of compliance with the drift-feeding assumption, and the simple nature of the models that did not account for tradeoffs between maximizing growth and reducing the chance of being preyed upon. The fact that both species chose similar habitats despite having different feeding strategies suggests other factors play a role in microhabitat selection. Thus, drift-feeding models based on energetics may not be useful in testing mechanisms of species replacement.

Chapter Three: We characterized spawning behavior and diurnal activity patterns in sympatric populations of native brook and introduced brown trout in a Minnesota stream to examine potential reproductive isolating mechanisms. There was no indication of any behavioral isolating mechanisms that might prevent interspecific courtship and hybridization between these species. We observed hybridization during four of ten spawning events in the main creek channel. Hybridization occurred both by interspecific pairing between male brown trout and female brook trout, and by sneaking of male brook trout. Male brook and brown trout spent similar amounts of time courting females of both species. Thus, there was no evidence of isolating mechanisms preventing males from courting heterospecific females. Female spawning behaviors did not differ when courted by heterospecific males. Spawning behaviors appear identical between species, except the method by which females cover eggs, which occurs after fertilization. Both species were active on spawning redds throughout the day and night, and spawning occurred throughout the day. Male brown trout may be more successful at pairing with females of both species due to their larger size. Interspecific spawning interactions and hybridization probably play a role in the replacement of native brook trout by introduced brown trout.

**Manolis, J.C.** 1999. Clearcut edge effects on avian nesting success in extensively forested, northern hardwood-conifer landscapes. Ph.D. Dissertation, University of Minnesota, St. Paul. 92pp.

Abstract: Edge and fragmentation effects on avian nesting success are well documented in agricultural landscapes in North America and in Scandinavia. However, evidence of edge effects due to timber harvest in predominantly forested landscapes has been equivocal. To better understand this problem, I examined nesting success in relation to distance from clearcut edges in north-central Minnesota. I found and monitored 266 nests of 7 species of ground nesting birds during 1992-1994. Distance to nearest clearcut edge was the best predictor of nest failure ( $P < 0.05$ ). Source-sink modeling indicated that distances  $< 175$  m from clearcut edges may be sink habitats (i.e. recruitment is lower than survival). In 1993 and 1994, I conducted 3 artificial nest experiments, placing 1188 nests on the ground. Predation rates were highest near clearcut edges in all three experiments ( $P < 0.01$ ). To aid interpretation of studies conducted in the Northern-Hardwood-Conifer Forest Region (NHCF) of North America, I retrospectively estimated statistical power for 26 analyses (subsets of 11 papers and my own analyses) and examined additional study design issues. Statistical power was unacceptably low for many of these studies and pseudoreplication was evident in several. Without considering power or design issues, 13 (50%) of the analyses reported higher predation rates near edges or in fragmented vs. unfragmented areas, 12 showed no effects, and 1 yielded higher predation rates in unfragmented vs. fragmented areas ( $P = 0.05$ ). When studies with low statistical power ( $< 0.80$ ) and pseudoreplication were excluded from analysis, 9 (69.2%) of the remaining studies reported edge

or fragmentation effects, 3 showed no effects, and 1 showed higher predation rates in unfragmented vs. fragmented areas. Variability in results may be due in part to variability in strength of study design. Previous evaluations have suggested that edge or fragmentation effects are mainly found in agricultural landscapes, but my results suggest that these effects may be common in extensively forested, NHCF landscapes as well. Within extensive but managed forests of this region, relatively large, contiguous patches of mature forest, unfragmented by even-aged management, may be required to conserve some area-sensitive avian species.

## 2000

**Meneks, M.L. 2000.** Larval and juvenile fishes of the Red River of the north. M.S. Thesis, University of Minnesota, St. Paul. 85pp.

Abstract: During the summers of 1998 and 1999, larval fish distributions were characterized with seine and drift nets at 13 sites - 7 channelized and 6 unchannelized - in the Buffalo and Sand Hill rivers, tributaries of the Red River of the North. Temperature, dissolved oxygen (DO), and water velocity were measured at each site. No significant differences were observed for mean water temperature; however, channelized sites tended to have increased maxima, decreased minima, and greater daily fluctuation in relation to unchannelized sites. Significant differences in DO were observed between channel type with channelized sites having higher mean values and a greater range in values. Intermittent flow or dry conditions were found at many channelized sites at least once during both study years, whereas unchannelized sites always had measureable flow. Common carp (*Cyprinus carpio*), fathead minnow (*Pimephales promelas*), and spotfin shiner (*Cyprinella spiloptera*) were abundant in both years, whereas creek chub (*Semotilus atromaculatus*) were abundant only in 1999. Fathead minnow, creek chub, northern redbelly dace (*Phoxiniscus eos*), and sand shiner (*Notropis ludibundus*) likely were stranded when channels became intermittent or dry based on timing of occurrence and collection date. Greater taxa richness was associated with unchannelized sites. Larval taxa were categorized into four guilds - tolerance to habitat degradation, feeding, parental care, and spawning substrate. Principle component analysis (PCA) explained more than 85% of the variance for the first two axes for larval catch across guilds, with axis 1 associated with channelization, and axis 2 associated with temperature and DO. Communities at unchannelized sites were associated with species of intermediate tolerance, insectivores, simple parental care, and lithophils and phyto-lithophils. Larval assemblages in channelized systems were characterized by tolerant fishes, omnivores, complex-guarders, and speleophils.

**Frost, J.A. 2000.** Macroinvertebrate monitoring: potential for volunteers. M.S. Thesis, University of Minnesota, St. Paul. 116pp.

Abstract: In chapter one, I examine the effectiveness of standard macroinvertebrate monitoring techniques to discriminate among agricultural land management practices in a small Minnesota watershed. The relationship between land use and instream physical habitat parameters was investigated using a transect approach. Exposed bank was significantly higher in wooded riparian areas than in successional or grazed riparian areas. Macroinvertebrate community metrics were not significantly different among riparian management practices. Macroinvertebrate metrics were affected by microhabitat conditions. Velocity, substrate embeddedness, and the percentage of algae present were correlated with several standard metrics: Hillsenhoff Biotic Index (HBI), Ephemeroptera, Plecoptera, Trichoptera index (EPT) and number of taxa. I conclude that macroinvertebrates may not be an appropriate monitoring tool for assessing the effects of local management practices at the scale of a single farm; rather this tool should be used on a broader temporal and spatial scale in the context of a whole watershed.

In chapter two, I investigate the ability of untrained volunteers to assess water quality using benthic macroinvertebrate monitoring protocols. In the Wells Creek watershed, tolerance values for the Save our Streams (SOS) method indicated lower water quality than family-level or species-level tolerance metrics. This simplified method may not be precise enough to detect differences in the macroinvertebrate community composition or the associated habitat quality. In addition, I found that monitoring is challenging for untrained volunteers. Beginner volunteers were biased in their approach to randomly sorting a sub-sample of organisms, selecting larger organisms more often than professionals. Untrained volunteers were not able to consistently identify organisms correctly. If macroinvertebrate monitoring programs are to be effective, significant time must be devoted to training volunteers. Locally developed keys should be made available. In conjunction with the results from chapter one, I conclude that for volunteer macroinvertebrate monitoring to be an effective tool we must focus on helping volunteers produce accurate results.

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# PRESENTATIONS

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## INVITED PRESENTATIONS

1999

Kennedy, P.L. and **D.E. Andersen**. 1999. Methods for monitoring regional populations of northern goshawks (*Accipiter gentilis*): an example protocol from the western Great Lakes region. Annual Meeting of the Raptor Research Foundation, Inc., La Paz, Mexico. November 1999.

2000

Epton, J. and **D.C. Fulton**. 2000. Building community through conflict management. Trout and the trout angler: Workshop II. Sponsored by the Salmonid Technical Committee, North Central Division of the American Fisheries Society, La Crosse, Wisconsin. July 2000.

**Fulton, D.C.** 2000. Integrating social information into decision-making. Trout and the trout angler: Workshop II. Sponsored by the Salmonid Technical Committee, North Central Division of the American Fisheries Society, La Crosse, Wisconsin. July 2000.

**Vondracek, B.** 2000. Grazing, landscape health and water quality. Enhanced Landscape, Food Systems, Human and Animal Health Symposium, University of Minnesota. April 2000.

**Vondracek, B.** and K.L. Blann. 2000. Catchment and riparian scale influences on streams in southeastern Minnesota. 130<sup>th</sup> Annual meeting of the American Fisheries Society, St. Louis, Missouri. August 2000.

**Vondracek, B.,** K.L. Blann and B. A. Nerbonne. 2000. Habitat-fish relationships across local to watershed scales. Trout and the trout angler: Workshop II. Salmonid Technical Committee, North Central Division of the American Fisheries Society, La Crosse, Wisconsin. July 2000.

## CONTRIBUTED PRESENTATIONS

1999

Blann, K.L. and **B. Vondracek**. 1999. Stream fish distribution, community structure, and habitat in relation to land use, geology, and geomorphology in southeastern Minnesota. Joint meeting of the Iowa, Minnesota and Wisconsin Chapters of the American Fisheries Society, La Crosse, Wisconsin.

Frost, J.A. and **B. Vondracek**. 1999. Citizen macroinvertebrate monitoring: does it meet the mark? 47<sup>th</sup> Annual meeting of the North American Benthological Society, Duluth, Minnesota.

**Fulton, D.C.**, K.J. Hundertmark, G. Del Frate, and M. Masteller. May 1999. Moose hunters' assessment of a selective harvest system for bull moose in southcentral Alaska. 35<sup>th</sup> North American Moose Conference. Grand Marais, Minnesota.

**Fulton, D.C.**, A.D. Bright, and C. Matt. September 1999. The effects of experience on reported preferences for brown bear viewing opportunities, McNeil River, AK. The Wildlife Society Annual Conference. Austin, Texas.

Meneks, M. and **B. Vondracek**. 1999. Larval and juvenile fishes of the Red River. Joint meeting of the Iowa, Minnesota, and Wisconsin chapters of the American Fisheries Society, La Crosse, Wisconsin.

Ruetz, C.R., III, R.M. Newman and **B. Vondracek**. 1999. Do fish affect leaf litter decay in Valley Creek, Minnesota? 11<sup>th</sup> Annual St. Croix River Research Rendezvous, Marine on St. Croix, Minnesota.

Ruetz, C.R., III, **B. Vondracek** and R.M. Newman. 1999. Top-down effects of slimy sculpin in Valley Creek, Minnesota. 47th Annual meeting of the North American Benthological Society, Duluth, Minnesota.

## 2000

Blann, K.L. and **B. Vondracek**. 2000. Catchment and riparian scale influences on streams in southeastern Minnesota. 7<sup>th</sup> Biennial Conference of Minnesota Water 2000, Minneapolis, Minnesota, April 2000.

Blann, K.L. and **B. Vondracek**. 2000. Catchment and riparian scale influences on streams in southeastern Minnesota. Joint meeting of the Minnesota chapters of the American Fisheries Society and the Wildlife Society, St. Cloud, Minnesota. January 2000.

Boal, C.W., **D.E. Andersen**, and P.L. Kennedy. 2000. Breeding season, home range, and habitat use of male northern goshawks (*Accipiter gentilis*) in Minnesota. 2000 Annual Meeting of the Raptor Research Foundation, Inc. Jonesboro, Arkansas. November 2000.

Dougherty, E.M. and **D.C. Fulton**. 2000. Understanding values and attitudes related to deer management in Cuyahoga Valley National Recreation Area. 8<sup>th</sup> International Symposium on Society and Resource Management, Bellingham, Washington. June 2000.

Epton, J.A. and **D.C. Fulton**. 2000. Procedural justice in natural resource decision making: building healthy communities of interest. 8<sup>th</sup> International Symposium on Society and Resource Management, Bellingham, Washington. June 2000.

**Fulton, D.C.** 2000. A planning framework for experience-based wildlife viewing management. Wildlife Viewing: A Management Planning Workshop. Winterpark, Colorado. May 2000.

**Fulton, D.C.** 2000. Applying outcomes-based management to fish and wildlife recreation. Human Dimensions of Natural Resource Management: Emerging Issues and Practical Applications. University of Minnesota, St. Paul. February 2000.

**Fulton, D.C.** 2000. Social Dimensions of Bear Management at McNeil River, AK. Winter

Seminar Series, Department of Fisheries and Wildlife, University of Minnesota.

- Hayes, S., D.H. Anderson, and **D.C. Fulton**. 2000. Identifying social benefits of waterfowl production areas in Minnesota. 62<sup>nd</sup> Midwest Fish and Wildlife Conference, Minneapolis, Minnesota. December 2000.
- Meneks, M. and **B. Vondracek**. 2000. Fish assemblages in channelized and unchannelized streams in the Red River of the North. 130<sup>th</sup> Annual meeting of the American Fisheries Society, St. Louis, Missouri. August 2000.
- Meneks, M.L. and **B. Vondracek**. 2000. Juvenile and larval fishes of the Red River of the North-Year 2. Joint meeting of the Minnesota chapters of the American Fisheries Society and the Wildlife Society, St. Cloud, Minnesota. January 2000.
- Murray, L. and **D.C. Fulton**. 2000. Using a normative approach to assessing fishing bag limits in Minnesota. 62<sup>nd</sup> Midwest Fish and Wildlife Conference, Minneapolis, Minnesota. December 2000.
- Ruetz, C. R., III, R.M. Newman and **B. Vondracek**. 2000. Effects of fish on grazers and periphyton in a coldwater Minnesota stream. 130<sup>th</sup> Annual meeting of the American Fisheries Society, St. Louis, Missouri. August 2000.
- Ruetz, C.R., III, R.M. Newman and **B. Vondracek**. 2000. Fish effects on shredders and leaf litter decay in a coldwater Minnesota stream. Joint meeting of the Minnesota chapters of the American Fisheries Society and the Wildlife Society, St. Cloud, Minnesota. January 2000.
- Sammler, J.E., **D.E. Andersen**, and S.K. Skagen. 2000. Population trends of tundra nesting birds at Cape Churchill, Manitoba. 7<sup>th</sup> National Wildlife Society Conference. Nashville, Tennessee. September 2000.
- Sammler, J.E., **D.E. Andersen**, and S.K. Skagen. 2000. Population trends of tundra nesting birds at Cape Churchill, Manitoba. 62<sup>nd</sup> Midwest Fish and Wildlife Conference, Minneapolis, Minnesota. December 2000.

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# HONORS AND AWARDS

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**David Andersen:**

Promoted to GS-14, 1999

Promoted to Adjunct Professor, Department of Fisheries and Wildlife, 1999

**Bruce Vondracek:**

Special Recognition Award, Minnesota Chapter of the American Fisheries Society, 2000

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## UNIT NEWS

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Bruce Vondracek and six colleagues from the University of Minnesota were invited to Nepal by Rabi Bista, Secretary of the Ministry of Forests, and Dr. Thirta Maskey, Director General of the Department of National Parks and Wildlife Conservation. Bruce and colleagues explored the Narayani River and the surrounding watershed in the Royal Chitwan National Park to develop an understanding of the nature of the pending industrial development and potential impact on the biodiversity of the watershed. He was assisted by local fishers to sample the riverine fish community and brought fish samples back to Minnesota to analyze for contaminants. During the trip, he and his colleagues wrote a grant proposal to be submitted with the support of the Nepal Ministry of Forests and the Department of National Parks and Wildlife Conservation to the Global Environmental Fund.

Gerda Hagen retired from the Unit in April 1999 after over ten years of outstanding service. Teri Kanikula joined the Unit upon Gerda's retirement as the new Unit secretary, and although Gerda will never be replaced, Teri has admirably risen to the task of Unit administration. Our thanks to Gerda and Teri for all of their effort.

Blair Joselyn retired from his position as Wildlife Research Supervisor with the Minnesota Department of Natural Resources (MNDNR). Blair had jointly represented the MNDNR on our Coordinating Committee since the inception of our Unit, and we appreciate his support and effort on behalf of the Minnesota Cooperative Fish and Wildlife Research Unit.