MINNESOTA COOPERATIVE FISH AND WILDLIFE RESEARCH UNIT

Biennial Report

January 2005— December 2006

U.S. Geological Survey

University of Minnesota

Minnesota Department of Natural Resources

The Wildlife Management Institute

U.S. Fish and Wildlife Service

U.S. Geological Survey
Minnesota Cooperative Fish and Wildlife Research Unit
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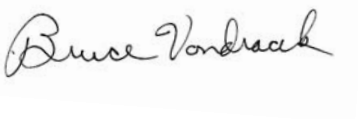
Introduction

The Cooperative Research Units Program was established over sixty years ago to facilitate cooperation among the U.S. Department of the Interior (currently through the U.S. Geological Survey), 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. That mission continues today, with support from both long-standing and new partners. At the Minnesota Cooperative Fish and Wildlife Research Unit, we emphasize 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.

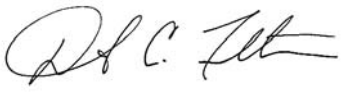
The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987, and staffed beginning in 1988. This is the ninth biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 2005 and 2006. Over the past two years, support for the Unit program in general, and for our Unit in particular, has remained strong. We have worked with a wide range of cooperators, outstanding graduate students, and university, federal, state, and nongovernmental scientists and resource managers to further our research and teaching missions, and to provide technical assistance to partners and clients. We invite you to review this summary of our Unit's accomplishments and to contact us with comments or to request additional information. Thanks to our many partners and supporters!

Sincerely,

Dr. David E. Andersen
Leader



Dr. Bruce Vondracek
Assistant Leader - Fisheries



Dr. David C. Fulton
Assistant Leader - Wildlife

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Personnel and Cooperators

Unit Personnel

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Dr. Bruce Vondracek, Assistant Leader – Fisheries

Dr. David C. Fulton, Assistant Leader – Wildlife

Unit Staff – University of Minnesota

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Michelle Payton, Research Fellow

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Louis Cornicelli, Ph.D. (Fulton)
Samantha Hayes, M.S. (Fulton and Anderson)
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David Huff, Ph.D. (Vondracek and Newman)
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Eric Merten, Ph.D. (Vondracek and Newman)
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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.

Name	Year	Title of Project	Faculty Sponsor
Brian Reichert	2005	Bird Observations at Cape Churchill, Wapusk National Park of Canada	Andersen
Lisa Pugh	2006	Use of Otoliths to Age Slimy Sculpin	Vondracek

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Todd Arnold
Robert Blair
Yosef Cohen
James A. Cooper (emeritus)
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Alan Franklin (adjunct)
David Garshelis (adjunct)
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Jay Hatch (adjunct)
Frederick J. Jannett (adjunct)
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Anne R. Kapuscinski
Loren Miller
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Raymond M. Newman
John Nieber (Bioproducts and Biosystems Engineering)
Gad Perry (Texas Tech University)
James Perry
Bruce Wilson (Bioproducts and Biosystems Engineering)

Cooperating University of Minnesota Academic Units

Biosystems and Agricultural Engineering Graduate Program
College of Natural Resources
College of Food, Agricultural and Natural Resource Sciences
Conservation Biology Graduate Program
Consortium on Law and Values in Health, Environment, and the Life Sciences
Department of Fisheries, Wildlife, and Conservation Biology
Department of Forest Resources
Natural Resources Research Institute (NRRI)
Natural Resources Science and Management Graduate Program
Undergraduate Research Opportunities Program
Water Resources Center
Water Resources Science Graduate Program
Wildlife Conservation Graduate Program

Cooperating Organizations

Legislative Committee for Minnesota Resources
Michigan Department of Natural Resources
Minnesota Forest Resources Council
Minnesota Department of Natural Resources
Minnesota Pollution Control Agency
Mississippi Flyway Council
- U.S. Fish and Wildlife Service
- Canadian Wildlife Service
- Manitoba Conservation
- Minnesota Department of Natural Resources
- Iowa Department of Natural Resources
- Missouri Department of Conservation
- Arkansas Game and Fish Commission

National Council for Air and Stream Improvements
Northern Michigan University
Potlatch Corporation
South Dakota Game, Fish, and Parks
Texas Tech University
University of Minnesota
- Cargill Fellowship
- MacArthur Fellowship

University of Wisconsin – Madison
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service
- Division of Migratory Birds, Region 3
- Sherburne National Wildlife Refuge, Region 3
- Ecological Services, Region 2
- Webless Migratory Gamebird Research Program

U.S. Forest Service
- Chippewa National Forest
- Superior National Forest
- Eastern Region

U.S. Geological Survey
- Mississippi Cooperative Fish and Wildlife Research Unit
- Northern Prairie Wildlife Research Center
- Texas Cooperative Fish and Wildlife Research Unit

Wapusk National Park of Canada

Completed Research

Applied Ecology

An Assessment of Terrestrial Snail Biology and Ecology with Threats Analysis

Investigators: Ron Moen (Cooperating Faculty) *(former PI: Joseph Mayasich)*

Students: Anna Peterson, M.S. (Biology, University of Minnesota Duluth)

Duration: September 2004 to April 2006

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

Project Location: University of Minnesota Duluth; Natural Resources Research Institute

There is little information available on the biology and ecology of various species of terrestrial snails that inhabit the Midwestern United States. Although some survey work was completed in the early 1990s, there has since been no follow-up effort on terrestrial snails regarding species-specific population trends and distributional patterns, or research on potential threats to their persistence. Terrestrial snails have unique and specific habitat requirements, with a preference for cool and moist microclimates associated with areas of limestone and dolomite that were unaffected by historical glacial drift. Because terrestrial snails are habitat specialists, their populations tend to be relatively isolated. Their patchy distribution makes them vulnerable to stresses imposed by land use changes, especially development for commercial and/or residential use. Given the high potential for anthropogenic activities to significantly impact unique habitats and thereby threaten the relatively isolated populations of any species associated with them, a thorough range-wide status assessment of terrestrial snails is warranted.

The objectives of the proposed research were to determine the status and distribution of select terrestrial snail species and to identify data gaps in biological information available on these species. This was accomplished through a review, interpretation, and summary of published and unpublished literature, reports, plans, and data. In addition, extensive personal communications with terrestrial snail experts were used to update essential information and/or close data gaps. The deliverable product was a Status Assessment that included a detailed and thorough analysis of all potential threats to terrestrial snails, an assessment of trends in their populations, and present geographic distributional patterns.

Ecology of Canada Lynx in Minnesota

Investigators: Ronald Moen (Cooperating Faculty)

Students: Chris Burdett, Ph.D. (Conservation Biology)
Nick McCann, M.S. (Biology)
Julie Palakovich, M.S. (Biology)
Brice Hanson, M.S. (Integrative Biological Sciences)

Duration: April 2003 to December 2006

Funding Sources: U.S. Department of Agriculture, Forest Service – Superior National Forest
U.S. Fish and Wildlife Service
U.S. Geological Survey, Northern Prairie Wildlife Research Center
Minnesota Department of Natural Resources

Project Location: University of Minnesota Duluth; Natural Resources Research Institute

Minnesota historically supported the largest Canada lynx (*Lynx canadensis*) population in the Great Lakes region. It was thought that lynx had been extirpated from Minnesota in the early 1990s, but videos, sightings, and DNA evidence documented the presence of Canada lynx in Minnesota during the process of lynx being listed as a Threatened Species under the Endangered Species Act in 2000. This project was undertaken to increase understanding of the (1) location, (2) distribution, (3) persistence, and (4) habitat use of Canada lynx in and near the Superior National Forest (SNF) in northeastern Minnesota. We captured and deployed radio telemetry collars on 33 Canada lynx and 3 bobcats (*Lynx rufus*). One major question being addressed in the project is whether Canada lynx persist in Minnesota through a lynx-hare cycle. Monitoring radio-collared individuals over the next decade, observations, and genetic analysis will all provide supporting data on the question of persistence. VHF telemetry provides data on the distribution of Canada lynx in Minnesota. Genetic analysis of scat, hair, and tissue identifies individual Canada lynx, and also provides a baseline for mark-recapture estimates of abundance as well as persistence in future years. Habitat use is being evaluated primarily with GPS collars; over 12,000 locations have now been collected. GPS collar data are supplemented with snow-tracking in the winter

months. The status of the major prey species of Canada lynx, snowshoe hare (*Lepus americanus*) is monitored with permanent plots established throughout the SNF. Plots were distributed based on stratified random, systematic, and selective site selection strategies. These methods collectively make it possible to greatly increase understanding of Canada lynx in Minnesota.

Further details on the Canada lynx project are available on the Lynx Project website at www.nrri.umn.edu/lynx. The website provides a history of the project, lists project goals and accomplishments, and has annual reports available for download.

Effects of Biotic and Physical Heterogeneity on Trophic Interactions in Headwater Streams

Investigator: Bruce Vondracek

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

Duration: September 2001 to July 2005

Funding Source: Cargill Fellowship

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

We conducted 6 experiment trials to examine interactions between native brook trout (*Salvelinus fontinalis*) and slimy sculpin (*Cottus cognatus*) versus nonnative brown trout (*Salmo trutta*) to investigate whether introductions of nonnative trout affect food web relationships in small streams. Few studies have investigated effects of introduced trout on stream communities where native trout still occur. Enclosures (1 m^2) were stocked according to 6 treatments: combined-species treatments (juvenile brown trout with sculpin, juvenile brook trout with sculpin), single-species controls, and no fish at 3 densities to examine intraspecific versus interspecific competition. Enclosures did not reduce abundance of drifting invertebrate prey. Interactions between brown trout and sculpin led to reduced growth of both large sculpin and large brown trout in enclosures, whereas brook trout were not associated with changes in sculpin growth. Brown trout were associated with indirect effects on food web dynamics and shifts in sculpin diets. Feeding behavior and intraspecific

interactions among brown trout, along with shifts in feeding behavior of sculpin when brown trout were present, likely was a mechanism underlying reduced growth of both species. We suggest that introducing non-native trout can have cascading effects in a stream system and could negatively affect natural fish populations, especially in areas where a native fish is threatened.

Fall Movements, Habitat Use, and Survival of the American Woodcock in the Western Great Lakes Region

Investigator: David E. Andersen

Collaborators: Michigan—John Bruggink and Eileen Oppelt (Northern Michigan University)
Wisconsin—Scott Lutz and Jed Meunier (University of Wisconsin, Madison)

Student: Kevin Doherty, M.S. (Wildlife Conservation)
Staff: Becky Hylton (Project Field Supervisor, 2004)

Duration: September 2000 to June 2005

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

Project Location: Mille Lacs and Four Brooks Wildlife Management Areas
Minnesota Cooperative Fish and Wildlife Research Unit
North-central Wisconsin
Upper Peninsula of Michigan

Little is known regarding fall movements, habitat use, and survival of American woodcock (*Scolopax minor*), 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, in 2000 we initiated a 4-year study of fall woodcock ecology in the western Great Lakes region. Field work began in Minnesota in 2000, with parallel studies initiated in Wisconsin and Michigan in 2001. In Minnesota, Wisconsin, and Michigan, we identified a pair of study sites in close geographic proximity where woodcock habitat and population densities were similar. One of these areas was open to woodcock hunting, and the other was closed to woodcock hunting or experienced very low hunting pressure. On each study site, we annually captured and equipped 30-90 woodcock with radio transmitters in late summer and early fall, prior to the initiation of the woodcock hunting season. Subsequent to capture and release, we monitored survival and habitat use of radio-marked woodcock through

the hunting season or until surviving woodcock migrated from study sites. From 2001-2004 across all 3 states we captured and radioequipped 1,169 woodcock; 594 on hunted areas and 575 on non-hunted or lightly-hunted areas. Survival estimates during the hunting season were generally higher in non– or lightly-hunted than in hunted areas. However, survival estimates between study sites in the same state during the same year were not statistically different from

one another, except in 2 instances. Survival was variable among years and sites, but highest in non-hunted areas, suggesting that hunting mortality may vary more than other causes of mortality. We also monitored a sub-sample of after-hatch-year (AHY) female woodcock intensively in each state and analyses of movement and habitat use data from these birds suggest that woodcock make primarily small-scale movements (47.7% <50 m between locations on subsequent days and 5.82 ha average 95% fixed-kernel home-range size) prior to migration. Primary cover types used were aspen (*Populus* spp.) seedling/sapling, aspen pole, alder (*Alnus* spp.), conifer, and willow (*Salix* spp.). Woodcock used edges within individual covers, but use of edge habitats was variable among habitat types and years. Results of this research have been incorporated into 3 M.S. theses (1 each at the University of Minnesota, University of Wisconsin – Madison, and Northern Michigan University), presented at multiple national and international conferences, and submitted for publication in the peer-reviewed scientific literature.

Genetic Methods of Biological Control of Non-native Fish in the Gila River System

Investigator: Anne Kapuscinski (Cooperating Faculty)

Students: Timothy Patronski, M.S. (Humphrey Institute)
Ron Millen, Ph.D. (Conservation Biology)
Pouya Najmaie, Undergraduate (College of Natural Resources)

Duration: August 2003 to September 2005

Funding Source: U.S. Fish and Wildlife Service, Region 2

Project Location: Gila River System
University of Minnesota

Non-native fish, habitat degradation, and water development have combined to become major stressors on the health of native fish and their habitats in the U.S. Southwest. In recent years, the impact of these stressors has led to the precipitous decline of many native fish species endemic to this area. Biologists have been searching for more effective ways to reduce the negative impact of undesirable non-native fish. Improved biological control of non-native fish could help address this complex challenge. This project addressed the feasibility of using genetic methods as a new approach for biological control of non-native fish within the Gila River basin, and reviewed the status of existing genetic methods including chromosome set manipulations and recombinant DNA techniques. The project also included a preliminary assessment of potential ecological and human health risks, outlined policy and regulatory considerations, identified the need for and developed an approach for multi-stakeholder deliberation, estimated general cost and time considerations, and outlined integration of these considerations into a multi-component research and development program.

Any future effort to further develop the potential use of genetic methods for biological control of nonnative fish within the Gila River basin or elsewhere would raise some difficult social and ecological questions. This is especially true for any proposed application of transgenic fish for biological control. Genetic biocontrol of non-native fish is a potentially powerful new tool to help recovery of precipitously declining native fish but may also be controversial. Recommendations include scientifically sound analysis of efficacy and risks, trusted multi-stakeholder deliberation, and a coordinated staged program. It would also be desirable to strengthen the base of scientific information regarding whether a specific non-native fish is indeed substantially impeding recovery of 1 or more native fish species. Current understanding suggests that genetic methods alone will not be a panacea to the challenge of controlling non-native fish in the Gila River basin. We recommend moving forward with a research effort to fully explore development, efficacy, and potential risks of various genetic biocontrol methods only if: (1) this is pursued as part of a multicomponent research and development program ; and (2) the

program is implemented as part of a broader, basinwide integrated pest management strategy that might also include mechanical and chemical control methods and pheromone attractants to improve control efficiencies.

The Great Lakes Piping Plover: Population Research and Recovery

Investigator: Francesca Cuthbert (Cooperating Faculty)

Student: Cathy Haffner, M.S. (Conservation Biology)
Vanessa Pompei, Ph.D. (Conservation Biology)

Duration: May 2003 to December 2005

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

Project Location: United States Great Lakes
University of Minnesota

Little is known about the migration biology of the endangered and threatened piping plover (*Charadrius melodus*). Published records of piping plover sightings throughout North America were compiled and used to identify and rank current and historic stopover sites, explore the spatial patterns of stopover sites, document chronology of migration, and examine differences between spring and fall migration patterns and timing. Our results showed that piping plovers use sites throughout the region east of the Rocky Mountains. More than 3,400 fall and spring stopover records were located at 1,196 sites. Approximately half the sites were current stopover sites; the other half were historic sites with no recent records of use by plovers. Birds stop at both coastal and inland sites during migration. Published reports indicate plovers do not concentrate in large numbers at inland sites, and that they seem to stop opportunistically. In most cases, birds were reported as single individuals. For these reasons, protecting specific stopover sites for migrating piping plovers does not seem feasible or warranted at this time. Additionally, our study of the breeding-season spatial requirement of Great Lakes piping plovers indicated that human beach use and proximity to other nesting plovers were the most important factors influencing plover movement and home range size. These results suggest that small parcels of suitable habitat have high conservation value for this species.

Survival of Elk Calves in Yellowstone National Park

Investigator: James Perry (Cooperating Faculty)

Student: Shannon Barber, Ph.D. (Wildlife Conservation)

Duration: September 2004 to October 2005

Funding Source: U. S. Geological Survey; Northern Prairie Wildlife Research Center

Project Location: Yellowstone National Park

Wolves (*Canis lupus*) were restored to Yellowstone National Park (YNP) during 1995-1996. Annual counts of northern Yellowstone elk (*Cervus elaphus*) have declined by approximately 50% from 19,045 just prior to wolf restoration (1994) to 9,545 10 years post-wolf reintroduction (2005) and indices of recruitment during 2002-2005 were among the lowest (12-14 calves/100 cows) recorded during the past several decades. We began a 3-year study in May 2003 of mortality in northern Yellowstone elk calves to determine the basis for the decline in calf recruitment. Calves $\leq$6-days old (n = 151; 83 females: 68 males) were captured and fit with radio transmitters. Annual survival was 0.216 (SE = 0.035, n = 149) and varied by calving area but not year. Neonates captured in the Stephens Creek/Mammoth area had annual survival rates more than 3 times higher (0.544) than those captured in the Lamar Valley area (0.173). Summer survival (20 weeks following radio-tagging) was 0.313 (SE = 0.041, n = 147), and calving area and individual covariates including absolute deviation from median birth date and sex were important predictors of summer survival. Survival during

winter (November-April) was 0.899 (SE = 0.048, n = 42) and did not vary by calving area or year. Sixty-nine percent (n = 104) of calves died within the first year of life, 24% (n = 36) survived their first year, and 7% (n = 11) had unknown fates. Grizzly bears (*Ursus arctos*) and black bears (*U. americanus*) accounted for 58-60% (n = 60-62) of deaths, and wolves accounted for 14-17% (n = 15-18). Summer predation (95% of summer deaths) has increased while winter malnutrition (0% of winter deaths) has decreased compared to a 1987-1990 study (72% and 58%, respectively).

Completed Research

Human Dimensions, Management, and Conservation

Biodiversity Conflict Management: Land-use Policies in Island Landscapes, a State-level Comparison

Investigators: Bruce Vondracek and Kristen Nelson

Student: Fiona Nagle, M.S. and Ph.D. (Conservation Biology)

Duration: September 1998 to April 2007

Funding Sources: Consortium on Law and Values in Health, Environment, and the Life Sciences
University of Minnesota
MacArthur Fellowship

Project Location: Hawaii and Tasmania

Our 4-member team focused on state and regional policies that designate land for biodiversity reserves in 2 regions, Hawaii and Tasmania. With escalating globalization, development, and biodiversity crises, policy goals to achieve biodiversity face increasingly intense competition from human-oriented land uses. Island landscapes, both oceanic and terrestrial (i.e., geographically isolated areas), foster particularly contentious disputes between management authorities and land users due to the juxtaposition of biodiversity, limited land area, and limited economic alternatives. Disputes over land use in an "environment versus economy" context are notably chronic, long-standing, and socially disruptive. We used policy case studies and disputes that disrupt policy implementation to explore whether conflict management effectively promotes biodiversity and environmentally sensitive land use. Our objectives were to: (1) develop a framework for decision-making and conflict management, (2) provide a comprehensive set of guidelines by which existing disputes can be evaluated, and (3) develop predictions about what will constitute a 'successful' versus 'unsuccessful' process to manage disputes. We found that Hawaii's Land Use Commission generated quality agreements that were satisfactory, less confrontational, constructive and productive, and environmentally and socially sustainable in the long term based on the framework for decision-making and conflict management.

Geospatial Techniques for National Wildlife Refuge Planning and Management

Investigator: Thomas E. Burk (Cooperating Faculty)

Students: Jennifer Sieracki, Nicole Brown, Brian Mueller, Marcelle Caturia, Leah Rathbun, Karen Walker, Kari Geurts, Perry Nacionales, Jim Gonsoski

Duration: August 2000 to December 2006

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

Project Location: University of Minnesota, St. Paul

This work has focused on developing a framework for generating timely and accurate geospatial data in support of National Wildlife Refuge Comprehensive Conservation Planning (CCP). We have gone through several iterations of the framework and have illustrated its application on specific refuges. U.S. Fish and Wildlife Service Region 3 office staff members are now applying the final framework and associated protocols to complete GIS development for other refuges. Vegetation mapping is an important component of GISs of this type. We developed and applied new procedures for vegetation mapping of National Wildlife Refuge lands. These procedures include a rigorous and valid accuracy assessment protocol, the results of which are published with the final map products.

As part of this project, a number of products were produced that are currently being used by the U.S. Fish and Wildlife Service:

(1) GISs were completed for 5 test refuge cases. Data and metadata have been delivered and the efforts have been documented via publication.

(2) Species and habitat work was completed for both the Muscatatuck and Patoka River National Wildlife Refuges. Critical species lists were produced for each, and a matrix linking species to

habitat requirements has been produced for Muscatatuck. Additionally, a habitat classification map was completed, and a 2-panel poster describing the work was provided to the U.S. Fish and Wildlife Service.

(3) Procedures were developed and implemented for mapping Waterfowl Production Areas. A case study using lands in the state of Wisconsin was completed.

(4) Refuge boundary delineation was completed for all of U.S. Fish and Wildlife Service Region 3 National Wildlife Refuges. The methods used, building on a U.S. Fish and Wildlife Service Standard Operating Procedure, were documented in a Department of Forest Resources Staff Paper.

(5) A general approach to vegetation classification, resulting in a product useful for CCP, was developed and documented (in-house Web document). The approach is imagery independent and uses the National Vegetation Classification System (formation and alliance levels). A detailed approach to accuracy assessment has been formulated, including specification of sampling protocol and statistical analysis. The mapping and assessment approaches have been successfully implemented for the Swan Lake National Wildlife Refuge. This effort utilized Ikonos satellite imagery and resulted in > 85% classification accuracy overall and for significant (area basis) classes. The approach was also evaluated at Rice Lake National Wildlife Refuge using color infrared aerial photography.

(6) The changing status of the wild rice beds prevalent at the Rice Lake National Wildlife Refuge was the focus of 2 separate efforts. Assessing this resource is complicated by the high year-to-year variability in wild rice establishment success. We obtained historical aerial photography, flew over and took photographs of the refuge in 2004, and obtained historical (on-the-ground) transect data to address this issue. We developed a classification system for the primary vegetation types that occur in the lake, including wild rice, and obtained reference data to apply the classification system to the most recent photography. We also applied the classification system to the older photography and used the transect data for accuracy assessment. A rigorous accuracy assessment (including ground visits) was applied to the classification using the most recent photography.

(7) In support of the basic CCP GIS efforts we have developed several additional protocols that are documented via in-house Web documents. These include: a QA/QC document for evaluating data and metadata delivered from the framework we developed; a metadata generation/ verification procedure using new ArcCatalog functionality in conjunction with metaparser; a detailed, step-by-step documentation for orthorectification and mosaicing of aerial photography that strikes an appropriate (for CCP usage) tradeoff between producing a “visually appealing” and an analytically useful end product; a document on a protocol for matching internal refuge data layers according to an accuracy hierarchy.

(8) Finally, a small side effort in support of the completed Shiawassee CCP GIS was completed that involved making conservation easement data available for digital analysis.

Potential Effects and Costs of Sinkhole Buffers in Southeastern Minnesota: Conservation in Karst

Investigator: Bruce Vondracek

Students: Adam Petersen, M.S. (Conservation Biology)

Duration: September 2003 to June 2005

Funding Source: Minnesota Cooperative Fish and Wildlife Research Unit

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

Our goal was to evaluate how water quality and quantity might change if vegetative buffers were installed around 8,339 sinkholes in southeastern Minnesota, and to estimate the investment needed to install buffer strips through the Conservation Reserve Program (CRP). Data from ArcGIS on land use and topography were incorporated into a database to model impacts of runoff volume, sediment, nitrogen, and phosphorus for buffers from 2.5 to 30m wide around sinkholes. Row crops covered 40 to 70% of land across the study area, but represented 83% of land use adjacent to sinkholes. Most sinkholes have little to no vegetative cover around their margin and likely receive runoff that contains agricultural contaminants. In general, our estimates indicate that >90% of soluble and insoluble pollutants and runoff would be trapped in buffers 30 m wide. Buffers 30 m wide around all sinkholes would remove ~ 1,530 ha of agricultural land from production

and would cost about $1,100,000 based on recent CRP payments. The reduction in sediment, nitrogen, and phosphorus would contribute to the State of Minnesota's goal of reducing pollutant loads in streams and rivers at a relatively low cost and remove only a small faction of agricultural land from production.

Trends in Human Use and Conservation of Fisheries and Wildlife Resources in Minnesota

Investigator: David C. Fulton

Student: Susan Schroeder, Ph.D. (Natural Resources Science and Management)

Duration: September 2002 to December 2005

Funding Sources: Minnesota Department of Natural Resources
Division of Fisheries
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This study was a 3-year program of research for 2 divisions of the Minnesota Department of Natural Resources (Fisheries and Wildlife) to conduct a series of research projects to develop baseline information and monitoring tools for assessing the quality of fisheries and wildlife-dependent experiences. This project facilitated development of a long-term database to examine trends in participation and satisfaction related to fisheries- and wildlife-dependent recreation activities in the State of Minnesota.

In total, 9 studies were completed under this project including studies addressing: retention and constraints to hunting and fishing; attitudes and behaviors concerning the management of aquatic plant resources; waterfowl hunting and management in Minnesota in 2002 and 2005; trends in statewide attitudes concerning fisheries management in Minnesota; crowding and conflict related to angling in Minnesota; and stewardship concerns among Minnesota anglers.

Discrete Choice Modeling of Preferences for Alternative Deer Harvest Regulations

Investigator: David C. Fulton

Student: Louis Cornicelli, Ph.D. (Natural Resources Science and Managment)

Duration: January 2005 to July 2006

Funding Sources: Minnesota Department of Natural Resources
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

When faced with the choice of hunting under less than desirable regulations or not hunting in their traditional areas, Minnesota deer hunters will choose to hunt. Our results indicated a high fidelity to traditional hunting locations (90%) and unwillingness to move, even if they disagreed with the regulations (mean = 2.63/3.00). Which regulations hunters chose, however, depended on the scenario and an individual's perception of its effectiveness. For example, when faced with scenarios that called for a 25% and 50% reduction in the deer population, respondents were more likely to choose more liberal regulations under the 50% scenario.

There were 2 issues that stood out in this survey. First, moving the deer season out of the rut has been noted by individuals as an acceptable and 'easy' change that would result in more mature bucks in the deer herd. However, in the choice portion of this study, it was clear that respondents believed moving the deer season was less attractive than antler point restrictions. Indeed, when asked whether they supported or opposed moving the season, the regulation garnered less support (28%) than a buck license lottery (29%), which ranked lowest in all the choice scenarios. Most notably, southeast Minnesota respondents who are closest to Iowa where the deer season is in December were least likely to choose moving the deer season. Second, antler point restrictions have been proposed for northwestern Minnesota and work

has been done by local hunters to garner support for the regulation. However, in our survey, respondents in northwest Minnesota were not inclined to choose antler point restriction regulations. When we asked specifically about antler point regulations, northwest Minnesota respondents were more likely to choose the option of "not agreeing with the regulations but would hunt anyway", than any other group.

Finally, respondents clearly wanted an opportunity to hunt bucks every year. In all cases, the buck license lottery choice ranked lower than all other regulatory alternatives. The only choice that ranked lower than a buck license lottery was moving to another hunting location if the regulations were implemented. Clearly, if a buck license lottery were implemented, the Minnesota Department of Natural Resources would experience at best dissention among a majority of hunters and at worst, a movement of hunters to other areas of the state.

Social Science Research Support for Comprehensive Conservation Planning: Developing a Standardized Measurement Approach for Understanding Visitor Uses, Motives, and Preferences at USFWS National Wildlife Refuges

Investigator: David C. Fulton

Staff: Michelle Payton, Research Fellow

Duration: September 2002 to December 2005

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

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Previous visitor studies and literature were used to design a measurement instrument for ascertaining refuge visitor uses, motivations, and preferences concerning wildlife-related recreation activities within the U.S. Fish and Wildlife Service National Wildlife Refuge (NWR) System. Previous data sets collected from NWR visitors and elsewhere were used to assess reliability and validity of measurement scales through reliability analysis, confirmatory factor analysis, and path analysis modeling.

This study:

- Identified motivations for visiting NWRs;
- Identified the desired experiences and benefits that visitors receive from NWRs;
- Identified objectives preferred by various visitor segments interested in the management NWRs;
- Provided recommendations for developing a programmatic review process for collecting social science in support of the NWR System.

Ongoing Research

Applied Ecology

Ammonia, Nitrite, and Nitrate Toxicity to the Topeka Shiner

Investigator: Ira Adelman (Cooperating Faculty)

Staff: Jessica Koehle, Research Fellow

Duration: May 2006 to July 2009

Funding Source: U.S. Fish and Wildlife Service

Project Location: University of Minnesota

We are conducting a series of toxicity tests in accordance with ASTM guidelines in which Topeka shiners (*Notropis topeka*) will be exposed to ammonia, nitrite, and nitrate as separate tests. Concentrations of nitrogen chemicals in Topeka shiner Critical Habitat are of sufficient magnitude to either directly or indirectly adversely affect native minnows. However, the specific concentrations at which the various nitrogen forms adversely affect the Topeka shiner compared to the other native minnows are not known because chemical toxicity data are lacking for this endangered species. Regulatory agencies often need species-specific sensitivities of the Topeka shiner to nitrogen chemicals. To date, information that is available for closely related species such as other native shiner or minnow species that may or may not represent the sensitivity of the Topeka shiner is being used, but this information may not be protective of Topeka shiners. Therefore, this project will determine the concentrations of ammonia, nitrate, and nitrate that cause adverse affects on survival, growth, and development of Topeka shiners.

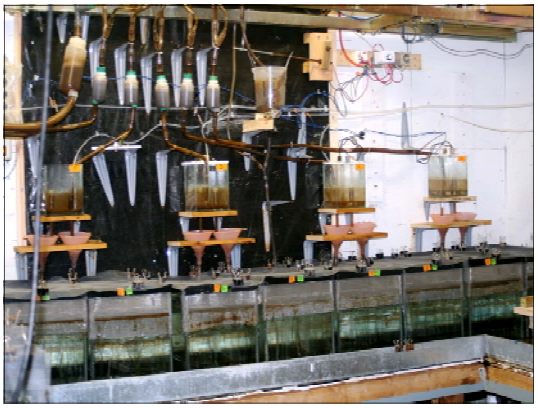


Photo: Partial view of the toxicant dosing apparatus and several of the test aquaria. (by Ira Adelman)

Ecological and Genetic Characteristics of Slimy Sculpin in Southeast Minnesota Streams

Investigators: Bruce Vondracek and Loren Miller (Cooperating Faculty)

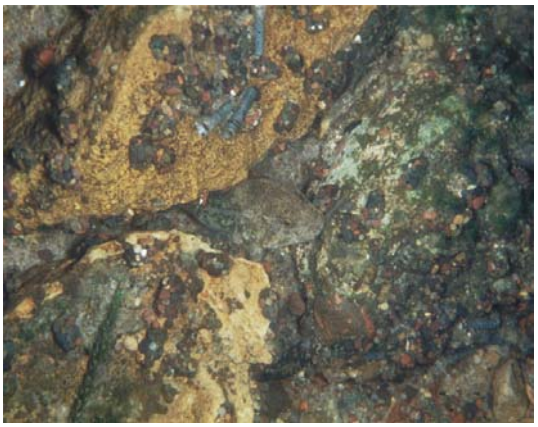
Students: David Huff, Ph.D. (Conservation Biology)
Rebecca Bronk, M.S. (Conservation Biology)

Duration: July 2006 to December 2009

Funding Source: Minnesota Department of Natural Resources
Cargill Fellowship

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

The Departments of Natural Resources in Iowa, Minnesota, and Wisconsin have implemented a "reintroduction" programs for sculpin (*Cottus* spp.) in streams in the Driftless Area Ecoregion of each state. The goal of these projects is to increase the distribution of sculpin by re-establishing viable, self-sustaining populations in trout streams where native populations are presumed to have been present historically, but were extirpated and unable to recolonize (http://www.dnr.state.mn.us/areas/fisheries/lanesboro/management.html). This effort will potentially restore an ecologically important species to these coldwater streams and provide an additional forage component to wild trout populations. Sculpin were successfully reintroduced to a southwest Wisconsin stream in the 1970s. However, the reintroduction programs were instituted with limited information about the ecological suitability of the streams selected for reintroduction. This study will investigate



genetic characteristics, survival, prey availability, diet of slimy sculpin, and habitat of donor and recipient streams to determine characteristics of streams most amenable to establishing reintroduced populations and examine ecological exchangeability of the sculpin.

Estimating Detectability Rates for Colonial Waterbirds in the U.S. Great Lakes

Investigator: Francesca Cuthbert (Cooperating Faculty)

Staff: Linda Wires, Research Fellow`

Duration: May 2005 to December 2006

Funding Source: U.S. Fish and Wildlife Service

Project Location: Northern Lakes Michigan and Huron
University of Minnesota

The U.S. Fish and Wildlife Service (USFWS) and Canadian Wildlife Service (CWS) have conducted 3 Great Lakes-wide surveys of breeding colonial waterbirds, one every decade since the 1970s. The second 2 surveys were organized to produce a temporally coordinated database. Data from all 3 surveys are stored at the U.S. Geological Survey's National Bird Population Data Center at Patuxent Wildlife Research Center. This repository archives data on waterbirds throughout their ranges and was facilitated through the North American Waterbird Conservation Plan and the Waterbird Monitoring Partnership. It is publicly accessible and allows biologists to submit and retrieve data over the Internet. Data collected in future Great Lakes colonial waterbird surveys will be deposited there.

In preparation for the next binational survey (scheduled 2007-2009), a workshop was convened at LaCrosse, Wisconsin (as part of the 2000 Annual Meeting of the Waterbird Society) to identify ways to improve the accuracy and frequency of the Great Lakes survey and ability to detect colonial waterbird population trends. As a result of the workshop, we submitted a report to the U.S. Fish and Wildlife Service with the following recommendations for research/ pilot studies:

(1) determine detection rates to assess accuracy of total nest counts
(2) develop and test species-specific census strategies for improving our ability to detect trends in Great Lakes colonial waterbird populations
(3) develop and test sampling designs for large colonies and compare their accuracy with total nest counts
(4) investigate the feasibility of censusing certain species/colonies using aerial photography.

This agreement provides funding to develop and evaluate methods to be used in the 2007 Binational Great Lakes Waterbird Survey to improve the accuracy of this effort. This project focuses on 3 of the recommendations developed at the 2000 LaCrosse workshop: estimation of nest detection rates, development of sampling designs for large colonies, and the feasibility of censusing certain species/colonies using aerial photography.

Since initiation of the project we have determined detection rates for double-crested cormorants (*Phalacrocorax auritus*), Caspian terns (*Sterna caspia*), common terns (*Sterna hirundo*), ring-billed gulls (*Larus delwarensis*), and herring gulls (*Larus argentatus*). Birds nesting on the ground in little or no vegetation were detected at higher rates than those in trees or birds nesting on the ground in dense vegetation. We also worked to determine under which conditions we can use aerial photographs to estimate sizes of colonial waterbird colonies through both complete counts and sampling efforts. In high quality photographs, ground-nesting birds can be easily identified, and birds on nests can be counted. Birds nesting in trees can also be identified and counted in high-quality aerial photographs. The best estimates (as compared to direct ground counts) are obtained using photos to count cormorants because their black plumage contrasts well against lighter substrates. Because islands do not have to be accessed to obtain data, counting colonial waterbirds using aerial photography includes the following benefits: greatly reduced impacts to nesting birds that can result from human intrusion into colonies and reduction in time, cost, and safety risks. To estimate numbers in large colonies of colonial waterbirds through aerial photography, we assessed the utility of estimating colony size via sampling. In this approach, the nesting colony can be measured using a GIS. Birds on nests within small sections (sample plots) can be counted and an average density for the colony can be estimated. This density can then be extrapolated to the entire area of the colony to estimate the number of breeding pairs. This method appears promising for estimating sizes of large colonies of multiple species, and will enable more frequent survey efforts to be undertaken, which will help detect population changes more rapidly.

Estimation and Evaluation of Demographic Parameters Required for Recovery of the Endangered Great Lakes Piping Plover Population

Investigator: Francesca Cuthbert (Cooperating Faculty)

Student: Erin Roche, Ph.D. (Conservation Biology)

Duration: March 2005 to June 2007

Funding Source: U.S. Geological Survey, Science Support Initiative

Project Location: University of Michigan Biological Station
University of Minnesota

The piping plover (*Charadrius melodus*) is a federally endangered migratory shorebird endemic to the Great Lakes, Great Plains, and Atlantic Coast of North America. Piping plovers nested historically along the shoreline of all the Great Lakes and were once considered locally common throughout the region. Due to loss of breeding sites to development and increased use of plover habitat by humans, the population dropped to fewer than 31 breeding pairs in Michigan by 1979. By 1986, when the Great Lakes piping plover was listed as federally endangered under the Endangered Species Act, only 17 pairs remained. In 2000, a population viability analysis of all the piping plover populations projected the Great Lakes population would decline to eventual extirpation. However, since 2000, the Great Lakes population has more than doubled, increasing to an estimated >50 breeding pairs. The discrepancy between model projections and observed population growth necessitates the demographic parameters necessary for population recovery be re-evaluated.

We employed 2 single-population stochastic models to project the viability of this population over 20- and 50-year periods. Our goals were to:

(1) Clarify assumptions about current demographic parameters of Great Lakes piping plovers (e.g., age of first breeding, age-specific survival).
(2) Refine proposed reproductive success estimates required to meet recovery goals established in the 2003 Great Lakes Piping Plover Recovery Plan.
(3) Re-assess projected time lines for population recovery utilizing recent demographic data and examine current recovery-program management options (e.g,. increasing reproductive success).
(4) Estimate genetic variability of the population using non-invasive inferential methods (pedigree analysis) derived from software models developed for management of small populations.

Our results suggest that under current best-case scenarios the Great Lakes population will require a fledging success rate of >1.87 chicks per nest to reach the target population size of 150 pairs in the next 20 years. Vital-rate values necessary to achieve this goal fall within the range of rates observed in the Great Lakes population since 2000. Using program MARK we estimated mean > 1st year survival at 77.0% (SE = 1.91%) and 1st

year survival at 26.1% (SE = 2.15%). The long-term reproductive rate (measured as chicks fledged per nesting female) was estimated at 1.53 (SE = 0.4) with 36.2% (SE = 8.77%) of laid eggs yielding a fledged chick. We used these vital rates to investigate several model scenarios. These scenarios revealed that environmental stochasticity and the presence of unaccounted-for nesting individuals may play a role in the continued viability of the Great Lakes population. The high level of uncertainty inherent to population viability analysis requires that any conservation plan for the Great Lakes piping plover population account for the potential effects of annual vital rate variation. Limiting the scope of population viability projections and conservation targets to <20 years would allow managers of this population to better assess target vital rates and potential management strategies in light of current population trends.

Factors Affecting Distribution and Detection of Boreal Chorus Frogs and Wood Frogs at Cape Churchill, Manitoba

Investigators: David E. Andersen
Clint Boal (Texas Cooperative Fish and Wildlife Research Unit)
Gad Perry (Texas Tech University)

Student: R. Nicholas Mannan, M.S. (Wildlife and Range Sciences)

Duration: June 2005 to January 2008

Funding Source: Texas Tech University
Wapusk National Park of Canada
Minnesota Cooperative Fish and Wildlife Research Unit

Project Location: Cape Churchill, Manitoba, Canada
Texas Tech University

Trends in population size and population dynamics are not well understood for most amphibian populations. In addition, at a global scale, many amphibian populations are thought to be declining. Compared to more temperate areas in North America, information is almost nonexistent regarding anuran populations in subarctic and arctic ecosystems. In Wapusk National Park (WNP) in northern Manitoba, Canada, 2 species of anurans exist in tundra habitats, the boreal chorus frog (*Pseudacris maculata)* and the wood frog (*Rana sylvatica)*. While the breeding range of both of these species extend across a large portion of North America, no published information regarding the ecology of either species in tundra environments exists. Based on previous anuran survey work in WNP, boreal chorus frogs and wood frogs appear to be distributed from coastal areas inland to the boreal forest-tundra interface. As an extension of these survey efforts, and to better understand anuran habitat relationships in the tundra biome, we propose to: (1) evaluate associations between anuran occurrence and water body type, vegetative structure, and environmental conditions (pH, salinity, total dissolved solids, and temperature), (2) evaluate and compare abundance of boreal chorus frogs and wood frogs

within vegetation patches that have and have not been impacted by lesser snow geese (*Chen caerulescens*) and Ross's geese (*Chen rossii*) herbivory, (3) assess factors influencing anuran detection, including temporal variation of calling rates of each species, both across diurnal periods and across the breeding season, and (4) evaluate plausible anuran survey methodologies by comparing automated call recorders and manual audile surveys and evaluating the effectiveness of broadcasting breeding calls of each species during a survey as a means of eliminating false negatives collected during audile surveys.

Genetic Determination of the Boundary between Northern and California Spotted Owls

Investigator: Ralph J. "Rocky" Gutiérrez (Cooperating Faculty)

Duration: August 2006 to July 2008

Funding Source: U.S. Fish and Wildlife Service

Project Location: North-central California and the University of Minnesota

Understanding the boundaries between populations of northern (*Strix occidentalis caurina*) and California spotted owls (*S. o. occidentalis*) is important for management and conservation of the species. Morphometric characteristics have proved unreliable in delineating subspecies, but the boundary between subspecies occurs somewhere in northern California. Currently, there are no relevant samples from north-central California that could be used to delineate this range boundary. The objectives of this project are to evaluate whether this boundary exists in the vicinity of the Pit River in northeastern California using genetic analysis.

Capture and tissue sampling of owls will begin in spring 2007.

Habitat Use of Post-fledging Forest-nesting Songbirds in Northern Hardwood-coniferous Forests in Northern Minnesota

Investigator: David E. Andersen

Student: Henry Streby, Ph.D. (Natural Resources Science and Management)

Duration: January 2005 to September 2009

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

Project Location: Chippewa National Forest, Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Compared to use of nesting habitat, habitat use by forest-nesting songbirds following fledging is relatively poorly understood. Recent studies based on point counts and mist-netting, and monitoring movement of fledglings via radio-telemetry, suggest that for at least some species of forest-nesting songbirds, habitat use post-fledging can be quite different from breeding-habitat use. To date, information regarding habitat use following fledging for forest-nesting birds is limited to a few studies from eastern (Virginia and West Virginia) and southern (Missouri) deciduous forests, and from only a few species of forest-nesting birds. No published information regarding post-fledging habitat use exists for northern hardwood-coniferous forest birds in the western Great Lakes region. Forest-management plans that incorporate considerations for forest-nesting birds generally do not consider habitat use following fledging. A more complete understanding of habitat use by forest-nesting birds in northern hardwood-coniferous forests would provide the basis for better incorporating considerations for forest-nesting birds in forest management in the western Great Lakes region. To address these

information needs, we initiated this project to (1) determine what species of forest-nesting birds use early successional habitats during the post-fledging period, (2) how fledgling interior-forest nesting birds use habitat after leaving the nest, and (3) what factors influence habitat use and movements. We have completed 1 pilot season in 2005 (focusing on mist-netting) and the first field season in 2006 (focusing on mist-netting and telemetry monitoring of fledgling songbirds).

Ongoing Research

Human Dimensions, Management, and Conservation

2005 Minnesota Waterfowl Hunter Survey and Waterfowl Recruitment Study

Investigator: David C. Fulton

Student: Susan A. Schroeder, Ph.D. (Natural Resources Science and Management)

Duration: January 2006 to July 2007

Funding Source: Minnesota Department of Natural Resources
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This research is a continuation of a long-term research program initiated in 2000 with Minnesota Department of Natural Resources waterfowl researchers and managers. Two previous studies identified waterfowl hunter preferences/opinions on various waterfowl hunting, management, and regulations issues and identified the experiences and regulatory factors that affect hunter satisfaction and participation. Objectives for the current research are to: (1) continue to trend information collected in previous studies; (2) conduct a follow-up study with participants from the original study to examine changes in individual motivations and participation in waterfowl hunting; (3) identify the factors leading to the recruitment of new waterfowl hunters; and (4) examine the motivations of Minnesota residents who decide to hunt waterfowl in North Dakota. The overall purpose of this study is to further our understanding of the social factors that influence waterfowl hunter participation and satisfaction to improve decision making related to Adaptive Harvest Management.

Alternative Deer Management Strategies in Minnesota State Parks

Investigator: David C. Fulton

Student: Louis Cornicelli, Ph.D. (Natural Resources Science and Management)

Duration: January 2006 to December 2008

Funding Source: Minnesota Department of Natural Resources
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Developing hunting regulations that help reduce deer numbers and balance deer sex ratios is a challenge throughout the eastern half of the United States. Working closely with the Minnesota Department of Natural Resources statewide big game manager, this project is designed to assess hunter attitudes and behavior in reaction to experimental regulations designed to help reduce deer numbers. This project will assist Minnesota Department of Natural Resources managers in selecting regulations that will be both effective and supported by hunters.

Data are being collected over 3 annual deer hunting seasons (2005, 2006, 2007) to examine hunter support for regulatory alternatives, change in support for regulatory alternatives after experience with the alternatives, and the relationship between hunter support and biological effectiveness. Final study results will be available in late 2008.

American Woodcock Singing-ground Surveys in the Western Great Lakes Region: Assessment of Trends in Woodcock Counts, Forest Cover Types Along Survey Routes, and Landscape Cover Type Composition

Investigator: David E. Andersen

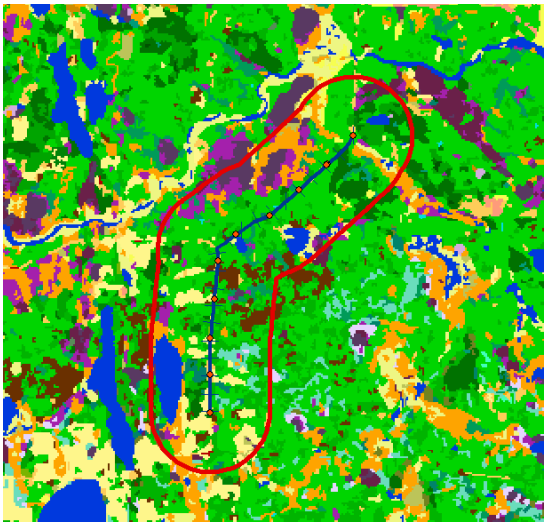
Student: Matt Nelson, M.S. (Natural Resource Science and Management)

Duration: June 2006 to June 2009

Funding Source: U.S. Fish and Wildlife Service

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Our overall objective is to better understand the relationship(s) between changes in counts of American woodcock (*Scolopax minor*) on Singing-ground Surveys in Minnesota and Wisconsin and forest land cover. We plan to assess patterns in annual counts of woodcock along existing survey routes, assess changes in time in land cover types along these routes, relate temporal changes in woodcock counts to changes in land cover composition, and compare current cover type composition along routes to current landscape cover type composition. If possible, we will also compare past cover type composition along survey routes to landscape cover composition. Specific project objectives are as follows:



(1) Assess patterns in annual counts of American woodcock along survey routes in Minnesota and Wisconsin,
(2) Assess changes through time in land cover types along Singing-ground Survey routes in Minnesota and Wisconsin,
(3) Relate temporal changes in land cover types to woodcock counts,
(4) Compare current cover type composition along routes to current landscape composition, and if possible, compare past cover type composition along routes to past landscape composition.

Bioregional Monitoring for Northern Goshawks in the Western Great Lakes

Investigator: David E. Andersen

Postdoc: Jason Bruggeman

Duration: June 2006 to June 2008

Funding Source: U.S. Forest Service
Wisconsin Department of Natural Resources

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Little is known regarding northern goshawk (*Accipiter gentilis*) abundance, distribution, and population trend at the scale of the western Great Lakes region. Following a regional goshawk meeting in Wisconsin in 2004, there was consensus among natural resource agencies and researchers that development of a regional biomonitoring program for northern goshawks was desirable, and the U.S. Forest Service provided funding to support a postdoc to develop a sampling program and compile necessary landcover information to conduct such a program. The objectives of this program are to assess goshawk population status in the western Great Lakes region, and provide a baseline for monitoring population trend across the region.

Comparison of Effects on Stream Habitat and Fish Nine Years after Harvest Treatments

Investigators: Bruce Vondracek and Raymond M. Newman (Cooperating Faculty)

Student: Eric Merten, Ph.D. (Water Resources Science)

Duration: July 2006 to June 2007

Funding Sources: Minnesota Department of Natural Resources
U.S. Forest Service
National Council for Air and Stream Improvement

Project Location: Pokegema Creek System, Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Several variables were examined in a previous study initiated in 1997 of the effects of timber harvests on stream habitats in central Minnesota, including: plant community composition and diversity, tree regeneration, song bird communities, blowdown in riparian management areas, fish communities, and stream habitat. We revisited sites sampled in this previous study to collect data from the 9th year post-harvest time period in summer 2006. Our portion of a larger project with collaborators from the U. S. Forest Service and the Natural Resources Research Institute examined fish populations and stream channel characteristics. In the initial study of the Pokegama Creek system, one of the most striking observations was the significant year effect of fine sediments in the streambed. We found that the initial increases in fine sediment persisted at least 9 years post-harvest. Most fish variables showed no site-level effects, as we found for most stream characteristics. However,

brook trout (*Salvelinus fontinalis*) abundance and an Index of Biological Integrity declined over the 9-year study. This study will serve as the basis for longer-term assessment of the effects of riparian harvest and provide information about the ecology of forest streams and will be used directly by the Minnesota Forest Resources Council to develop timber harvest policy in Minnesota.

Eastern Prairie Population Canada Goose Breeding Ecology

Investigator: David E. Andersen

Student: Matt Reiter, M.S. and Ph.D. (Wildlife Conservation)

Duration: January 2004 to December 2009

Funding Sources: Mississippi Flyway Council (U.S. Fish and Wildlife Service, Canadian Wildlife Service, Manitoba Conservation, Minnesota Department of Natural Resources, Iowa Department of Natural Resources, Missouri Department of Conservation, Arkansas Game and Fish Commission)
U.S. Geological Survey

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

For over 30 years, the breeding grounds of Eastern Prairie Population (EPP) Canada geese (*Branta canadensis interior*) at Cape Churchill, Manitoba have been monitored as part of a larger research and management program for this flock. In the 1980s, monitoring efforts indicated that a rapidly increasing snow goose (*Chen caerulescens*) population might be displacing Canada geese from traditional brood-rearing and foraging areas by both reducing the extent of and altering available habitat. The objectives of this study are to document current levels of interaction between these 2 species with respect to nesting and brood-rearing behavior of Canada geese, ascertain whether increased snow goose abundance has had an adverse impact on habitat quality, and if so, what are the implications for productivity of Canada geese. As an extension of a previous project, we will also focus on Canada goose-snow goose interactions across a range of

historic conditions in the central sub-Arctic, and assess existing survey data to describe and understand how factors identified as important at a local scale are translated across the breeding range. Field work was completed in summer 2006, and data analysis is currently underway.

Effects of Riparian Forest Harvest on Instream Habitat and Fish and Invertebrate Communities

Investigators: Bruce Vondracek and Raymond M. Newman (Cooperating Faculty)

Students: Dickson Atuke, Ph.D. (Conservation Biology)
Nicholas Schlesser, M.S. (Conservation Biology)

Duration: July 2003 to December 2007

Funding Sources: Minnesota Department of Natural Resources
Legislative Committee for Minnesota Resources
University of Minnesota Water Resources Center

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

This project examines the effectiveness of guidelines to protect forested riparian areas at a site level, and is part of a larger effort with the U. S. Forest Service and the Natural Resources Research Institute. Guidelines developed in Minnesota in 1999 provided recommendations for timber harvest in riparian areas. Our interdisciplinary team is evaluating effects of riparian forest harvest on water quality, fish, invertebrates, and stream morphology across 3 riparian harvest treatments (none, low, and intermediate) in association with totally unharvested (riparian and upland) control sites and sites with no harvest in the riparian zone adjacent to upland clearcuts. Our time frame is 1 year pre-harvest (2003) and 3 years post-harvest (2004-2006). We have found significant variation among years in habitat scores and macroinvertebrate assemblages and differences within and among sites in fish species composition and abundance. Continued monitoring will be required before we can fully assess the effects of riparian harvest. This study will serve as the basis for longer-term assessment of the effects of riparian harvest and provide information about the ecology of forest streams and will be used directly by the Minnesota Forest Resources Council to develop timber harvest policy in Minnesota.

Evaluating Trends in Electronic Licensing Questions

Investigator: David C. Fulton

Student: Jeremy T. Bruskotter, Ph.D. (Natural Resources Science and Management)

Duration: September 2004 to September 2008

Funding Source: Minnesota Department of Natural Resources
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Since 2000, the Minnesota Department of Natural Resources has sold licenses electronically. At the point of sale each license purchaser has been asked a single question concerning their behavior or attitudes concerning fisheries in Minnesota. These data provide a potential mechanism to further segment license purchasers or provide long-term trend information. This study evaluated the reliability and validity of information collected at the point of sale by re-contacting license purchasers and assessed the accuracy of point-of-sale information. In summary, attitudinal information collected through this mechanism was found to be in error much of the time while descriptive information was accurate 75-80% of the time.

This study provides an important contribution in understanding the psychological measurement challenges involved with social data collection via license sales, and is the first of its kind to attempt to assess the validity of such information that is now routinely being collected by state and federal agencies. Our findings have practical ramifications for using this kind of information in policy decisions or as surrogate information for biological harvest data in programs such as the Harvest Information Program for migratory bird hunting.

An Evaluation of Storm-water Management in a Watershed of the Minnesota Valley National Wildlife Refuge

Investigator: Bruce Wilson (Cooperating Faculty)

Student: Brian Ash, M.S. (Bioproducts and Biosystems Engineering)

Duration: May 2004 to September 2007

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

Project Location: Minnesota Valley National Wildlife Refuge; Bloomington, MN

We are studying the magnitude and spatially varied characteristics of contaminant loading into the Minnesota Valley National Wildlife Refuge from subwatersheds within the city limits of Bloomington, Minnesota. Knowledge of these characteristics has important management implications for the Refuge, and provides useful information on urban runoff in the Minneapolis-St. Paul metropolitan area.

Seven monitoring stations have been established in the watershed to measure the flow and contaminant loads. Good flow rate data were collected for the storms of summer 2004. However, we experienced problems in gathering water quality samples. Most of these problems were related to the limitations of time-increment or flow-depth protocols established by the manufacturer of the instrumentation systems.

After the problems in the instrumentation systems experienced in 2004, monitoring instruments were revised and used to collect high quality data for the summer and fall of 2005. The analyses of the 2 years of data are currently being conducted.

Features of the Farm Bill that Influence Breeding Birds

Investigators: David E. Andersen
Doug Johnson, U.S. Geological Survey, Northern Prairie Wildlife Research Center

Research Associate: Maiken Winter

Duration: January 2006 to August 2006

Funding Source: U.S. Geological Survey, Northern Prairie Wildlife Research Center

Project Location: U.S. Northern Prairie Region
University of Minnesota

Conservation Reserve Program (CRP) fields have been highly successful in providing habitat for grassland-nesting birds, and CRP fields are linked to recent increases of some grassland bird populations. Recent guidelines for CRP plantings encourage the use of native rather than introduced species. However, native plantings are significantly more expensive than introduced plantings. It is therefore critical to understand how planting type affects grassland-bird communities to better evaluate whether the increased monetary investment is justified. We studied breeding-bird use of CRP fields in 5 north-central states during 2001-2003, involving 128 fields planted either with primarily native or introduced species. Both planting types supported large populations of some grassland bird species, such as bobolinks (*Dolichonyx oryzivorus*) and savannah (*Passerculus sandwichensis*) and grasshopper sparrows (*Ammodramus savannarum*). Some species of conservation concern either were not detected in either planting type [such as Sprague's pipits (*Anthus spragueii*), greater prairie-chicken (*Tympanuchus cupido*)] or occurred in very low numbers [Baird's sparrow (*Ammodramus bairdii*), dickcissel (*Spiza americana*)]. The only species of conservation concern that occurred in high numbers in CRP fields was grasshopper sparrows. There were 2 major differences in bird communities between native and introduced fields: (1) several grassland birds of conservation concern did not occur in introduced plantings [chestnut-collared longspurs (*Calcarius ornatus*), Henslow's sparrows (*Ammodramus henslowii*), marbled godwit (*Limosa fedoa*), willet (*Catoptrophorus semipalmatus*), Nelson's sharp-tailed sparrow (*Ammodramus nelsoni*)]; and (2) the only grassland bird species that preferred introduced to native plantings were bobolinks and brown-headed cowbirds (*Molothrus ater*). These patterns were consistent among regions and years. Native plantings had lower and less dense vegetation with more litter – a feature that was preferred by species typical of mixed-and short-grass prairie. Therefore, native plantings are likely to be more valuable in the western portion of the Great Plains. In contrast, introduced plantings should be valuable in the eastern portion of the Great Plains as long as fields are allowed to develop litter extensive enough to provide shelter and nest sites.

Fishing in the Neighborhood: Understanding Motivations and Constraints for Angling among Twin Cities Metro Residents

Investigator: David C. Fulton

Student: Susan A. Schroeder, Ph.D. (Natural Resources Science and Management)

Duration: January 2006 to July 2007

Funding Source: Minnesota Department of Natural Resources
Division of Fisheries

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

One constraint to fishing participation in urban areas is lack of perceived opportunity to fish. This study examines urban residents' perceptions of constraints to fishing and awareness of the Fishing in the Neighborhood Program in the Twin Cities Metro area through a mail survey. In addition, focus group research was conducted with African-American, Latino, American Indian, Hmong, Cambodian, and Vietnamese residents to identify specific interests and constraints to angling participation. This study makes a substantive contribution to our understanding of constraints to angling. The applied purpose of this study is to help the Minnesota Department of Natural Resources design angling programs to help address recent declines in fishing participation and low participation rates in angling among people of color.

Geographical Information Systems Techniques to Channel Slope Delineation in Minnesota

Investigator: Bruce Vondracek

Student: Matt Kocian, M.S. (Conservation Biology)

Duration: August 2005 to September 2006

Funding Source: U.S. Geological Survey

Project Location: State of Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Our goal is to evaluate automated methods to estimate channel gradient, and to develop estimates of stream power and flood discharge and frequency for unregulated streams within Minnesota. Previous studies have demonstrated relationships between the gradient of stream channels and fish and macroinvertebrate assemblages. Twenty-one of 35 habitat features in Wyoming streams were related to channel gradient. Although field techniques to measure channel gradient are standardized, several techniques to estimate stream gradient using a GIS exist, but a standard technique has not been chosen. The objectives of our research are to: (1) determine a method for measuring channel gradient that provides similar estimates to field measurements with standard techniques, (2) identify GIS method(s) that provide similar estimates to measurements made in the field, and (3) develop estimates of flood discharges using regression equations based on our field and GIS methods.

Long-term Research and Monitoring of Human Dimensions Information on Fisheries and Wildlife Management Issues in Minnesota

Investigator: David C. Fulton

Student: Susan A. Schroeder, Ph.D. (Natural Resources Science and Management)

Duration: July 2006 to December 2010

Funding Source: Minnesota Department of Natural Resources
Division of Fisheries
Division of Wildlife

Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This project is the continuation of a long-term research effort established in 2002 that provides funding for a full-time research fellow to work closely with Minnesota Department of Natural Resources fisheries and wildlife researchers and managers to collect timely information to assist in the evaluation of management programs. The primary focus of this position is on developing experience-based management information for fisheries and wildlife management in Minnesota and to use this information to further our understanding of what factors influence angler and hunter experience satisfaction and level of support for management programs. This project provides a consistent process to develop a long-term database to improve our understanding of factors influencing trends in both recreational participation in fisheries and wildlife-based activities and to examine how attitudes and beliefs about fish and wildlife management issues are changing over time. This project provides a unique contribution nationally by providing a long-term research program with consistent measurement that will allow examination of long-term trends in values, attitudes, and behavior from a theory-directed perspective.

Mortality of Walleye Caught in Live-release Tournaments: Assessment, Reduction, and Determination of Acceptable Levels

Investigators: Bruce Vondracek and David Fulton

Students: John Loomis, M.S. (Conservation Biology)
Jeremy Bruskotter, Ph.D. (Natural Resources Science and Management)

Duration: July 2004 to December 2007

Funding Source: Minnesota Department of Natural Resources

Project Location: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin
Minnesota Cooperative Fish and Wildlife Research Unit

Research on black bass tournaments indicates that fish die from hook and handling injury, bacterial disease, or poor conditions in boat livewells or during weigh-in and release. Most mortality is due to poor livewell and tournament handling conditions. Numerous studies of black bass tournaments indicate that total mortality has averaged 28% during the past 2 decades. Assessments of walleye (*Sander vitreus*) tournaments suggest mortality is substantially higher although fewer studies have been completed for walleye. Three issues must be addressed for the conservation of high-quality walleye fisheries in light of walleye tournaments: (1) accurate estimates of total mortality in live-release tournaments, (2) development and evaluation of procedures to maximize survival of walleye in live-release tournaments, and (3) determine levels of mortality that are biologically and socially acceptable. Our objectives are to: (1) determine accurate estimates of total mortality in 14 walleye tournaments, (2) develop and evaluate procedures to maximize the survival

of walleye caught in live-release tournaments, (3) determine potential effects of tournament mortality on walleye populations using population models, and (4) determine levels of mortality for tournaments that are socially acceptable. This research will produce information useful to maximize survival of tournament-caught walleye and the effective integration of walleye tournaments in fishery management by tournament organizers and fishery agencies.

Red-shouldered Hawk Distribution and Productivity in Relation to Land-use Practices in Central Minnesota

Investigator: David E. Andersen

Student: Carlene Henneman, M.S. (Wildlife Conservation)

Duration: January 2003 to December 2006

Funding Source: Minnesota Department of Natural Resources

Project Location: Camp Ripley Army National Guard Training Site and surrounding central Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Little is known about landscape-level habitat requirements for red-shouldered hawks (*Buteo lineatus*) in Minnesota and throughout most of their breeding range. In addition, red-shouldered hawk response to habitat changes is not well understood, which confounds making informed land-management decisions. In this study we examined how red-shouldered hawk distribution and productivity in central Minnesota were related to current and historical land use and management practices. We conducted repeated call-broadcast surveys and nest searches in central Minnesota in 2004 and 2005 to assess habitat characteristics associated with red-shouldered hawk nest sites and occupancy and estimated the probability of detection and occupancy, and assessed habitat associations at 2 spatial scales (100 and 314-ha circular plots, which were based on reported minimum and maximum red-shouldered hawk home-range size). To evaluate red-shouldered hawk habitat associations at nests, we used standard logistic regression methods to compare nests sites to random sites at 3 spatial scales (25-ha, 100-ha, and 314-ha circular plots). For both nest sites and call-broadcast survey locations, we developed models relating habitat characteristics at multiple spatial scales to red-shouldered hawk nest site use and occupancy, and assessed support for these models in an Information-Theoretic framework. Overall, the amount of non-forest (grass, clear-cut area, forest <5 years old) and the amount of mature deciduous forest (>40 years old) had the strongest association with red-shouldered hawk occupancy and nest sites, but their importance varied across years, study areas, and survey techniques. Most nests and call broadcast sites with red-shouldered hawk responses were associated with ≥40% and averaged approximately 50% mature deciduous forest. Our findings suggest that red-shouldered hawks are associated with a high proportion of mature forest and a small proportion of open, non-forested areas across a range of spatial scales.

Stream Classification for TMDL Assessment Using a Dimensionless, Reference Reach Approach

Investigators: Bruce Vondracek, James A. Perry, Bruce Wilson, and John Nieber (Cooperating Faculty)

Student: Brenda Asmus, M.S. (Water Resources Science)

Duration: November 2003 to November 2007

Funding: U.S. Environmental Protection Agency and Minnesota Pollution Control Agency

Project Location: Redwood River and Snake River basins, Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Clean rivers, lakes, and streams consistently rank foremost among environmental priorities for citizens of Minnesota. Recent research has emphasized the importance of using physical, chemical, and biological indicators of stream health for diagnosing impaired watersheds and their receiving water bodies. A multidisciplinary team of biologists and hydrologists from the University of Minnesota and the Minnesota Pollution Control Agency (MPCA) is developing a regional stream classification system to facilitate Total Maximum Daily Load (TMDL) assessment of impaired waters in Minnesota. The classification will use regional reference reaches to account for complex factors related to precipitation, land use, soil, and geology. Objectives are to: (1) investigate the relationship between indicators of stream health and local characteristics in 2 ecoregions, (2) develop and evaluate dimensionless curves using reference reach values for stream classification and TMDL assessment, and (3) test a stream classification system using the prediction intervals of the dimensionless curves. An independent data set will be used for validating the dimenionless curves. The approach is well suited to affect changes in land use and other watershed practices to address nonpoint source pollution. The classification system will be used by the MPCA to prioritize TMDL programs.

Activities

Publications

Peer-Reviewed

2005

Andersen, D.E., S. DeStefano, M.I. Goldstein, K. Titus, C. Crocker-Bedford, J.J. Keane, R.G. Anthony, and R.N. Rosenfield. 2005. Technical review of the status of northern goshawks in the western United States. *Journal of Raptor Research* 39:192-209.

Boal, C.W. and **D.E. Andersen**. 2005. Microhabitat characteristics of Lapland longspur (*Calcarius lapponicus*) nests at Cape Churchill, Manitoba. *Canadian Field-Naturalist* 119:1-6.

Boal, C.W., **D.E. Andersen**, and P.L. Kennedy. 2005. Foraging and nesting habitat of breeding male northern goshawks in the Laurentian Mixed Forest Province, Minnesota. *Journal of Wildlife Management* 69:1516-1527.

Boal, C.W., **D.E. Andersen**, and P.L. Kennedy. 2005. Productivity and mortality of goshawks in Minnesota. *Journal of Raptor Research* 39:222-228.

Boody, G., **B. Vondracek**, D. Andow, M. Krinke, J. Westra, J. Zimmerman, and P. Welle. 2005. Multifunctional agriculture in the United States. *BioScience* 55:27-38.

Laudon, M., **B. Vondracek**, and J.K.H. Zimmerman. 2005. Prey selection by trout in a spring-fed stream: terrestrial versus aquatic invertebrates. *Journal of Freshwater Ecology* 20:723-733.

Payton, M., **D.C. Fulton**, and D.H. Anderson. 2005. Influence of place attachment and trust on civic action: a study at Sherburne National Wildlife Refuge. *Society and Natural Resources* 18:511-528.

Roberson, A.M., **D.E. Andersen**, and P.L. Kennedy. 2005. Do breeding phase and detection distance influence the effective area surveyed for northern goshawks? *Journal of Wildlife Management* 69:1240-1250.

Singh, U., M. Kocian, B. Wilson, A. Bolton, J. Nieber, **B. Vondracek**, J. Perry, and J. Magner. 2005. Analyzing indicators of stream health for Minnesota streams. Pages 570-576 *in* Proceedings of the Third Conference on Watershed Management to Meet Water Quality Standards and Emerging TMDLs. Atlanta, Georgia. American Society of Agricultural Engineers, St. Joseph, Michigan, USA.

Smithers, B.L., C.W. Boal, and **D.E. Andersen**. 2005. Northern goshawk food habits in Minnesota: an analysis using time-lapse video recording systems. *Journal of Raptor Research* 39:264-273.

Vondracek, B., K.L. Blann, C.B. Cox, J.A. Frost Nerbonne, K.G. Mumford, B.A. Nerbonne, L.A. Sovell, and J.K.H. Zimmerman. 2005. Land use, spatial scale, and stream systems: lessons from an agricultural region. *Environmental Management* 36:775-791.

Westra, J.V., J.K.H. Zimmerman, and **B. Vondracek**. 2005. Economic and environmental benefits from mandated agriculture Best Management Practices. *Journal of American Water Resources Association* 41:309-322.

2006

Boal, C.W., **D.E. Andersen**, P.L. Kennedy, and A.M. Roberson. 2006. Northern goshawk ecology in the western Great Lakes region. *Studies in Avian Biology* 31:126-134.

Nack, R.R. and **D.E. Andersen**. 2006. Brood movements of Eastern Prairie Population Canada geese: potential influence of light goose abundance. *Journal of Wildlife Management* 70:435-442.

Petersen, A. and **B. Vondracek**. 2006. Vegetative buffer strips around sinkholes to improve water quality. *Journal of Soil and Water Conservation* 61:380-390.

Schroeder, S.A., **D.C. Fulton**, L. Currie, and T. Goeman. 1996. He said, she said: gender and angling motivations, ethics, and behaviors. *Human Dimensions of Wildlife* 11:301-315.

Schroeder, S.A., **D.C. Fulton**, and J. Lawrence. 2006. Managing for preferred hunting experiences: a typology of Minnesota waterfowl hunters. *Wildlife Society Bulletin* 34:380-387.

Ulrich, J.B., U. Singh, B.N. Wilson, M.J. Kocian, and **B. Vondracek**. 2006. Analysis of stream health indicators for Total Maximum Daily Load (TMDL) assessment in Minnesota (Paper number 062331). Proceedings of the Annual International Meeting of the American Society of Agricultural and Biological Engineers, Portland, Oregon, USA.

Zimmerman, J.K.H. and **B. Vondracek**. 2006. Interactions between slimy sculpin and a native versus a nonnative trout: consequences for growth. *Canadian Journal of Fisheries and Aquatic Sciences* 63:1526-1535.

Zimmerman, J.K.H. and **B. Vondracek**. 2006. Stream enclosure effects on drifting invertebrates and fish growth: do enclosure experiments produce biased results? *Journal of the North American Benthological Society* 25:453-464.

In Press, Review, or Revision

Andersen, D.E., M.E. Reiter, K.E. Doherty, and D.C. Fulton. *In Review.* Magnitude and spatial distribution of American woodcock hunting pressure in a central Minnesota wildlife management area. *Proceedings of the 10th American Woodcock Symposium.*

Andersen, D.E. *In Press*. Raptor survey techniques. D.M. Bird and K. Bildstein, eds. Raptor research and management techniques (revised edition). Hancock House Publishers, Blaine, Washington, USA.

Bruskotter, J. and **D.C. Fulton.** *In Press*. The influence of angler value orientations on fisheries stewardship norms. B.A Knuth and W.F. Siemer, eds. Proceedings of Human Dimensions Symposium at AFS Annual Meeting. *American Fisheries Society Symposium*.

Doherty, K.E., **D.E. Andersen**, J. Meunier, E. Oppelt, R.S. Lutz, and J.G. Bruggink. *In Review*. Past patch quality as a predictor of future habitat selection: relating movement behavior of American woodcock to environmental factors. *Condor*.

Fulton, D.C., and D.H. Anderson. *In Revision.* Experience preferences as mediators of the wildlife related recreation participation-place attachment relationship. *Human Dimensions of Wildlife*.

Henneman, C., M.A. McLeod, and **D.E. Andersen**. *In Press*. Red-shouldered hawk occupancy surveys in central Minnesota, USA. *Journal of Wildlife Management*.

Meunier, J., L.S. Lutz, K.E. Doherty, **D.E. Andersen**, E. Oppelt, and J.G. Bruggink. *In Review.* Fall diurnal habitat use by adult female American woodcock in the western Great Lakes region. *Proceedings of the 10th American Woodcock Symposium*.

Oppelt, E., J.G. Bruggink, K.E. Doherty, **D.E. Andersen**, J. Meunier, and R.S. Lutz. *In Review*. Fall survival of American woodcock in the western Great Lakes region. *Proceedings of the 10th American Woodcock Symposium*.

Perry, E.F., J.C. Manolis, and **D.E. Andersen**. *In Review*. Reduced predation at interior nests in least flycatcher clustered all-purpose territories. *Auk*.

Reiter, M.E., **D.E. Andersen**, and C.W. Boal. *In Review*. Species composition, distribution, and habitat associations of anurans in a subarctic tundra landscape near Cape Churchill, Manitoba, Canada. *Journal of Wildlife Management*.

Reiter, M.E. and **D.E. Andersen**. *Accepted*. Trends in collared lemming abundance near Cape Churchill, Manitoba. *Journal of Mammalogy*.

Zimmerman, J.K.H. and **B. Vondracek**. *In Press*. Interactions between sculpin and trout: slimy sculpin growth and diet in relation to native and nonnative trout. *Transactions of the American Fisheries Society*.

Zimmerman, J.K.H. and **B. Vondracek**. *Accepted*. Brown trout and food web interactions in a Minnesota stream. *Freshwater Biology.*

Technical and Semi-Technical

2005

Andersen, D.E., et al. 2005. Production of EPP Canada geese near Cape Churchill in 2005. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Andersen, D.E. 2005. Habitat use of post-fledging forest-nesting songbirds in northern hardwood-coniferous forests in northern Minnesota: 2005 summary report. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Andersen, D.E., C.W. Boal, and M.E. Reiter. 2005. Wood frog and boreal chorus frog distribution and habitat associations in Wapusk National Park, Cape Churchill, Manitoba: 2005 summary report. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Andersen, D.E., J.G. Bruggink, K. Doherty, R.S. Lutz, J. Meunier, and E. Oppelt. 2005. Fall survival, movements, and habitat use of American woodcock in the western Great Lakes region: 2004 field season report. Annual Progress Report. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Newman, R.M., J.A. Perry, and **B. Vondracek**. 2005. Effects of riparian forest harvest on instream habitat and fish and invertebrate communities. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Reiter, M.E. and **D.E. Andersen**. 2005. Sympatric nesting Eastern Prairie Population (EPP) Canada geese and lesser snow geese on the Hudson Bay Lowlands: nest depredation and spatial distribution. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Reiter, M.E. and **D.E. Andersen**. 2005. Historical trends in lemming abundance and nest success of Canada geese: examining the "bird-lemming" hypothesis at Cape Churchill, Manitoba. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Newman, R.M., J.A. Perry, and **B. Vondracek**. 2005. Effects of riparian forest harvest on instream habitat and fish and invertebrate communities. Final Report to the Water Resources Center, University of Minnesota. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Schroeder, S. and **D.C. Fulton**. 2005. Fishing in Minnesota: a study of angler participation and activities: gender differences. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Schroeder, S.A. and **D.C. Fulton**. 2005. Fishing in Minnesota: a study of angler participation and activities. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Steil, J.C., C.R. Blinn, R.M. Newman, **B. Vondracek**, D.M. Atuke, J. Lind and J. Hanowski. 2005. Evaluating riparian timber harvesting guidelines: 2005 bridge funding report. Report to the Minnesota Forest Resources Council, St. Paul, Minnesota. Available at http://www.frc.state.mn.us/Info/MFRCdocs.html in the Monitoring Programs section.

2006

Andersen, D.E., et al. 2006. Production of EPP Canada geese near Cape Churchill in 2006. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Bruskotter, J.T. and **Fulton, D.C**. 2006. Results of 2005 survey evaluating Minnesota electronic licensing system database. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit. St. Paul, Minnesota.

Fulton, D.C. and L. Cornicelli. 2006. Results of 2005 survey of deer hunter satisfaction and preferences for regulation changes in Minnesota. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Henneman, C. and **D.E. Andersen**. 2006. Habitat associations of red-shouldered hawks in central Minnesota: 2005 summary report. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Kocian, M. and **B. Vondracek**. 2006. Geographical Information Systems techniques to channel slope delineation in Minnesota. Final Report to the U.S. Geological Survey, Moundsview, Minnesota. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Mannan, R.N., G. Perry, **D.E. Andersen**, and C.W. Boal. 2006. Factors affecting distribution and detection of boreal chorus frogs (*Pseudacris maculata)* and wood frogs (*Rana sylvatica)* at Cape Churchill, Manitoba. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Reiter, M.E. and **D.E. Andersen**. 2006. Sympatric nesting Eastern Prairie Population (EPP) Canada geese and lesser snow geese on the Hudson Bay Lowlands: nest depredation and spatial distribution. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Schroeder, S. and **D.C. Fulton**. 2006. Fishing in the neighborhood: a study of recreation and fishing participation in the Twin Cities Metropolitan Area. Final Report to the Minnesota Department of Natural Resources. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Streby, H.M. and **D.E. Andersen**. 2006. Habitat use of post-fledging forest-nesting songbirds in northern hardwood-coniferous forests in northern Minnesota: 2006 summary report. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Wilson, B.N., **B. Vondracek**, J. Ulrich, U. Singh, P. VanBuren, M. Kocian, B. Asmus, B. Hansen, J. Perry, J.L. Nieber, and T. Zearling. 2006. Quantifying the variability of stream health indicators for TMDL assessment. Final Report to the Minnesota Pollution Control Agency. Minnesota Cooperative Fish and Wildlife Research Unit, St. Paul, Minnesota.

Cooperating Faculty Publications *(partial list)*

Peer-Reviewed

2005

Barber, S., L.D. Mech and P.J. White. 2005. Yellowstone elk calf mortality following wolf restoration: bears remain top summer predators. *Yellowstone Science* 13:37-44.

Gonsoski, J.A., T.E. Burk, P.V. Bolstad, and M. Balogh. 2005. Rice Lake National Wildlife Refuge vegetation cover (2004) Project Report. University of Minnesota, Department of Forest Resources Staff Paper Series No. 180. St. Paul, Minnesota. 31pp.

Gonsoski, J.A., K.A. Geurts, T.E. Burk, P.V. Bolstad and M. Balogh. 2005. Rice Lake National Wildlife Refuge historic wild rice mapping (1983-2004). University of Minnesota, Department of Forest Resources Staff Paper Series No. 181. St. Paul, Minnesota. 14pp.

In Press, Review, or Revision

Barber-Meyer, S.M., C.R. Johnson, M.P. Murtaugh, L.D. Mech, and P.J. White. *In Press*. Interleukin-6 and tumor necrosis factor-a values in elk neonates. *Journal of Mammalogy*.

Barber-Meyer, S.M., L.D. Mech, and P.J. White. *In Press.* Survival and elk calf mortality following wolf restoration. *Wildlife Monographs.*

Barber-Meyer, S.M. and L.D. Mech. *In Review.* Factors influencing predation on juvenile ungulates and natural selection implications. *Wildlife Biology in Practice.*

Completed Theses and Dissertations of Minnesota Coop Unit Students

2005

Petersen, A. 2005. Buffer strips around sinkholes to protect and improve water quality in southeastern Minnesota: conservation in karst. M. S. Conservation Biology (Fisheries and Aquatic Biology track), University of Minnesota, St. Paul, Minnesota, USA. 109pp. (Bruce Vondracek)

Abstract: There are approximately 8,600 mapped sinkholes in karst terrain of southeast Minnesota. Most sinkholes are adjacent to row crops that likely contribute pollutants to surface waters and aquifers. Vegetated buffers can improve water quality by reducing sediment, fertilizers, pesticides, and other potential contaminants from runoff, and may benefit water quality when placed around sinkholes. We evaluated sediment, nitrogen, phosphorus, and runoff for buffers from 2.5 to 30 m wide with a spreadsheet model. We found buffers 30 m wide may reduce pollution by 80%, although buffers 15 m wide may be most cost effective. Buffers could contribute to goals of reducing sediment, nitrogen, and phosphorus loads in Minnesota waters. Buffers 15 m wide around all sinkholes would retire approximately 436 ha of land from production and cost approximately $260,000/year based on Conservation Reserve Program payments, while requiring <14% of the budget of the program for groundwater protection in southeast Minnesota.

Spicklemier, G. 2005. The new zoo? Construction and validation of a scale measuring zoo visitor beliefs about the function of zoos. M.S. Conservation Biology, University of Minnesota, St. Paul, Minnesota, USA. 136pp. (David C. Fulton)

Abstract: Zoos in the developed world are increasingly focusing their efforts on wildlife conservation. Conservation breeding programs, support for *in situ* conservation efforts, and conservation education are becoming more prominent functions of the modern day zoo. This change represents a departure from zoos of 30-40 years ago, which primarily focused on providing recreation experiences for families and children. Recent research has questioned whether zoo visitors have perceived this paradigm shift or if most visitors believe zoos are still primarily recreation institutions. According to the cognitive hierarchy theory, the beliefs that visitors hold about the function of zoos could impact their attitudes towards zoos and their behaviors during their visit. Equally critical, zoo visitor beliefs about zoos as credible conservation organizations could affect the impact of conservation education messages that zoo visitors are exposed to during their zoo visit. Using zoo visitor focus groups and a panel of zoo professionals, I developed a scale to measure zoo visitor beliefs about the importance of eighteen different zoo functions. I then administered the Function of Zoos scales as part of a broader questionnaire to 500 Minnesota Zoo visitors. In general, the scales demonstrated reliability. Scale validity, however, was less clear. Many of the Function of Zoos scales correlated highly with each other, potentially indicating that the average visitor does not see a large difference in the importance of many zoo functions (such as conservation and education). Correlations with other measures of zoo visitor beliefs and attitudes, however, did demonstrate the scales' predictive validity. With further testing, the Functions of Zoos

scales could provide a valuable tool for zoo managers and researchers investigating the impact of zoo visitor beliefs on the attitudes that zoo visitors hold and the behaviors they engage in during their visit.

Zimmerman, J. K. H. 2005. Interactions between native and nonnative species: consequences of a brown trout introduction on a coldwater stream community. Ph.D. Fisheries, University of Minnesota, St. Paul, Minnesota, USA. 125pp. (Bruce Vondracek)

Abstract: Although previous research has investigated competition between native and nonnative trout, few studies have examined effects of introduced trout on other species in coldwater stream communities. I designed a field experiment to examine interactions between native brook trout versus nonnative brown trout with native slimy sculpin to investigate whether introductions of nonnative trout affect food web relationships in small streams. I hypothesized that brown trout would compete with sculpin and reduce sculpin growth, whereas competition would not occur between brook trout and sculpin, based on the premise that brook tout and slimy sculpin have coevolved in Minnesota streams. Enclosures (1 m^2) were stocked with fish according to six treatments: combined-species treatments (juvenile brown trout with sculpin, juvenile brook trout with sculpin), single-species controls, and no fish. Fish were stocked at three densities to examine intraspecific versus interspecific competition. Replicates of each treatment were placed in riffles in Valley Creek, Minnesota, and six 38-day experiment trials were conducted over three summers (2002-2004). Enclosures did not reduce abundance of drifting invertebrate prey. Interactions between brown trout and sculpin led to reduced growth of both large sculpin and large brown trout in enclosures, whereas presence of brook trout was not associated with changes to sculpin growth. Presence of brown trout also led to indirect effects on food web dynamics that may have resulted in these observed changes in growth. Brown trout was the only species associated with a decrease in abundance of a benthic invertebrate taxon, suggesting that brown trout may feed in the benthos to a greater extent than brook trout. Brown trout were also associated with shifts in sculpin diets, indicating a change in sculpin feeding behavior when sculpin were with brown trout that was not evident when sculpin were alone or with brook trout. Feeding behavior and intraspecific interactions among brown trout, along with shifts in feeding behavior of sculpin when brown trout were present, likely was a mechanism underlying reduced growth of both species. My research shows that introduced brown trout have effects on the stream community in Valley Creek that are different than native brook trout.

Nagle, F. 2005. Hawaii's land use law: functional authenticity. M.S. Conservation Biology, University of Minnesota, St. Paul, Minnesota, USA. 35pp. (Bruce Vondracek and Kristen Nelson)

Abstract: Taken as a whole, the arena for Hawaii's Land Use Commission (LUC) appears to be most strongly supported in its arena-culture symbiosis, responsiveness, and agreement durability, and moderately supported in its intention/action and subjective fulfillment. I interpret this to mean that the arena is highly organic and sensitive to its host cultures as well as relatively enabled in its intention/ action and subjective fulfillment, all of which together lead to generally durable agreements. This allows the LUC to be both authentic and functional on a daily and perpetual basis. However, its functionality and authenticity both could be improved and strengthened through increased attention to the diminished aspects of the six conditions, particularly those related to weakened political will, the lack of certain decision-making tools, and Communicative Authenticity. By increasing its functional authenticity, the LUC arena could then help generate quality agreements that are more fully satisfactory, less confrontational, more constructive and productive, and more environmentally and socially sustainable in the long-term.

2006

Henneman, C. 2006. Habitat associations of red-shouldered hawks in central Minnesota landscapes. M.S., Wildlife Conservation, University of Minnesota, St. Paul, Minnesota, USA. 56pp. (David E. Andersen)

Abstract: The red-shouldered hawk (*Buteo lineatus*) is a species of special conservation concern in much of the Great Lakes region, although little information exists about its habitat associations at the landscape scale. I conducted repeated call-broadcast surveys and nest searches in central Minnesota in 2004 and 2005 to assess habitat characteristics associated with red-shouldered hawk nest sites and occupancy. For call broadcast surveys, I estimated the probability of detection and occupancy, and assessed habitat associations at 2 spatial scales (100 and 314-ha circular plots), which were based on reported minimum and maximum red-shouldered hawk home-range size. To evaluate red-shouldered hawk habitat associations at nests, I used standard logistic regression methods to compare nests sites to random sites at 3 spatial scales (25-ha, 100-ha, and 314-ha circular plots). I estimated habitat amount, average patch size, patch density, edge density, and habitat diversity at all 3 spatial scales. I chose 4 study areas that represent a gradient of habitat conditions, from large, contiguous tracts of mature forest to small, isolated stands that have been fragmented and reduced in size, mostly due to timber harvest. In 2004, I conducted call broadcast surveys at 128 locations in 2 study areas, and in 2005, I surveyed 247 locations in 4 study areas. Estimates of probability of detection ranged from 0.1747 to 0.7500 and occupancy ranged from 0.5948 to 1.00 across years and study areas. I found a total of 68 red-shouldered hawk nests at 3 study areas in 2004 and 2005. For both nest sites and call-broadcast survey locations, I developed models relating habitat characteristics at multiple spatial scales to red-shouldered hawk nest site use and occupancy, and assessed support for these models using an Information-Theoretic framework. Overall, the amount of non-forest (grass, clear-cut area, forest <5 years old) and the amount of mature deciduous forest (>40 years old) had the strongest association with red-shouldered hawk occupancy and nest sites, but their importance varied across years, study areas, and survey techniques. The amount of non-forest was negatively correlated and amount of mature deciduous forest was positively correlated with red-shouldered hawk occupancy and nest-sites. Red-shouldered hawk nests in central Minnesota were associated with the amount of mature deciduous forest in combination with low levels of non-forest. With call broadcast surveys, red-shouldered hawk occupancy was either associated with amount of mature deciduous forest or limited amount of non-forest, rather than the combination of both, as observed for nest sites. Other metrics describing patterns of mature deciduous forest, such as the number of patches, mean patch size, and landscape diversity were retained in some best-supported models and may be important in red-shouldered hawk-habitat associations. Based on circular plots surrounding nests, the lower limit of mature forest (including mature deciduous and mature coniferous) at red-shouldered hawk nests was approximately 30% and did not vary across spatial scale. Most nests and call broadcast sites with red-shouldered hawk responses were associated with ≥40% and averaged approximately 50% mature deciduous forest. My findings suggest that red-shouldered hawks are associated with a high proportion of mature forest and a small proportion of open, non-forested areas across a range of spatial scales.

Reiter, M.E. 2006. Historical trends in collared lemming (*Dicrostonyx richardsoni*) abundance and nest success of Eastern Prairie Population (EPP) Canada geese (*Branta canadensis interior*) in northern Manitoba: evaluating the "bird-lemming" hypothesis. M.S. Wildlife Conservation, University of Minnesota, St. Paul, Minnesota, USA. 80pp. (David E. Andersen)

Abstract: Regular, multi-annual cycles observed in the population abundance of small mammals in arctic and sub-arctic ecosystems across many regions has stimulated substantial research, particularly among population ecologists. Hypotheses addressing the cause of regular cycles include mechanisms

such as predator-prey interactions, limitation of food resources, and migration or dispersal, as well as abiotic factors such as cyclic climatic variation and environmental stochasticity. However, long-term time-series of population data for small mammals in North America are generally lacking. Small rodent abundance is typically quantified by trapping grids and capture-mark-recapture techniques. These methods are time-consuming and provide data only for the time period during which trapping occurred. Alternative approaches may provide useful information regarding population trends, especially in remote areas where logistics make intensive trapping and marking of individual small mammals impractical. In 2004 and 2005, we used indirect methods to estimate trends in population size of collared lemmings (*Dicrostonyx richardsoni*), and evaluated the extent of synchrony between lemming populations at 2 coastal tundra study areas separated by ~60 km near Cape Churchill, Manitoba, Canada. We collected scars on willow plants (*Salix* spp.) resulting from lemming feeding. Scar ages ranged from 0 to 13 years at both study areas. Scar-age frequency appeared cyclic and we used Poisson regression to model the observed scar-age frequency. Lemming populations cycled with 2.83 year periodicity and the phase of the cycle was synchronous between the 2 study areas. Modeling scar-age frequency data resulted in estimates of relative lemming abundance at broad spatial and temporal scales, and allowed us to evaluate synchrony between study areas.

The bird-lemming hypothesis, a specific form of the alternative prey hypothesis, describes the dynamic interaction of predator, prey, and alternative prey in determining reproductive success in arctic-nesting birds. We assessed this hypothesis using data collected during annual Eastern Prairie Population (EPP) Canada goose (*Branta canadensis interior*) breeding ground surveys at Cape Churchill, Manitoba, and measures of relative abundance of collared lemmings based on analysis of willow (*Salix* spp.) scar-age frequency distribution. We assessed nest success prior to and post-discovery of nests, and included the following variables in regression models of annual nest success; arctic fox (*Alopex lagopus*) abundance in the current and previous year, lemming abundance in the current and previous year, and nest density. We analyzed 2 separate time periods, 1993 – 2004 and 1998 – 2004, because fox removal occurred on our study area from 1994 – 1996. We developed models *a priori* and ranked them using Akaike's Information Criterion corrected for small sample sizes (AICc). Our results were not consistent with predictions of the bird-lemming hypothesis, but suggested that nest density, arctic fox relative abundance, and lemming relative abundance from the previous year influenced predator-prey dynamics and subsequently, nest success. Furthermore, local fox trapping and nest-discovery may also impact nest success. Our results also suggest that predators may respond more quickly and across a broader spatial scale to declines in primary prey (e.g., lemmings) than previously considered under the bird-lemming hypothesis.

Theses and Dissertations supported by RWOs

2005

Haffner, C.D. 2005. Breeding season spatial requirements of Great Lakes piping plovers in northern lower Michigan. M.S., Conservation Biology, University of Minnesota, St. Paul, Minnesota, USA. 40pp. (Cooperating faculty – Francesca Cuthbert)

Abstract: The population of piping plovers (*Charadrius melodus*) in the Great Lakes region is endangered at state and federal levels. To adequately protect nesting habitat it is important to understand spatial and temporal movements of breeding individuals. Because endangered status of the population precluded use of radio-telemetry for this study, geographic coordinates of individual plovers were calculated using coordinate geometry. I determined home range sizes, maximum linear shoreline traversed and length of shoreline traversed 95% of the time for 35 individually color-banded breeders from May to August 2003 and 2004. I examined relationships between spatial movement and nest stage

(incubation v. chick rearing), sex, minimum age, public beach use, and nearest neighbor nest distance. Mean home range size was 0.35 km^2, mean maximum linear distance traversed was 0.64 km, and mean linear distance for 95% of locations was 0.48 km. Individual home range sizes and linear distances traveled varied among individuals, sites, and years. No significant relationships were found between nest stage or minimum age and home range size or linear distances. Males used more area and took longer excursions from the nest than females during the chick rearing period in 2003 ($p < 0.05$). Home range size for plovers nesting on high public use beaches was greater than those nesting on medium or low public use beaches in 2003 ($p < 0.05$). Maximum linear distance traveled increased as proximity to other plover nests increased ($p < 0.05$) in 2004. This study found that human beach use and proximity to other nesting plovers were the most important factors influencing plover movement and home range size. Additionally, results indicate that small parcels of suitable habitat have high conservation value for Great Lakes piping plovers. Protection of large blocks of continuous shoreline habitat, however, is recommended for long term persistence of this population.

2006

Barber-Meyer, S. 2006. Elk calf mortality following wolf restoration to Yellowstone National Park. Ph.D., Wildlife Conservation, University of Minnesota, St. Paul, Minnesota, USA. 195pp. (Advisor – L. David Mech)

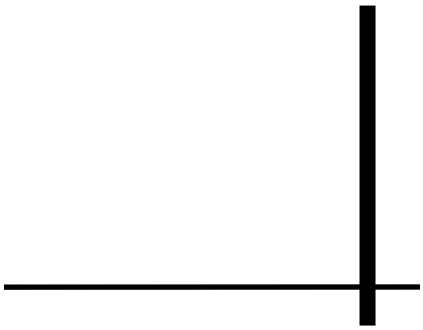
Abstract: Wolves (*Canis lupus*) were restored to Yellowstone National Park (YNP) during 1995-1996. Annual trend counts of northern Yellowstone elk (*Cervus elaphus*) have declined by approximately 50% from 19,045 just prior to wolf restoration (1994) to 9,545 10 yr post-wolf reintroduction (2005) and indices of recruitment during 2002-2005 were among the lowest (12-14 calves/100 cows) recorded during the past several decades. I began a 3-year study in May 2003 of mortality in northern Yellowstone elk calves to determine the basis for the decline in calf recruitment following wolf restoration. I captured calves ≤6-days old (n = 151; 83 females: 68 males), fit them with radio-transmitters, and collected blood to assess potential condition indicators and disease status. Following wolf restoration to YNP, elk calf annual survival was low (0.216, SE = 0.035, n = 149) and varied by calving area but not year. Neonates captured in the Stephens Creek/Mammoth area had annual survival rates more than 3 times higher (0.544) than those captured in the Lamar Valley area (0.173). Summer survival (20 weeks following radio-tagging) was low (0.313, SE = 0.041, n = 147) and calving area and individual covariates including absolute deviation from median birth date and sex were important predictors of summer survival. Survival during winter (Nov-Apr) was high (0.899, SE = 0.048, n = 42) and did not vary by calving area or year. Sixty-nine percent (n = 104) of calves died within the first year of life, 24% (n = 36) survived their first year, and 7% (n = 11) had unknown fates. Grizzly bears (*Ursus arctos*) and black bears (*U. americanus*) accounted for 58-60% (n = 60-62) of deaths, and wolves accounted for 14-17% (n = 15-18). Bears killed younger calves on average than other predators. Concentrations (mean, SE) of potential condition indicators were: thyroxine (13.80 ug/dl, 0.43), serum urea nitrogen (17.40 mg/dl, 0.57), gamma glutamyltransferase (66.42 IU/L, 4.36), gamma globulins (1.53 g/dl, 0.07), insulin-like growth factor (253.60 ng/ml, 9.59), interleukin-6 (median = 0.03 pg/ml, range 0-1.21), and tumor necrosis factor-α (median 1.92 pg/ml, range = 0-225.43). Seroprevalences of diseases were: brucellosis (*Brucella abortus*; 3.1%), bovine-respiratory syncytial virus (3.1%), bovine-viral-diarrhea virus type 1 (25.0%), infectious-bovine rhinotracheitis (57.9%), and bovine parainfluenza-3 (32.0%). Summer predation (95% of summer deaths) has increased while winter malnutrition (0% of winter deaths) has decreased compared to a 1987-1990 study (72% and 58%, respectively) indicating some form of compensatory mortality may be occurring. My results suggest that changes in bear abundance and the varying spatial survival of elk calves across Yellowstone's northern range should be considered when predicting northern Yellowstone elk calf recruitment rates.

Student Awards

Julie Zimmerman. 2005. J. Francis Allen Award, American Fisheries Society.

Julie Zimmerman. 2005. Best Student Presentation, Minnesota Chapter of the American Fisheries Society.

Matthew Reiter. 2005. Best Oral Presentation, 66th Midwest Fish and Wildlife Conference.



Presentations

Invited Presentations

2005

Bruskotter, J. and **D.C. Fulton**. 2005. Angler ethics in a rapidly changing world. 135th Annual Meeting of the American Fisheries Society. Anchorage, Alaska.

Fulton, D.C. and S. A. Schroeder. 2005. *(Keynote presentation).* Human dimensions of fisheries and the changing face of outdoor recreation. Minnesota Chapter of the American Fisheries Society. Grand Rapids, Minnesota.

Henneman, C. and **D.E. Andersen**. 2005. Red-shouldered hawk (*Buteo lineatus)* distribution in relationship to landscape structure in central Minnesota. 2005 Minnesota Ornithologists' Union Annual Meeting. Minneapolis, Minnesota.

Vondracek, B. 2005. Multifunctional agriculture in the United States. University of Minnesota Faculty, Staff and Students Forum. St. Paul, Minnesota.

Vondracek, B. 2005. Modeling and assessment of conservation practices and effects on aquatic ecosystems in farmed landscapes. U.S. Geological Survey Science Workshop, Environmental Effects of Agricultural Practices. Denver, Colorado.

Zimmerman, J.K.H. and **B. Vondracek**. 2005. Interactions between trout and sculpin: sculpin growth and diet in relation to native versus nonnative trout. 135th Annual Meeting of the American Fisheries Society. Anchorage, Alaska.

2006

Andersen, D.E. 2006. Goose ecology and conservation in the Hudson Bay Lowlands: abundance, population management, and species interactions. Landcare Research. Lincoln, New Zealand.

Andersen, D.E. 2006. Habitat use and reproduction of forest-nesting songbirds in north-central Minnesota. 1st Annual Boreal Hardwood Transition Zone Forest Bird Diversity Workshop. Cass Lake, Minnesota.

Andersen, D.E. 2006. Northern goshawk and red-shouldered hawk breeding-season ecology in north-central Minnesota: detection, reproduction, food habits, and habitat use. 1st Annual Boreal Hardwood Transition Zone Forest Bird Diversity Workshop. Cass Lake, Minnesota.

Blann, K., J. Anderson, G. Sands, and **B. Vondracek**. 2006. Ecology of agricultural drainage. Symposium of the Chesapeake Research Consortium on Improved Management of Agricultural Drainage Ditches for Water Quality Protection. College Park, Maryland.

Fulton, D.C. 2006. Using structural equation modeling to assess relationships among cognitive constructs: applications to values, attitudes, norms and behaviors. Seminar in the College of Built and Natural Environments. University of South Australia, Mawson Lakes, Australia.

Oppelt, E., J.G. Bruggink, K. Doherty, **D.E. Andersen**, J. Muenier, and R.S. Lutz. 2006. Fall survival of American woodcock in the western Great Lakes region. Mississippi Flyway Council Technical Section Meeting. Louisville, Kentucky.

Vondracek, B., D.M. Atuke, N. Schlesser, and R. Newman. 2006. Effects of riparian forest harvest on aquatic systems in northern Minnesota. 1st Minnesota Natural Resources Conference. Brainerd, Minnesota.

Contributed Presentations

2005

Atuke, D.M., R.M. Newman, **B. Vondracek**, and N. J. Schlesser. 2005. Effects of riparian forest harvest on instream habitat, water quality, and macroinvertebrate communities in northern Minnesota. Joint Annual Meeting of the Minnesota Chapters of the American Fisheries Society and the Society for Conservation Biology. Grand Rapids, Minnesota.

Atuke, D.M., R.M. Newman, and **B. Vondracek**. 2005. Evaluating the effects of riparian forest harvest on macroinvertebrate communities and water quality in northern Minnesota. Minnesota Water 2005 and Annual Water Resources Joint Conference. Brooklyn Center, Minnesota. (POSTER)

Atuke, D.M., N. J. Schlesser, **B. Vondracek**, and R. M. Newman. 2005. Variability in response of instream habitat and fish and macroinvertebrate assemblages to riparian forest harvest in northern Minnesota. 53rd Annual Meeting of the North American Benthological Society. New Orleans, Louisiana. (POSTER)

Doherty, K., **D.E. Andersen**, and G.I. Jones. 2005. Effects of spatial configuration and smoothing parameter choice on fixed kernel home range estimation: American woodcock home range analysis using field and simulated data. The Wildlife Society 12th Annual Meeting. Madison, Wisconsin.

Fulton, D.C. 2005. Understanding aquatic plant removal in Minnesota lakes. 135th Annual Meeting of the American Fisheries Society. Anchorage, Alaska

Henneman, C., M.A. McLeod, and **D.E. Andersen**. 2005. Using presence/absence surveys to assess status and population trend of red-shouldered hawks (*Buteo lineatus)* in central Minnesota. 2005 Raptor Research Foundation, Inc., Annual Meeting. Green Bay, Wisconsin.

Henneman, C., M.A. McLeod, and **D.E. Andersen**. 2005. Using presence/absence surveys to assess status and population trend of red-shouldered hawks (*Buteo lineatus)* in central Minnesota. 66th Midwest Fish and Wildlife Conference. Grand Rapids, Michigan.

Kocian, M., C. Sanocki, **B. Vondracek**, and B.N. Wilson. 2005. Evaluating variability in stream slope estimates using GIS. 15th Annual Meeting of the Minnesota GIS/LIS Consortium Conference and Workshops. St. Cloud, Minnesota.

Kocian, M., U. Singh, B.N. Wilson, and **B. Vondracek**. 2005. Uncertainty in stream gradient estimation in TMDL. Minnesota Water 2005 and Annual Water Resources Joint Conference. Brooklyn Center, Minnesota.

Meunier, J., R. Song, R.S. Lutz, **D.E. Andersen**, J.G. Bruggink, K. Doherty, and E. Oppelt. 2005. Fall migration chronology of American woodcock in the western Great Lakes region. The Wildlife Society 12th Annual Meeting. Madison, Wisconsin.

Petersen, A. and **B. Vondracek**. 2005. Potential effects and costs of sinkhole buffers in southeastern Minnesota: conservation in karst. Joint Annual Meeting of the Minnesota Chapters of the American Fisheries Society and the Society for Conservation Biology. Grand Rapids, Minnesota.

Reiter, M. and **D.E. Andersen**. 2005. Historical trends in lemming abundance and nest success of Canada geese: evidence in support of the "bird-lemming" hypothesis at Cape Churchill, Manitoba. North American Arctic Goose Symposium. Reno, Nevada.

Reiter, M. and **D.E. Andersen**. 2005. Historical trends in lemming abundance and nest success of Canada geese: evidence in support of the "bird-lemming" hypothesis at Cape Churchill, Manitoba. Minnesota Chapter of The Wildlife Society 2005 Annual Meeting. Fergus Falls, Minnesota.

Reiter, M. and **D.E. Andersen**. 2005. Historical trends in nest success of Eastern Prairie Population Canada geese: examining the "bird-lemming" hypothesis at Cape Churchill, Manitoba. 66th Midwest Fish and Wildlife Conference, Grand Rapids. Michigan. (*Best Oral Presentation*)

Schlesser, N.J., R.M. Newman, **B. Vondracek**, and D.M. Atuke. 2005. Effects of riparian forest harvest on instream habitat and fish assemblages in northern Minnesota. Joint Annual Meeting of the Minnesota Chapters of the American Fisheries Society and the Society for Conservation Biology. Grand Rapids, Minnesota.

Schlesser, N.J., D.M. Atuke, R.M. Newman, and **B. Vondracek**. 2005. Effects of riparian forest harvest on instream habitat and fish assemblages in northern Minnesota. Joint Annual Meeting of the Minnesota Chapters of the American Fisheries Society and the Society for Conservation Biology. Grand Rapids, Minnesota. (POSTER)

Schroeder, S.A. and **D.C. Fulton**. 2005. What keeps hunters in the field? Factors that predict hunting participation. The Wildlife Society 12th Annual Meeting. Madison, Wisconsin.

Schroeder, S.A. and **D.C. Fulton**. 2005. Hooked on fishing: factors that predict commitment and behavioral consistency in angling. 135th Annual Meeting of the American Fisheries Society. Anchorage, Alaska.

Singh, U., M. Kocian, A. Bolton, B. Wilson, J. Nieber, **B. Vondracek**, J. Perry, and J. Magner. 2005. Analyzing indicators of stream health for Minnesota streams. 3rd Conference on Watershed Management to Meet Water Quality Standards and Emerging TMDLs. Atlanta, Georgia.

Singh, U., J. Ulrich, B.N. Wilson, M. Kocian, **B. Vondracek**, J. Magner, and G. Johnson. 2005. Analysis of stream data for TMDL assessment. Minnesota Water 2005 and Annual Water Resources Joint Conference. Brooklyn Center, Minnesota.

Solensky, M.J., M.L. Crozier, M. Hamady, **D.E. Andersen**, and C.W. Boal. 2005. Determining northern goshawk (*Accipiter gentilis*) breeding area occupancy, nesting activity, and reproduction in northern Minnesota, 2003-2005. 2005 Raptor Research Foundation, Inc., Annual Meeting. Green Bay, Wisconsin.

Zimmerman, J.K.H. and **B. Vondracek**. 2005. Interactions between trout and sculpin: consequences of trout introductions for a native fish. 53rd Annual Meeting of the North American Benthological Society. New Orleans, Louisiana.

Zimmerman, J.K.H. and **B. Vondracek**. 2005. Interactions between trout and sculpin: effects of native versus nonnative trout on sculpin growth and diet. Joint Annual Meeting of the Minnesota Chapters of the American Fisheries Society and the Society for Conservation Biology. Grand Rapids, Minnesota. *(Best Student Presentation)*

2006

Andersen, D.E., M.E. Reiter, K.E. Doherty, and D.C. Fulton. 2006. Magnitude and spatial distribution of American woodcock hunting pressure in a central Minnesota wildlife management area. 10th American Woodcock Symposium. Roscommon, Michigan.

Anderson, D.H., T.V. Stein, M. Davenport, J.E. Leahy, D.C. Weber and **D.C. Fulton**. 2006. Managing landscapes for sustainable recreation: what do we know? What do we need to know? International Symposium on Society and Resource Management. Vancouver, British Columbia, Canada.

Asmus, B., J. Magner, **B. Vondracek**, and J. Perry. 2006. Assessing the relationship between channel stability, habitat quality, and fish communities. Joint Meeting of the American Society of Agronomy – Crop Science Society of America – Soil Science Society of America. Indianapolis, Indiana.

Asmus, B., J. Magner, **B. Vondracek**, and J. Perry. 2006. Assessing the physical integrity of streams. Minnesota Water 2006 and the Annual Water Resources Joint Conference. Brooklyn Center, Minnesota.

Blann, K., J. Anderson, G. Sands, and **B. Vondracek**. 2006. Effects of drainage on aquatic ecosystems: a literature review. 7th Annual Minnesota-Iowa Drainage Research Forum. Owatonna, Minnesota.

Blann, K., J. Anderson, G. Sands, and **B. Vondracek**. 2006. Implications of expanded tile drainage for aquatic ecosystems in the Red River basin. Northwest Regional Sustainable Development Partnership. Ada, Minnesota.

Bruskotter, J.T. and **D.C. Fulton**. 2006. The influence of angler values orientations on angler norms. International Symposium on Society and Resource Management. Vancouver, British Columbia, Canada.

Bruskotter, J.T. and **D.C. Fulton**. 2006. Land conservation in practice: attitudinal correlates of southeast Minnesota landowners' conservation behavior. The Wildlife Society 13th Annual Meeting. Anchorage, Alaska.

Cornicelli, L., **D.C. Fulton**, and M. Grund. 2006. Assessing hunter preference of deer management alternatives in Minnesota. The Wildlife Society 13th Annual Meeting. Anchorage, Alaska.

Fulton, D.C., S.A. Schroeder, and J. Lawrence. 2006. Do hunter satisfaction and trust in agency personnel predict support for waterfowl regulations? The Wildlife Society 13th Annual Meeting. Anchorage, Alaska.

Henneman, C. and **D.E. Andersen**. 2006. Habitat associations of red-shouldered hawks in central Minnesota based on site occupancy models. The Wildlife Society 13th Annual Meeting. Anchorage, Alaska.

Kocian, M., C. Sanocki, and **B. Vondracek**. 2006. Comparing Geographic Information System stream slope methods to field measurements in Minnesota. U.S. Geological Survey 6th Biennial Geographic Information Science Workshop. Denver, Colorado. (POSTER)

Kocian, M., **B. Vondracek**, and C. Sanocki. 2006. Using a GIS to estimate stream geomorphic characteristics. 1st Minnesota Natural Resources Conference. Brainerd, Minnesota. (POSTER)

Kocian, M., **B. Vondracek**, and C. Sanocki. 2006. Using a GIS to estimate stream physical characteristics. 26th Annual ESRI International User Conference. San Diego, California. (POSTER)

Meunier, J., R.S. Lutz, K.E. Doherty, **D.E. Andersen**, E. Oppelt, and J.G. Bruggink. 2006. Fall diurnal habitat use by adult female American woodcock in the western Great Lakes region. 10th American Woodcock Symposium. Roscommon, Michigan.

Oppelt, E., J.G. Bruggink, K. Doherty, **D.E. Andersen**, J. Muenier, and R.S. Lutz. 2006**.** Fall survival of American woodcock in the western Great Lakes region**.** 10th American Woodcock Symposium. Roscommon, Michigan.

Reiter, M.E., C.W. Boal, and **D.E. Andersen**. 2006. Species composition, distribution, and habitat associations of anurans in a subarctic tundra landscape near Cape Churchill, Manitoba, Canada. The Wildlife Society 13th Annual Meeting. Anchorage, Alaska.

Schroeder, S.A. and **D.C. Fulton**. 2006. Coping with recreation conflict: how user group and value conflicts predict recreation coping and satisfaction. The 3rd International Conference on Monitoring and Management of Visitor Flows in Recreational and Protected Areas. Rapperswil, Switzerland.

Schroeder, S.A. and **D.C. Fulton**. 2006. Protecting Minnesota's lakes: values, place attachment, and lake conservation. The 12th International Symposium on Society and Resource Management. Vancouver, British Columbia, Canada.

Singh, U., J.B. Ulrich, P. Van Buren, B. Wilson, M. Kocian, J. Perry, **B. Vondracek**, J. Magner, and G. Johnson. Total Maximum Daily Load (TMDL) research at the University of Minnesota. 1st Minnesota Natural Resources Conference. Brainerd, Minnesota. (POSTER)

Ulrich, J.B., U. Singh, B.N. Wilson, M.J. Kocian, and **B. Vondracek**. 2006. Analysis of stream health indicators for Total Maximum Daily Load (TMDL) assessment in Minnesota. Annual International Meeting of the American Society of Agricultural and Biological Engineers. Portland, Oregon.

Vondracek, B., K. Blann, J. Magner, and A. Petersen. 2006. Land use in southeast Minnesota: interactions with trout, water quality, and stream channels. Driftlesss Area Stream Restoration Workshop. LaCrosse, Wisconsin.

Weber, D.L., D.H. Anderson, M. Cuthill, and **D.C. Fulton**. 2006. Managing parks down under: the role of place attachment in benefit attainment and conservation action in Australian parks. The 12th International Symposium on Society and Resource Management. Vancouver, British Columbia, Canada.

Cooperating Faculty Presentations *(partial list)*

Contributed Presentations

2005

Haffner, C. and F. Cuthbert. 2005. Breeding season spatial requirements of Great Lakes piping plovers. Pacific Seabird Group/Waterbird Society Joint Meeting. Portland, Oregon.

Pompei, V. and F. Cuthbert. 2005. Inland piping plover migration stopover sites: using birders' reports to study migration patterns and habitat use. Pacific Seabird Group/Waterbird Society Joint Meeting. Portland, Oregon.

Pompei, V. and F. Cuthbert. 2005. Inland piping plover migration stopover sites: using birders' reports to study migration patterns and habitat use. Symposium on Wintering Ecology and Conservation of Piping Plovers. Jekyll Island, Georgia.

2006

Roche, E.A. and F.J. Cuthbert. 2006. The little plover that could? Modeling reality and the realities of modeling imperiled populations. 2006 North American Ornithological Union Annual Meeting. Veracruz, Mexico.

Western Great Lakes Colonial Waterbird Group. 2006. Binational Great Lakes colonial waterbird survey: preparing for 07-09. Sault Ste. Marie, Michigan.

Unit News

Over the past 2 years, we've added a new member to the Minnesota Cooperative Fish and Wildlife Research Unit. Hattie and Chad Saloka are the proud parents of Connor, who attended his first Cooperators Meeting in 2006! So now, in addition to keeping the Coop Unit running smoothly, Hattie has a youngster to keep her busy. Hattie did take some time away from work when Connor was born, and we were fortunate to have Deb Price ably fill in for Hattie while she was away. Thanks to Deb for helping keep things running for us during 2006.

Bruce Vondracek (Assistant Leader-Fisheries) was promoted through the federal review process to GS-14—congratulations to Bruce for being recognized for the scientific contributions that he and his students have made. Bruce continues to be involved in running the fisheries graduate program, teaching, working with cooperators, working with students and research, and still manages to find some time to fish now and then. David Fulton (Assistant Leader-Wildlife) spent part of 2006 at the University of South Australia, where he and collaborators worked on developing cooperative research projects, and where David presented results of some of his work on cognitive constructs and values and attitudes toward natural resources. He continues to work closely with the Minnesota Department of Natural Resources to address information needs, and Sue Schroeder continues to assist him in these efforts in her position as a Research Fellow. David Andersen (Leader) spent several weeks in 2006 on the South Island of New Zealand, and presented some of his research on Canada geese and arctic ecosystems at Landcare Research.

A few things have changed at the Minnesota Cooperative Fish and Wildlife Research Unit in the past couple of years. First, the College of Natural Resources, which has been the college that hosted the Coop Unit since its inception, ceased to exist in 2006. The College of Natural Resources merged with the College of Agricultural, Food, and Environmental Sciences to become the new College of Food, Agricultural, and Natural Resource Sciences. The implications of this merger for the Coop Unit are not yet clear, but we look forward to continuing a productive relationship with the University of Minnesota. Also, both Jack Wingate (Minnesota Department of Natural Resources) and Steve Wilds (U.S. Fish and Wildlife Service) are retiring in early 2007. Both Jack and Steve have been strong supporters of the Minnesota Cooperative Fish and Wildlife Research Unit, and their support and camaraderie will be sorely missed. We wish both of them the best.

Finally, thanks to all of the students, staff, cooperators, supporters, and other interested parties who have and continue to support the Minnesota Cooperative Fish and Wildlife Research Unit.