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BIENNIAL REPORT

JANUARY 2015—DECEMBER 2016



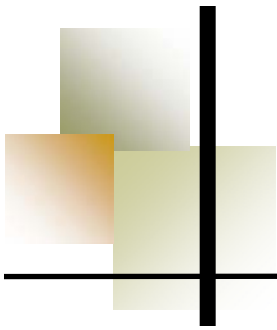
U.S. Geological Survey

University of Minnesota

Minnesota Department
of Natural Resources

The Wildlife
Management Institute

U.S. Fish and
Wildlife Service



The Minnesota Cooperative Fish and Wildlife Research Unit was established in 1987 on the St. Paul Campus of the University of Minnesota as part of the Cooperative Research Units Program and is hosted by the Department of Fisheries, Wildlife, and Conservation Biology. 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 resources 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 both the biological and social aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems.

This is the fourteenth biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 2015 and 2016. Over the past two years, support for the Unit program has remained strong, even in light of difficult economic conditions and budget pressures at the federal, state, and University levels. We currently have a vacancy in that Assistant Leader-Fisheries scientist Dr. Bruce Vondracek retired in May 2015. We continue to enjoy support from our Minnesota Department of Natural Resources, University of Minnesota, Wildlife Management Institute, and U.S. Fish and Wildlife Service partners. We are also fortunate to work with a wide range of cooperators, outstanding graduate students, and university, federal, state, and non-governmental scientists and resource managers to further our research and teaching missions, and to provide technical assistance to partners and clients. Please view our University of Minnesota website (<http://mncoopunit.cfans.umn.edu/>) or Cooperative Units Program website (<http://www.coopunits.org/Minnesota/>) for more information about our activities and to download copies of reports and publications. We invite you to review the summary of our Unit's accomplishments in this biennial report and to contact us with comments or to request additional information. Finally, thanks to our many partners and collaborators for their continued support, and we look forward to continuing a productive relationship to further our mission and shared interests.

Sincerely,

Dr. David E. Andersen
Leader

Dr. Bruce Vondracek
Assistant Leader - Fisheries

Dr. David C. Fulton
Assistant Leader - Wildlife

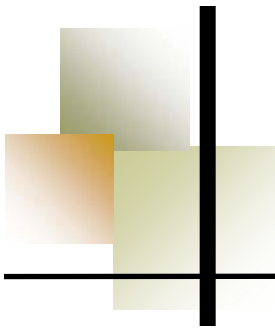
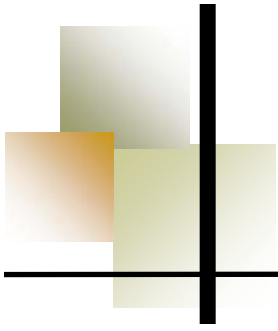


Table of Contents

Introduction	iii
Personnel and Cooperators	vii
Unit Students	viii
Unit Affiliated Staff and Students	ix
Unit Coordinating Committee	x
Unit Cooperators	xi
Cooperating Organizations	xii
Completed Research	1
Applied Ecology	1
Demographic Response of Golden-winged Warbler to Habitat and Management across a Climate Change Gradient in the Core of the Species Range	3
Historical and Current Black Tern Habitat Relationships in the Great Lakes Region	5
Lead Concentrations in Bald Eagle Nestlings and Fish in the Upper Midwest	7
Resource Use of Arctic Peregrine Falcons along the Colville River, Alaska	8
Human Dimensions, Management, and Conservation	9
The 2014 Waterfowl Hunting Season in Minnesota: A Study of Hunters' Opinions and Activities	11
Assessing Landowners'/Producers'/ Attitudes toward and Motivations for Participating in Conservation Programs Beneficial to Wildlife	13
Minnesota Fisheries Habitat Study	15
Northern Pike Management: A Study of Resident Anglers and Darkhouse Spearers	17
Wild Turkey Hunter Survey	19
Ongoing Research	21
Applied Ecology	21
An Integrated Population Model for American Woodcock	23
Delineating Sandhill Crane Populations in Minnesota	25
Determining the Behavioral and Physiological Chemosensory Sensitivity of Asian Carp to Chemical Attractants	27
Improving Survival of Juvenile Winged Mapleleaf Mussels through Identification of Host Fish Over-wintering Areas	28
Marshbird Response to Invasive Cattail Control Using Grazing, Mowing, and Herbicide Application in the Prairie Pothole Region of Minnesota	30
Range-wide Migratory Connectivity for the Full-cycle Conservation of the Golden- winged Warbler, Climate-sensitive Songbird of the Highest Conservation Concern ..	32

Human Dimensions, Management, and Conservation.....	35
Airspace as Habitat: Methods for Assessing Use by Animals	37
Assessing the Preferences of Stakeholders and Waterfowl Management	
Professionals to Inform the Implementation of the NAWMP Action Plan	39
Deer Goal Setting Surveys and Deer Hunter Attitude Research	42
Fishing for Panfish in Minnesota: A Study of Angler Participation and Activities	44
Landowner Attitudes Toward Elk in Northwest Minnesota	45
Long-term Research and Monitoring of Human Dimensions Information on	
Fisheries and Wildlife Management Issues in Minnesota	47
Restoration of Elk to Northeastern Minnesota	48
Understanding User Preferences and Visitor Numbers at Minnesota Wildlife	
Management Areas.....	50
Activities.....	53
Publications.....	55
Completed Theses and Dissertations of Minnesota Coop Unit Students.....	61
Student Awards	64
Presentations	65
Unit News.....	69



PERSONNEL AND COOPERATORS

Unit Personnel

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Susan A. Schroeder, Research Associate

Henry Streby, Postdoctoral Research Fellow

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Jennifer Cochran-Biederman, Ph.D. (Vondracek, graduated 2015)

Megan Cross, M.S. (Fulton, graduated 2015)

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Leslie McInenly, Ph.D. (Fulton)

Sean Peterson, M.S. (Andersen and Streby, graduated 2014)

Eric Walberg, M.S. (Fulton, graduated 2016), Ph.D. (Fulton)

David Wolfson, M.S. (Andersen and Fieberg)



UNIT AFFILIATED STAFF AND STUDENTS

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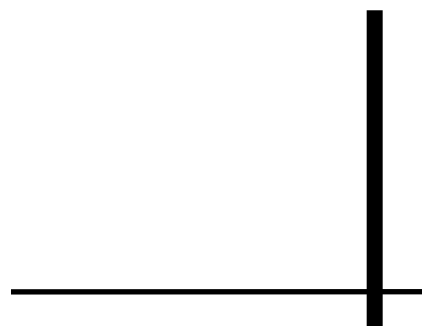
Aaron Claus, B.S. and M.S. (Sorensen, graduated 2015)

Kevin Heist, Ph.D. (Perry and Johnson, graduated 2014)

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Kristina Slagle, Postdoctoral Scientist (Fulton)

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Unit Cooperators

Cooperating Investigators in Unit Research

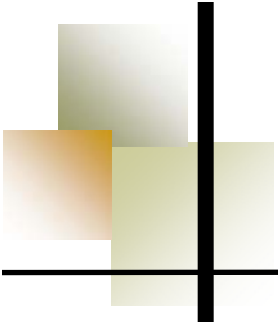
Todd Arnold (University of Minnesota)
David Buehler (University of Tennessee)
Tom Cooper (U.S. Fish and Wildlife Service)
Lou Cornicelli (Minnesota Department of Natural Resources)
Francesca Cuthbert (University of Minnesota)
Gino D'Angelo (University of Georgia)
John Fieberg (University of Minnesota)
James Forester (University of Minnesota)
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Christine Hertwig (Minnesota Department of Natural Resources)
Greg Hoch (Minnesota Department of Natural Resources)
Mark Hove (University of Minnesota)
Douglas H. Johnson (University of Minnesota / U.S. Geological Survey)
Patricia L. Kennedy (Oregon State University)
Jeff Lawrence (Minnesota Department of Natural Resources)
James A. Perry (University of Minnesota)
Andrew Raedeke (Missouri Department of Conservation)
Bill Route (U.S. National Park Service)
Mike Schraje (Fond du Lac Tribe)
Rudy Schuster (U.S. Geological Survey)
Peter W. Sorensen (University of Minnesota)
Sara Vacek (U.S. Fish and Wildlife Service)
Petra B. Wood (West Virginia Cooperative Fish and Wildlife Research Unit)

Cooperating University of Minnesota Academic Units

College of Food, Agricultural and Natural Resource Sciences
Conservation Biology Graduate Program
Department of Fisheries, Wildlife, and Conservation Biology
Fisheries and Aquatic Biology Graduate Program
Natural Resources Science and Management Graduate Program
University of Minnesota Graduate School

Cooperating Organizations

Ducks Unlimited
Fond du Lac Tribe
Legislative-citizen Committee on Minnesota Resources
Minnesota Department of Natural Resources
Missouri Department of Conservation
 Human Dimensions Working Group
National Flyway Council
Ohio State University
University of Alberta
University of Georgia
University of Tennessee
U.S. Bureau of Land Management
U.S. Fish and Wildlife Service
 Bird Habitat Conservation, Upper Mississippi River - Great Lakes Joint Venture
 Division of Migratory Birds, Region 3
 Webless Migratory Gamebird Research Program
U.S. Geological Survey
 Columbia Environmental Research Center
 Geosciences & Environmental Change Science Center
 Science Support Partnership
 West Virginia Cooperative Fish and Wildlife Research Unit
U.S. National Park Service
 Western Great Lakes Region



Completed Research



Applied Ecology



Demographic Response of Golden-winged Warbler to Habitat and Management across a Climate Change Gradient in the Core of the Species Range

Investigator: David E. Andersen
Staff: Henry M. Streby, Postdoctoral Researcher
Student: Sean Peterson, M.S. (Natural Resources Science and Management)
Duration: May 2010 to April 2015
Funding Source: U.S. Fish and Wildlife Service, U.S. Geological Survey,
Minnesota Department of Natural Resources
Location: Minnesota and Southern Manitoba, Canada

Golden-winged warbler (*Vermivora chrysop-tera*) populations have been declining across much of their distribution for at least 45 years. This Nearctic-Neotropical migratory species is listed as “threatened,” “endangered,” or “of management concern” in 10 states, and is described by the U.S. Fish and Wildlife Service as a “species of management concern.” The cause of range-wide declines, and some local extinctions, is a complex combination of habitat loss, blue-winged warbler (*Vermivora cyanoptera*) hybridization and competition, brood-parasitism by brown-headed cowbirds (*Moluthrus ater*), and likely effects of global climate change. Although golden-winged warbler range is contracting from the south, it is expanding to a lesser degree to the west and north. However, in areas of recent range expansion, populations have been declining over the past 15 years, and range expansion will soon be limited by lack of suitable habitat to the north and west. The only golden-winged warbler population experiencing positive growth in the past decade is the population breeding in Minnesota, our primary study area.

Golden-winged warblers are traditionally considered young forest specialists, nesting and raising their young in shrublands or young regenerating forests within a broader landscape of mature



forest. The northern hardwood forests of northern Minnesota, Wisconsin, Michigan, and south-central Canada host the highest densities of breeding golden-winged warblers, and Minnesota alone hosts approximately half of the global population during the breeding season. Predicted to be a bioregion among the earliest and most dramatically affected by global climate change, there is currently considerable debate about the desired future composition and juxtaposition of cover types within these forests. Considerations for wildlife, including species associated with early successional forests, are an important part of this conversation. Golden-winged warbler nesting habitat is in decline as abandoned farmlands regenerate to mature forest, timber harvest declines, and wetlands are



drained for development. Assessing the demographic response of golden-winged warbler populations to forest management and other habitat alterations is critical for this species to be appropriately considered in future management planning. Detailed knowledge of habitat-specific demographic parameters is necessary to predict golden-winged warbler population responses to climate change. Little is known about golden-winged warbler survival and habitat use throughout the nesting period in this region, and almost nothing is known about these parameters during the post-fledging period anywhere in the species' range.

Data collection for this project began in 2010 with a pilot study at Tamarac National Wildlife Refuge (NWR) and then continued in 2011 and 2012 at Tamarac NWR, Rice Lake NWR, and at Sandilands Provincial Forest in southeastern Manitoba. Since the end of the 2012 field season, we have been organizing and analyzing data and preparing manuscripts for publication.

The objective of this study was to investigate golden-winged warbler adult survival and reproductive success, including nest productivity and juvenile survival between the species' main breeding habitat types; upland shrublands/early successional forests and shrubby wetlands. Plans for comparing survival and productivity between these habitat types quickly changed as radio-telemetry monitoring of adults and fledglings revealed complex

movement patterns and use of various habitat types throughout the reproductive season. Golden-winged warbler nesting territories and home ranges were associated with edges of upland and wetland shrublands, but contrary to previous reports, they included substantial portions of mature forest. In addition, using radio telemetry to monitor nest site choice by females, we found a considerable number of birds nested in the mature forest portions of their territories, sometimes up to 100 m from shrubland/forest edge. Finally, regardless of nest location, fledged family groups (or subbroods after brood division) used mature

forest and mid-successional aspen (*Populus* spp.) more often than expected relative to availability, and they selected those cover types significantly over all other cover types including upland and wetland shrublands. Interestingly, nest success was higher in shrublands than in forest, but fledgling survival was higher from nests in forest than from nests in shrublands, creating an opportunity to investigate the role of fledgling survival in the evolution of nest-site choice.

Because golden-winged warbler habitat associations were much more complicated than we initially assumed, we abandoned the idea of simple comparisons of productivity between individual habitat types. Instead, we built models that incorporated the effects of all represented cover types on nest productivity and fledgling survival, and we have applied those models to our study sites and to hypothetical forest management scenarios to identify appropriate management actions for maximizing seasonal productivity, or number of young raised to independence per breeding pair.

Thus far, this project has produced multiple primary literature publications and has been featured in multiple public media outlets and was completed in early 2015. A companion project on migratory connectivity and full-life-cycle ecology is ongoing.

Historical and Current Black Tern Habitat Relationships in the Great Lakes Region

Investigator: Francesca Cuthbert (Cooperating Faculty)
Student: Katherine Wyman, Ph.D. (Conservation Biology)
Duration: May 2013 to March 2016
Funding Source: U.S. Fish and Wildlife Service—Bird Habitat Conservation, Upper Mississippi River & Great Lakes Joint Venture
Project Location: University of Minnesota, Twin Cities Campus
Minnesota, Wisconsin, Michigan, New York

The overall goal of this project is to inform regional planning for black tern (*Chlidonias niger*) conservation through a better understanding of historical causes of colony site abandonment and through refinement of an index to predict current landscape suitability for black tern nesting. Research resulted in two projects: an historical perspective of the relationship between black tern colony site abandonment and a suite of landscape-scale habitat features and a current examination of black tern-habitat relationships. This project has been completed and resulted in two publications.

Historical habitat relationships: Breeding colonies of black terns have become increasingly rare in U.S. Great Lakes coastal wetlands since the mid-twentieth century, with an almost 90% decline in the number of active colony sites since 1991. Although the specific causes of this wetland species' decline are unknown, habitat loss and degradation are thought to be a major barrier to conservation. Using data from the Great Lakes Colonial Waterbird Survey, we took a unique regional and historical approach to investigate the relationship between black tern colony site abandonment and a suite of local and landscape-scale habitat features in U.S. Great Lakes



Credit: Roger Eriksson 2013

coastal wetlands. We employed logistic regression models and a combination of stepwise selection procedures to identify the best predictive model for black tern colony abandonment. According to the selected model, breeding colonies with fewer nests were more likely to be abandoned over the following decadal observation period than breeding colonies with more nests. Colony sites were also more likely to be abandoned when vegetation within the wetland shifted towards larger, denser clusters. We performed a simulation study that showed that failing to account for association between observations from the same site affected model selection results, but that cross-validation error for the selected model remained low unless site effects were very strong. Results of this study

suggest that focus on protection of sites harboring large numbers of black terns and vegetation management will help limit further colony abandonments.

Current habitat relationships: Remotely sensed land cover data enable characterization of avian habitat over large spatial scales, which can be applied to regional conservation planning. The Upper Mississippi River and Great Lakes Region Joint Venture, a partnership for bird conservation in the Upper Midwest, developed a landscape suitability index for the wetland-breeding black tern based on remotely sensed land cover to choose habitat to enhance or restore. We tested the validity of this index and compared it to an alternative index we constructed from results of field surveys. Over two breeding seasons, we surveyed for presence of black tern breeding colonies in 158 wetlands across the Great Lakes region and compared our findings with predictions of the existing index. We used our first season of surveys, numerous remotely sensed landscape variables, and random forest classification to build our alternative index.



Credit: Roger Eriksson 2013

Key predictors of black tern colony presence in the alternative index were wetland area, wetland type (emergent vegetation, open water, or combination), and area of wetlands available for foraging within 2 km. The two indices performed similarly well, correctly identifying categories of sites most likely to host black terns, but even high-suitability sites had <20% predicted occupancy probability. The best use of these and similar indices is in prioritizing restoration projects at a regional scale by identifying sites with potential for use.

Lead Concentrations in Bald Eagle Nestlings and Fish in the Upper Midwest

Investigator: David E. Andersen, Jason E. Bruggeman (Post-doctoral Research Fellow)
Collaborators: Bill Route (U.S. National Park Service)
Duration: September 2014 to September 2017
Funding source: U.S. National Park Service
Project Location: Western Great Lakes Region National Parks
Minnesota Cooperative Fish and Wildlife Research Unit

Between 2006 and 2011 the National Park Service Great Lakes Inventory and Monitoring Network (GLKN) and the University of Wisconsin-La Crosse (UW-Lax) collected tissue samples from bald eagle (*Haliaeetus leucocephalus*) nestlings and fish as biosentinels for monitoring the levels of environmental contaminants in aquatic ecosystems. GLKN collected blood and feather samples from eagle nestlings from 2006-2011 at Apostle Islands National Lakeshore, the St. Croix National Scenic Riverway, the Mississippi National River and Recreation Area, and in two non-NPS areas in close proximity. Whole fish and fish fillets were collected by the UW-Lax from 2008-2011 at Voyageurs National Park, Grand Portage National Monument, Isle Royale National Park, Pictured Rocks National Lakeshore, Sleeping Bear Dunes National Lakeshore, and Indiana Dunes National Lakeshore. In this project we will

focus on assessing and reporting on concentrations of lead, a heavy metal that has been banned for use in many products but is still used in fishing tackle, ammunition, and other products. Lead enters aquatic systems and animal tissue through a variety of pathways. The National Park Service is responsible for understanding the implications of such contamination and reporting findings to constituents and the public. Specific objectives of this project are (1) analyze existing data on lead concentrations in bald eagles and (2) interpret those results and prepare a manuscript based on those results for the peer-reviewed, scientific literature.

Resource Use of Arctic Peregrine Falcons along the Colville River, Alaska

Investigators: David E. Andersen and Patricia L. Kennedy (Cooperating Faculty)
Staff: Jason Bruggeman, Postdoctoral Researcher
Duration: January 2011 to December 2015
Funding Source: U.S. Bureau of Land Management
Project Location: Alaska's North Slope
Minnesota Cooperative Fish and Wildlife Research Unit

The Colville River Special Area (CRSA) was designated in 1977 to protect nesting and foraging habitat of the then-endangered arctic peregrine falcon (*Falco peregrinus tundrius*). The CRSA is approximately 2.44 million acres, and provides nesting habitat for approximately one-fourth of Alaska's arctic peregrine falcon population. To afford additional protections to the arctic peregrine falcon, the Record of Decision (ROD) from the 2004 Integrated Activity Plan/Environmental Impact Statement (IAP/EIS) for the Northwest Planning Unit of the NPR-A and the final ROD for the Northeast Planning Unit required a management plan for the arctic peregrine falcon in the CRSA to be developed and put into effect prior to any lease sales. The Colville River Special Area Management Plan (CRSAMP) was completed in July 2008 (Bureau of Land Management 2008 Colville River Special Area Management Plan) and specifically addresses the need for additional measures to protect arctic peregrine falcon nesting habitat and the need for research to determine the characteristics of peregrine falcon nesting habitat in the CRSA.

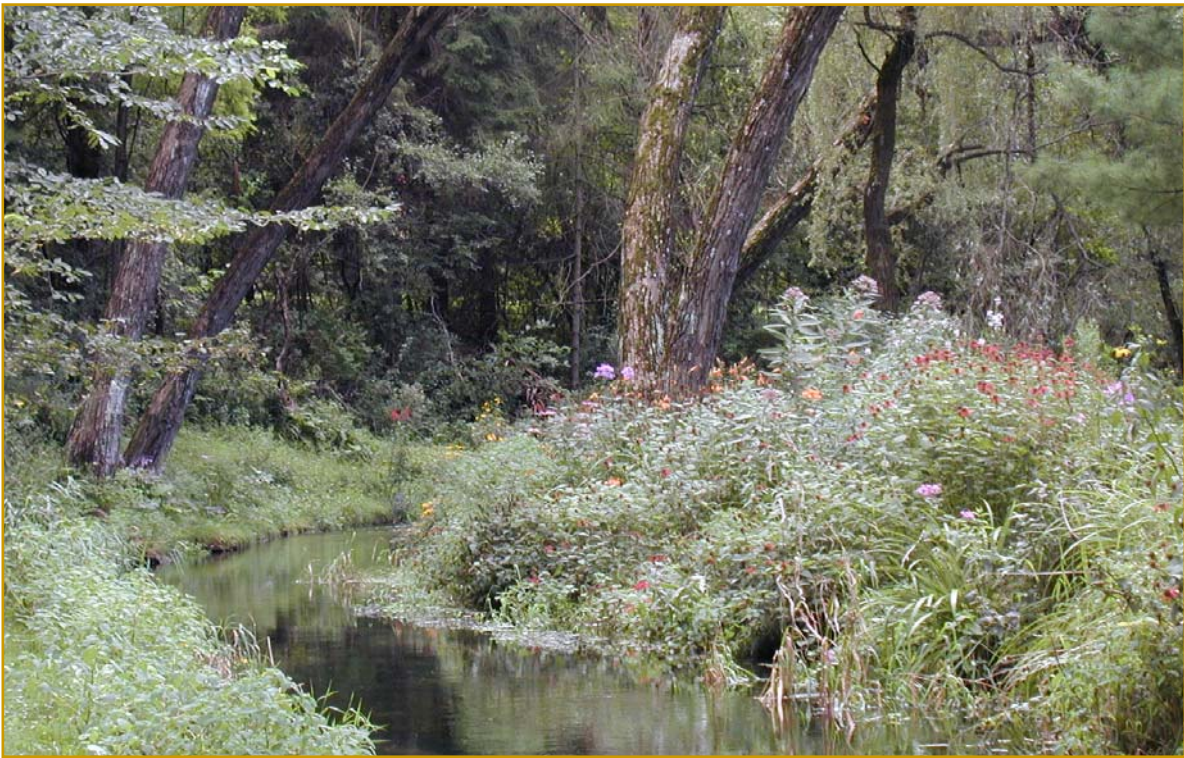
One objective of the CRSAMP was to improve knowledge about the ecology, life history, and behavior of arctic peregrine falcons to help decision makers and managers make informed decisions on proposals that could have an impact on falcons. To address that information need, we have (1) summarized and evaluated existing CRSA peregrine nesting data to assess nesting



habitat use and related productivity, and (2) implemented additional analyses focused on assessing nesting area occupancy related to habitat and other factors associated with productivity. To date, we have published two peer-reviewed manuscripts summarizing abundance and occupancy of peregrine falcons in the CRSA and are currently working on a spatially-explicit model of productivity and abundance of peregrines across the CRSA. As part of a companion project.



Completed Research



Human Dimensions, Management,
and Conservation



The 2014 Waterfowl Hunting Season in Minnesota: A Study of Hunters' Opinions and Activities

Investigator:	David C. Fulton
Staff:	Susan A. Schroeder, Ph.D. Research Associate
Duration:	October 2014 to January 2016
Funding Source:	Minnesota Department of Natural Resources
Project Location:	Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota has generally been in the top three states for number of waterfowl hunters in the United States. In recent years we have expanded efforts to obtain quantitative information about opinions and motivations for this important clientele. Minnesota participated in the North American Duck Hunter Survey and Minnesota hunter responses were compared to those in other states. More recently, reports documenting hunter activity and opinions following the 2000, 2002, 2005, and 2007 waterfowl hunting seasons were completed. In addition, a series of surveys looking at hunter recruitment and retention were completed following the 2005 waterfowl hunting season and a study of former waterfowl hunters was completed following the 2009 season. Information from these reports has been used to inform management decisions. We also conducted surveys following the 2010 and 2011 waterfowl seasons. This study of the 2014 Minnesota waterfowl-hunting season was conducted to assess waterfowl hunters':

- participation and activities,
- satisfaction,
- motivations,
- involvement with the activity, and
- attitudes about waterfowl management, including a potential teal season.

The survey was distributed to 3,600 waterfowl hunters; 1,738 surveys were returned. After adjusting for undeliverable surveys and invalid respondents, the response rate was 49.7%. Just

less than nine of 10 survey respondents (88.9%) hunted waterfowl during the 2014 Minnesota season. Respondents who had hunted in 2014 were asked if they had hunted for ducks, Canada geese during the early and regular seasons, and other geese. Responses ranged from 91% for ducks to only 4% for other geese. Hunters who reported pursuing ducks, Canada geese, or other geese reported bagging an average of 11.5 ducks, 6.6 Canada geese, and 5.3 "other" geese, respectively, over the course of the 2014 Minnesota season. Approximately two-thirds of hunters (65.0%) reported being satisfied with their general waterfowl-hunting experience. Younger hunters and hunters who have been hunting for fewer years reported higher levels of satisfaction.

Respondents were asked to indicate their opinion about the 6-duck bag limit, 2-hen mallard bag limit, and 3-wood duck bag limit. About two-thirds of respondents felt the 6-duck bag limit was about



right, with 2.9% indicating that it was too low, 15.9% too high, and 12.8% no opinion. Similarly, about two-thirds of respondents felt the 2-hen mallard bag limit was about right, compared to 4.4% too low, 16.1% too high, and 13.6% no opinion. Nearly two-thirds of respondents felt the 3-wood duck bag limit was about right, compared to 10.9% who felt it was too low, 12.4% who thought it was too high, and 11.9% who had no opinion. Respondents were asked to rate 13 statements about bag limits. Respondents generally agreed that bag limits should be based on biological impacts, and generally disagreed that they should follow what was socially desirable. Respondents were asked to indicate their level of support for 10 management strategies. Respondents reported the most support for beginning shooting hours ½ hour before sunrise on opening day and the least support for restricting the use of motorized decoys for the first part of Minnesota's waterfowl season. Respondents reported significantly higher satisfaction

levels for the 2014 season than for the 2005, 2007 or 2010 seasons, and lower than the 2002 season. Satisfaction was not significantly different from the 2000 and 2011 seasons. Support for Youth Waterfowl Hunting Day in 2014 was significantly higher than 2002, 2005, 2010, and 2011, but not significantly different than in 2000. Reported memberships in Ducks Unlimited, Delta Waterfowl, the Minnesota Waterfowl Association, and local sportsmen's clubs were lower in 2014 than in 2011, but similar to levels seen in previous study years.

Complete study findings are available in: Schroeder, S.A., Lawrence, J.S., and Cordts, S.D. 2015. The 2014 Waterfowl Hunting Season in Minnesota: A Study of Hunters' Opinions and Activities. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology. In addition a peer-review article from this study is under review for publication.

Assessing Landowners'/Producers' Attitudes toward and Motivations for Participating in Conservation Programs Beneficial to Wildlife

Investigator: David C. Fulton
Student: Megan Cross, M.S. (Natural Resources Science and Management)
Duration: August 2012 to July 2015
Funding source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

The Eastern Tallgrass Prairie and Big Rivers (ETPBR) Landscape Conservation Cooperative (LCC) cuts a vast swath across the middle of America's heartland, covering the area more commonly referred to as the "corn belt." The ETPBR LCC covers portions of 11 states, and runs from southwest Ohio westward across to parts of eastern Kansas, Oklahoma, and Nebraska and northward up into segments of Iowa, South Dakota, and Minnesota. It is where European settlers, moving west across a young America, discovered rich, rolling, fertile lands and ample farming opportunities. Millions of acres of forest and prairie were cleared, plowed, and put into agricultural production to help feed a new nation. The ETPBR LCC contains portions of some of America's premier rivers; including the Mississippi, Missouri, Illinois, Wisconsin, Ohio, and Wabash, providing critical riverine corridor habitat for wildlife. The LCC is also home to a wide variety of natural lakes and reservoirs.

The ETPBR LCC is dedicated to addressing the conservation challenges of a heavily agricultural landscape. Whereas the ETPBR LCC landscape is predominantly agricultural and in private ownership, the area also contains numerous state and federally managed tracts of land such as National Wildlife Refuges, State Wildlife Management Areas, land trust parcels, and nature preserves providing habitat for a wide variety of aquatic and terrestrial species of wildlife. Additionally,

many of the agricultural practices and set-aside programs through the Federal Farm Bill have created wildlife habitat and State and Federal programs to create and conserve forested lands, usually in small fragmented woodlots that dot the agricultural landscape.

The behaviors of individual landowners, many of whom actively farm their properties, have the potential to conserve water quality and conserve fisheries and wildlife habitat. In fact, the steering committee for the ETPBR LCC identified a need to better understand the motivations of landowners for participating in programs that improve wildlife habitat and water quality in the region. To help address this need, we conducted focus groups to identify and evaluate the motivating reasons that producers in the Eastern Tallgrass Prairie enroll in United States Department of Agriculture (USDA) Farm Bill conservation programs (FBCP). We collected information on perceived strengths and weaknesses of specific Farm Bill programs, such as the Conservation Reserve Program (CRP), Wetlands Reserve Program (WRP), and Agricultural Conservation Easement Program (ACEP). These focus group were conducted to develop a better understanding of individuals' beliefs about these programs and practical insights into designing and developing programs, practices, and messages that encourage broader participation in conservation and sustainable practices within the agricultural com-

munity.

Four landowner focus groups were conducted. A single focus group was held in Wahpeton, Richland County, North Dakota and Newton, Jasper County, Iowa. Two groups were held in Austin, Mower County, Minnesota. Focus group discussions were recorded and transcribed and analyzed following the protocol of Krueger and Casey.

Key issues revealed through the focus groups were:

- Participants were generally concerned about protecting the land for both agriculture and conservation for future generations
- There was a common sense of optimism about the potential of conservation programs to protect or enhance soil, air, water, and habitat quality
- Many focus group participants were interested in either learning more about FBCPs or participating in them, if they were not already enrolled
- Interest and optimism were tempered by confusion and frustration among many who had tried

to learn more or enroll in a program

- Major frustrations stemmed from lack of transparency, excessive paperwork required for enrollment, difficulty understanding the programs or finding detailed information, lack of flexibility/program rigidity, overly restrictive conditions for enrollment, lack of local control, poor targeting or selection of lands for enrollment, and a perceived preference for supporting large operators rather than the small scale farmers that all participants identified with
- Contract lengths were of particular interest in several groups as both an example of the lack of flexibility in programs, and of something participants felt could be changed to promote increased enrollment in programs

The ICR was approved by the Office of Management and Budget (OMB Control Number: 1090-0011).

Minnesota Fisheries Habitat Study

Investigator:	David C. Fulton
Staff:	Susan A. Schroeder, Ph.D. Research Associate
Duration:	June 2014 to December 2015
Funding Source:	Minnesota Department of Natural Resources
Project Location:	Minnesota Cooperative Fish and Wildlife Research Unit

This study was conducted to understand angler beliefs and perceptions about fish habitat. This information will inform how the Minnesota Department of Natural Resources (DNR) can better connect the importance of habitat to sustainable fisheries management. Surveys were distributed to 2,000 resident anglers. A total of 784 full-length surveys were returned, resulting in an adjusted response rate of 41.7%. An additional 80 shortened or late surveys, used to gauge nonresponse, were returned for a total response rate of 46.0%.



Respondents had fished in Minnesota for about 40 years, and purchased a Minnesota fishing license an average of eight of the past 10 years. Respondents fished 24 days in the past year. Respondents rated their preferences for targeting 20 fish species; walleye (*Sander vitreus*) was the most preferred species while carp (*Cyprinus carpio*) and bullhead (*Ameiurus* spp.) were least preferred. Respondents were asked to report their overall satisfaction with the overall fishing experience, along with six other specific aspects of fishing. Respondents were most satisfied with the overall fishing experience and access, and least satisfied with the number of fish they caught and the behavior of non-anglers. Respondents were asked how much they agreed with a series of 14 statements about fisheries-related values. Protection-related values were rated highest (3.6 on a five-point scale), compared to utilitarian (2.5) and human dominance (2.6) values.

Perceived Effectiveness of Strategies used to Improve Fish Habitat: Respondents were asked about the effectiveness of 22 strategies for improving fish habitat on a five-point scale. Generally, respondents seem to think all strategies were effective, with over half of respondents saying all strategies were very or extremely effective. Responses to the different statements, however, differed statistically and ranged from 3.4 for “Creation of log cribs and other human-made cover” to 4.2 for “protecting groundwater.” Fishing involvement and protection values were positively correlated with the perceived effectiveness of strategies for improving fish habitat. Utilitarian and human dominance values, and a stronger orientation to keep fish, were negatively correlated with ratings of the effectiveness of strategies.

Importance of and DNR Performance on Management Activities : Respondents were asked to rate the importance of 10 management activities



related to fish habitat, then rate DNR performance on the same 10 activities. Responses to the different statements differed statistically and ranged from 3.6 for “purchasing land or easements around lakes and streams” to 4.3 for “protecting the habitat in lakes and streams.” Although over half of respondents viewed all activities as important or very important, regulations and land acquisition were generally viewed as less important, whereas education, restoration, and protection were viewed as more important. Fishing involvement and protection values were positively correlated with the importance of management activities for improving fish habitat. Utilitarian and human dominance values, and stronger catch orientation, were negatively correlated with the importance of management activities for improving fish habitat.

Responses to DNR performance on the 10 activities differed statistically and ranged from 3.1 for “purchasing land or easements around lakes and streams” to 3.5 for “protecting the habitat in lakes and streams.” Across the board, about half of respondents rated DNR performance neutral on the listed management activities. There were small positive correlations between measures of fishing involvement and ratings of DNR performance on several management activities related to protection and restoration of habitat in and around streams

and lakes. Importance-performance analysis identified four activities where more focus could be emphasized: managing shoreline to protect fish spawning sites, restoring the habitat in lakes and streams, restoring land surrounding lakes and streams that have been damaged/developed, and educating people about lake and stream ecology/habitat.

Respondents were asked to indicate the percent of budget dollars on habitat protection versus restoration, up to 100%. On average, respondents wanted 57.4% of dollars spent on protection of intact, high-quality fish habitat, and 42.7% spent on restoration of degraded fish habitat. Respondents were then asked to indicate the percent of budget dollars they would like to see spent on four specific areas of fisheries management, again totaling 100%. Respondents indicated that they wanted an average of 31.0% on protection and restoration of fish habitat, 29.4% on stocking fish, 22.1% on enforcement of regulations, and 18.3% on monitoring fish populations.

Complete study findings are available in: Schroeder, S.A. 2015. Fishing and Fish Habitat in Minnesota: A Study of Anglers’ Opinions and Activities. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology. In addition a manuscript is undergoing peer-review for publication.

Northern Pike Management: A Study of Resident Anglers and Darkhouse Spearers

Investigators: David C. Fulton
Staff: Susan A. Schroeder, Ph.D. Research Associate
Duration: July 2015 to September 2016
Funding Sources: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This study was conducted to understand angler and darkhouse spearer beliefs and attitudes about northern pike (*Esox Lucius*) management in Minnesota. Anglers included those who: (a) specifically target northern pike, (b) harvest northern pike caught while targeting other species, (c) are primarily interested in fishing for other species but are concerned about northern pike management, or (d) would fish for northern pike if the size structure of northern pike populations was improved. Results were used to inform the DNR and guide management changes for northern pike in Minnesota.

The populations of interest in this study included Minnesota resident anglers and darkhouse spearers concerned about northern pike management in Minnesota. Postcards were distributed to a random sample of 20,000 Minnesota resident anglers 18 years of age and older who had

purchased a resident fishing license in the state for the 2014 season. The sampling frame used to draw the study sample was the Minnesota Department of Natural Resources' (DNR) Electronic Licensing System (ELS). We received 2,000 returned postcards from anglers interested in northern pike management in Minnesota and willing to complete a survey. In addition, a stratified random sample of 3,000 Minnesota resident darkhouse spearers in the ELS was drawn. The spearer sample was stratified by residence of individuals (determined by county) in three proposed northern pike management zones; south, north-central, and northeast. The target sample size was 400 spearers in each region ($n = 1,200$ statewide). Data were collected using a mail-back survey following a process to enhance response rates. We constructed a relatively straightforward questionnaire, created personalized cover letters, and made multiple contacts



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with the targeted respondents. Potential study respondents were contacted four times between September 2015 and January 2016. Of the 2,000 surveys mailed to prescreened anglers, 10 were undeliverable, two were sent to deceased individuals, and one to someone who had moved out of state. Of the remaining 1,987 surveys, a total of 1,563 were returned, resulting in a response rate of 78.7%. An additional 123 shortened or late full-length surveys, used to gauge nonresponse, were returned for a total response rate of 84.9%. Of the 3,000 spearer surveys mailed, 93 were undeliverable and four were sent to deceased individuals. Of the remaining 2,903 surveys, a total of 1,276 were returned, resulting in a response rate of 44.0%. An additional 316 shortened or late full-length surveys, used to gauge nonresponse, were returned for a total response rate of 54.8%.

Survey recipients were asked if they fished specifically for northern pike (i.e., northern pike are your primary fishing objective not incidental to targeting other types of fish). Nearly nine of 10 spearkers specifically targeted northern pike, compared to 62% of anglers who had been pre-screened for interest in northern pike management. Respondents from the spearing sample reported keeping more northern pike when spearing or angling. Respondents who specifically targeted northern pike were asked if they had fished for northern pike in Minnesota in the past 12 months, and over nine of 10 anglers and spearkers had. Respondents most frequently targeted northern pike in the north-central region of the state. Respondents were asked to report the minimum “keeper” size and preferred size of northern pike. On average, the minimum keeper sizes were 22.3 inches for anglers and 23.4 inches for spearkers, with preferred sizes of 27.8 inches and 26.1 inches.

After reading information on northern pike management in Minnesota, respondents were asked about management objectives, regulations, bag limits, and issues related to northern pike in the state. Respondents were asked to rate their support or opposition to 14 management objectives for northern pike. Generally, respondents supported all management objectives. Respondents were

asked about the likelihood of four proposed regional regulations in achieving the management objectives identified for the zones. On average, anglers rated the likelihood of regulations achieving objectives higher than spearkers did. For each of the regulations, there were substantive proportions of respondents who rated the regulations neutral (i.e., that the regulation was neither likely nor unlikely to achieve the management objectives). Respondents were also asked about the acceptability of four proposed regional regulations, along with the current statewide regulation for northern pike. On average, spearkers rated the acceptability of the current statewide regulation higher than anglers did, and anglers rated the acceptability of the proposed regional regulations higher than spearkers did. Again, for each of the regulations, there were substantive proportions of respondents who rated the regulations neutral (i.e., neither acceptable nor unacceptable).

Respondents were asked about the acceptability of managing some of Minnesota’s northern pike populations for high-quality trophy fishing opportunities, if it means giving up most harvest opportunity on those lakes. About 47% of spearkers felt it was slightly to extremely acceptable to manage for trophy fishing, compared to 64% of anglers. Respondents were asked to indicate how important it was that anglers and spearkers have the same regulations for northern pike, then they were asked to rate the acceptability of four alternative regulations for spearkers. About half of anglers felt it was somewhat or very important that spearkers and anglers have the same regulations for northern pike, compared to about 36% of spearkers. For each of the alternative regulations, the greatest proportion of respondents (both spearkers and anglers) rated the alternative neutral. This may reflect the complexity of the question and the alternative regulations presented.

Complete results are provided in: Schroeder, S.A. 2016. Northern Pike Management in Minnesota: A Study of Anglers’ and Darkhouse Spearkers’ Opinions. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology.

Wild Turkey Hunter Survey

Investigator: David C. Fulton
Staff: Susan A. Schroeder, Ph.D. Research Associate
Duration: June 2014 to April 2015
Funding Source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Wild turkey (*Meleagris gallopavo*) populations and hunting have increased greatly over time in Minnesota and hunting season management is in a state of change. For the last half decade, management has been moving from conservative strategies that allowed the population to expand to strategies that increase turkey-hunting opportunities and minimize regulatory complexity while still sustaining a healthy turkey population.

A legislative report outlining future direction of turkey hunting management was completed in 2009. Most recommendations from that report have been adopted including permit area consolidation, expansion of over-the-counter license sales, electronic registration, and expanded youth and disabled hunt opportunities. However, the basic structure of the spring hunting season has remained relatively unchanged. Additional youth and disabled hunts have become cumbersome to administer. Stakeholders and wildlife managers are both suggesting changes to how turkeys are hunted in Minnesota now that the state is essentially fully occupied and populations in many areas have reached social or biological carrying capacities.

As most of the administrative changes have been made, a comprehensive survey was needed of turkey hunters before additional changes could be considered. A random survey of turkey hunter attitudes toward possible regulatory changes and further expansion of turkey hunting opportunity was completed to take this 'next

step' in Minnesota turkey hunting season management.

This study of the 2014 Minnesota spring turkey-hunting season was conducted to assess hunters':

- participation and activities,
- satisfaction,
- motivations,
- identification and involvement with the activity,
- perceptions related to hunt quality, and
- attitudes about turkey management and season structure preferences.

The population of interest in this study included all Minnesota residents 18 years of age and older who purchased turkey licenses in 2014. The sampling frame used to draw the study sample was the Minnesota Department of Natural Resources' (DNR) Electronic Licensing System (ELS). A random sample of 2,500 resident turkey license buyers in the ELS was drawn. To have adequate power to conduct a season choice experiment, we developed 10 survey versions, and the study sample was divided into 10 subsamples that received different survey versions. Surveys were identical except for the choices included in the choice experiment.

Data were collected using a mail-back survey following a process outlined by Dillman to enhance response rates. We constructed a relatively straightforward questionnaire, created per-

sonalized cover letters, and made multiple contacts with the targeted respondents. Potential study respondents were contacted four times between August and November 2014. Of the 2,500 questionnaires mailed, 38 were undeliverable or otherwise invalid. Of the remaining 2,462 surveys, a total of 1,411 were returned, resulting in a response rate of 57.3%. An additional 229 shortened or late full-length surveys, used to gauge nonresponse, were returned for a total response rate of 66.6%.

This study included a stated choice experiment to examine season structure preferences. Stated choice models present hypothetical scenarios to respondents to derive individuals' preferences for alternatives composed of multiple resource and management attributes. Alternatives presented in this season choice experiment consisted of four attributes: (a) season structure, (b) second permit, (c) hunter interference, and (d) lottery. Respondents were presented with 10 season structure choice scenarios and asked to choose one option. Each scenario included two season structure choices plus a "none" (i.e., I would not hunt turkey in Minnesota with these season structures) option.

Attribute importances described how much influence each attribute had on season structure choice. The most important attribute was a second permit, followed by hunter interference, season structure, then lottery. Results of the stated choice model indicated that the current season structure, a second permit only to unsuccessful hunters, low hunter interference, and a lottery only in high demand areas were preferred.

Complete study results are available in a summary report completed in April 2015: Schroeder, S.A. 2015. Minnesota Spring Wild Turkey Hunting: A Study of Hunters' Opinions and Activities. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology. In addition, two manuscripts are under review for publication in peer-review journals.



Ongoing Research



Applied Ecology



An Integrated Population Model for American Woodcock

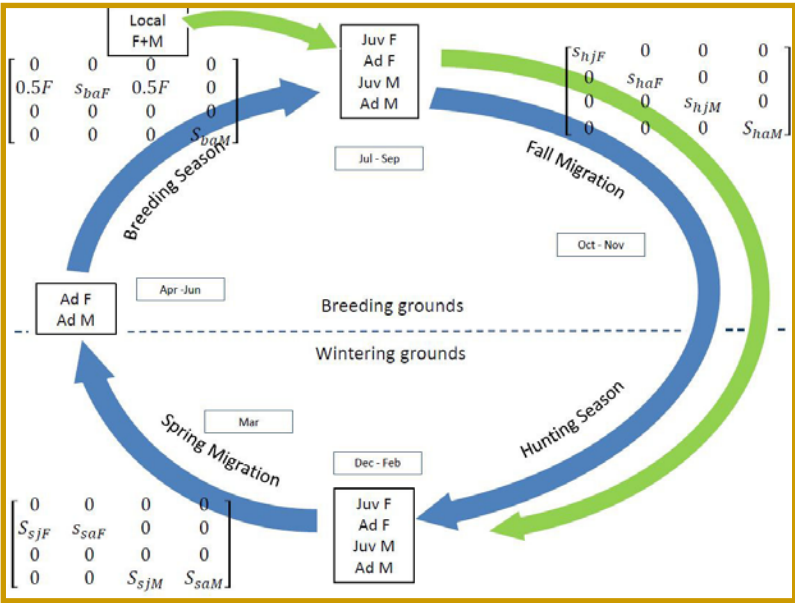
Investigator: Todd Arnold (Cooperating Faculty)
Staff: Sarah Saunders, Post-doctoral Research Fellow
Duration: August 2015 to December 2017
Funding Source: U.S. Fish and Wildlife Service -
 Webless Migratory Gamebird Research Program
Project Location: University of Minnesota, Twin Cities Campus
 Michigan State University, East Lansing, MI

The goal of this project is to use data from existing federal surveys for American woodcock (*Scolopax minor*), including the Singing-ground Survey, harvest surveys (Duck Stamp Survey, Harvest Information Program), Parts Collection Survey, and annual banding information (U.S. Geological Survey Bird-banding Laboratory) to create an integrated population model (IPM) to describe long-term woodcock population trends in the Central and Eastern Management Units. All data sets have been procured and are now being organized to facilitate combined analysis in a Bayesian framework.

Information on population abundance and trajectory will come from two sources, the annual

Singing-ground Survey that assesses abundance of singing male woodcock in spring, and from Lincoln estimators that use harvest and band-recovery data to estimate the size of adult male, adult female, and immature populations in late summer, immediately before the hunting season. Lincoln estimates also provide estimates of

annual fecundity, historically defined as average number of male plus female offspring per adult female during late summer. Band-recovery data will also be used to estimate juvenile and adult annual survival, thus providing all the data



Conceptual model

sources necessary to construct a full life-cycle model of American woodcock populations in each major management unit.

Data analysis is underway, and we are planning for two publications. The first paper will consist of Lincoln estimates of population sizes, which we will present and publish at the 11th Woodcock Symposium in October 2017. The second paper will combine Singing-ground Survey and Lincoln estimates with survival and fecundity estimates from banding data to create a full life-cycle integrated population model.

Delineating Sandhill Crane Populations in Minnesota

Investigators:	David E. Andersen and John Fieberg (Cooperating Faculty)
Collaborators:	Tom Cooper (U.S. Fish and Wildlife Service), Jeff Lawrence (Minnesota Department of Natural Resources), Dave Fronczak (U.S. Fish and Wildlife Service)
Students:	David Wolfson, M.S. (Natural Resources Science and Management)
Duration:	May 2014 to June 2017
Funding source:	U.S. Fish and Wildlife Service, Minnesota Cooperative Fish and Wildlife Research Unit, Minnesota Department of Natural Resources, and the State of Minnesota's Environment and Natural Resources Trust Fund as recommended by the Legislative-Citizen Committee on Minnesota Resources
Project Location:	Central and northern Minnesota Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota is one of few states that supports portions of two distinct breeding populations of sandhill cranes (*Antigone canadensis*)—the Mid-continent Population (MCP) that breeds and migrates through northwestern Minnesota, and the Eastern Population (EP) that breeds throughout much of the rest of the state. Although there is a small amount of gene flow between the two populations, genetic analyses in the early 2000s concluded that the two populations were genetically distinct enough to be managed separately. Sandhill cranes are long-lived birds with relatively low recruitment rates, making accurate knowledge of abundance and distribution critical for well-informed harvest management. Whereas the MCP of sandhill cranes has exhibited stable population estimates over time, the EP is currently experiencing a significant increase in population

size, and also appears to be experiencing a concurrent expansion in breeding range.

Sandhill crane numbers sharply declined following widespread European settlement during the late 19th century. Unregulated harvest and widespread habitat alteration led to a historic low of 25 breeding pairs of EP cranes in the 1930s. Since then, sandhill crane numbers increased following passage of the Migratory Bird Treaty Act of 1918, which banned all hunting of cranes. Cranes have also benefitted from widespread



public land acquisitions and wildlife habitat preservation.

Historically, the breeding range of MCP cranes in Minnesota was restricted to the extreme north-western portion of the state, especially Kittson and Roseau counties, whereas the breeding range of EP cranes was limited to the east-central part of the state, with a large area separating the two populations. The breeding ranges of these two populations have expanded and come into closer proximity as numbers of cranes have increased, particularly for the EP. However, the current distribution of these two populations, and the resulting implications for their management, is unknown.

To better understand the relationship between MCP and EP cranes along the boundaries of their breeding distributions in Minnesota, we will capture breeding cranes in the zone between the two historic range boundaries and equip them with Global System for Mobile Communication/Global Positioning System (GPS/GSM) transmitters to monitor their movement over multiple years. Specifically, we will address the following objectives:

- 1) Delineate the current boundary between breeding MCP and EP sandhill cranes in Minnesota
- 2) Test *a priori* spatial hypotheses regarding sandhill crane habitat use and selection in agricultural, upland, and wetland environments.
- 3) Evaluate year-round movement patterns (e.g., migration) and survival of Minnesota sandhill cranes.



Determining the Behavioral and Physiological Chemosensory Sensitivity of Asian Carp to Chemical Attractants

Investigator: Peter W. Sorensen (Cooperating Faculty)
Students: Aaron Claus, M.S. (Conservation Biology, Fisheries & Aquatic Biology)
Duration: July 2013 to June 2017
Funding Source: U.S. Geological Survey—Columbia Environmental Research Center
Project Location: University of Minnesota

Although it is well established that the bigheaded carps (*Hypophthalmichthys* spp.) are microphagous filter-feeders, how they locate and then identify their food is unknown. If understood, chemical feeding stimuli could be used to target these invasive species. This study, which commenced in the summer of 2013, is exploring the roles of olfaction (smell) and gustation (taste) in food finding and the possibility that these senses detect chemicals unique to plankton preferred by these fishes. We are especially interested in the possibility that feeding stimuli could be used as species-specific attractants for trapping or to permit easier population assessment using environmental DNA (eDNA) or as gustatory stimulants to evoke swallowing, and thus ingestion of poisoned microparticles for carp control. Behavioral studies have character-

ized ingestion behavior in both the silver (*H. molitrix*) and bighead (*H. nobilis*) carps and shown it to be largely mediated by the olfactory sense with the epibranchial organ, an internal taste organ playing a role in ingestion. We have also tested a dozen food items on both bigheaded and silver carp and whereas species differences are evident, *Spirulina*, a cyanobacterium, is especially active in both species. Studies of the L-amino acids released show that they can account for some but not all feeding activity. Recent work has identified novel fatty acids as additional cues and show strong evidence of mixture synergism. A manuscript is now in press in the *Journal of Chemical Ecology*. Studies in the upcoming year will examine these feeding stimuli as attractants.

Improving Survival of Juvenile Winged Mapleleaf Mussels (*Quadrula fragosa*) through Identification of Host Fish Over-wintering Areas

Investigators: Mark Hove, Susan Galatowitsch (Cooperating Faculty)
Student: Briana Burke, undergraduate (Fisheries, Wildlife and Conservation Biology)
Duration: May 2016 to May 2019
Funding Source: U.S. Geological Survey (USGS) - Upper Midwest Environmental Sciences Center
Project Location: University of Minnesota (UMN), Twin Cities Campus

The winged mapleleaf (*Quadrula fragosa*) is a federally endangered freshwater mussel with some unusual life history characteristics, which, if better understood, could improve conservation efforts. Most North American freshwater mussels must attach to host fish as larvae to metamorphose to the juvenile life stage. The winged mapleleaf is limited to the St. Croix River in Minnesota where the channel catfish (*Ictalurus punctatus*) is its only known host.

Research at the University of Minnesota is part of a larger U.S. Geological Survey project to identify host fish over-wintering areas, specifically, to: (1) use telemetry to describe movements of St. Croix River channel catfish living with winged mapleleaf before, during, and after the glochidia release period, and (2) monitor winged mapleleaf larvae release behavior. This project addresses the second research objective, specifically, to (1) monitor winged mapleleaf display period, and (2) video displaying winged mapleleaf behavior and host interactions in the St. Croix River.

We followed standard methods to study winged

mapleleaf brooding period, and utilized recent developments in underwater video and computer recording systems to video interactions between brooding winged mapleleaf and fishes. We worked with Upper Mississippi River Conservation Committee's Mussel Conservation Team divers to check mussels 2-3 times per week between 31 August and 3 October at Interstate State Park, and we checked mussels twice a week between 8-18 September at Hudson, Wisconsin. During each check the presence of displaying winged mapleleaf was recorded. To observe interactions between brooding winged mapleleaf and fishes we used underwater video. We reviewed several underwater video systems and chose the Aqua-Vu AV Multi-Vu HD (720p) system because of its internal light source, and



Redhorse swimming by winged mapleleaf in St. Croix River

capability to record >8 hours of video. We videoed for an hour before sunset to three hours after sunset during our visits to Hudson, Wisconsin throughout the winged mapleleaf display period.

Winged mapleleaf brooded glochidia during early fall 2016. Displaying winged mapleleaf were observed at Interstate State Park on the very first mussel check on 31 August, which may mean we missed the beginning of the brooding period. Winged mapleleaf continued to display magazines through 7 September, but stopped displaying the following week when river discharge doubled. Magazines re-emerged on 19 September and continued through 26 September. Similar to Interstate, displaying winged mapleleaf at Hudson, Wisconsin were observed on the first dive on 8 September. Mussels continued to display through 14 September.

Behaviors of brooding winged mapleleaf behavior and co-occurring fishes were videoed during fall 2016. Although no observations of channel catfish interacting with displaying winged mapleleaf occurred, we recorded a variety of winged mapleleaf



Student researcher at study site

and fish behaviors. Brooding winged mapleleaf generally moved very little. Some mussels rotated slightly (2-4 mm), and occasionally rocked back and forth, opened or closed their shells slightly, or slowly pulsed their mantles. Several fishes swam through the video field of view. Most were darters, probably river darters (*Percina shumardi*) or logperch (*Percina* spp.). On one occasion a large *Moxostoma* swam in and out of view for approximately 7 min. None of the fishes interacted with the mantle magazines; rather, most fishes seemed to be passing through the area.

Marshbird Response to Invasive Cattail Control Using Grazing, Mowing, and Herbicide Application in the Prairie Pothole Region of Minnesota

Investigator: David E. Andersen

Collaborators: Tom Cooper (U.S. Fish and Wildlife Service), Greg Hoch (Minnesota Department of Natural Resources), Doug Johnson (U.S. Geological Survey – retired), Christine Herwig (Minnesota Department of Natural Resources), Sara Vacek (U.S. Fish and Wildlife Service)

Student: Nina Hill, M.S. (Natural Resources Science and Management)

Duration: August 2014 to December 2017

Funding source: U.S. Fish and Wildlife Service—Region 3 and Webless Migratory Game Bird Research Program

Project Location: Western and northwest Minnesota
Minnesota Cooperative Fish and Wildlife Research Unit

Secretive marshbirds, including rails, bitterns, and snipe, are arguably the least monitored group of North American birds due to their cryptic behavior and low detectability. Over the past 15 years, stakeholders have made considerable progress in better monitoring marshbirds; however, many of these efforts have not focused on estimating marshbird response to wetland management. In 2011, participants at a national marshbird monitoring workshop recommended that future monitoring efforts be directed toward assessing marshbird response to management. Our proposed research is focused on assessing the response by marshbirds to invasive wetland vegetation management techniques in the Prairie Pothole Region and impoundments in northwestern Minnesota.

The Prairie Pothole Region, an important breeding area for many marshbird species, is facing serious threats, including wetland

loss through drainage and declining habitat quality of remaining wetlands primarily caused by invasive vegetation. Narrow-leaf (*Typha angustifolia*) and hybrid (*Typha x glauca*) cattail and reed canary grass (*Phalaris arundinacea*) have dramatically changed the character of many western Minnesota wetlands. These invasive species often form dense monotypic stands that





reduce plant diversity and change the vegetative structure in both the emergent and wet meadow zones of prairie pothole wetlands. Wetlands with invasive vegetation are often characterized as having low plant diversity, structural homogeneity, low

edge-to-area ratios, limited interspersions of vegetation and water, and no mudflats. Due to the concern about the effects of invasive wetland vegetation on marshbirds, the *Midwest Marshbird Monitoring Working Group* has hypothesized that the alteration of wetland vegetation and structure due to invasive species may reduce the attractiveness of wetlands to breeding marshbirds in the Midwest.

Our proposed research has two primary goals. First, we will examine the effect of different management treatments (herbicide application, mowing, grazing, and no treatment) on wetland use by secretive marshbirds. Second, the Minnesota Department of Natural Resources will use resulting data to calculate baseline population estimates of marshbirds in western Minnesota. We will focus our monitoring activities on game bird species including sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), and Wilson's snipe (*Gallinago delicata*); however, we will also record other marshbird species encountered during surveys including the following Prairie Pothole Joint Venture (PPJV) Region 3 Focal Species: Wilson's phalarope (*Phalaropus tricolor*), pied-billed grebe (*Podilymbus podiceps*), American bittern (*Botaurus lentiginosus*), least bittern (*Ixobrychus exilis*), yellow rail (*Coturnicops noveboracensis*), black tern (*Chlidonias niger*), and all waterfowl species encountered. We will share the results and management recommendations developed from this project with wetland managers throughout the Prairie Pothole Region via workshops, webinars, and other scientific conferences.

Range-wide Migratory Connectivity for Full-cycle Conservation of the Golden-winged Warbler, Climate-sensitive Songbird of the Highest Conservation Concern

Investigator:	David E. Andersen and Henry M. Streby (National Science Foundation Post-doctoral Fellow)
Collaborators:	David A. Buehler (University of Tennessee) and Petra B. Wood (West Virginia Cooperative Fish and Wildlife Research Unit)
Students:	Gunnar R. Kramer, M.S. (Natural Resources Science and Management)
Duration:	July 2013 to December 2017
Funding source:	U.S. Geological Survey, Science Support Partnership
Project Location:	Eastern North America Minnesota Cooperative Fish and Wildlife Research Unit

Compared to migration routes and Central and South American wintering grounds, extensive information is available on distributions, survival, and productivity for many species of migrant songbirds on their North American breeding grounds. However, most Neotropical migrant birds spend only four or five months on their breeding grounds, with the rest of the year spent on wintering grounds and migration routes. Recent demographic models suggest that songbird population growth is more sensitive to annual survival than to reproductive parameters. As a result, tracking songbirds during migration and linking breeding populations to their wintering grounds is a critical research need in songbird conservation and population dynamics. Furthermore, identifying population-specific wintering grounds is critical to allow state and regional North American stakeholders to justify targeted spending on wintering-ground conservation efforts.



It is particularly important to identify population-specific wintering grounds for species experiencing dramatic population declines and breeding-range shifts despite apparent high reproductive success. Golden-winged warblers (*Vermivora chrysoptera*; hereafter GWWA) have experienced

dramatic population declines in a portion of their breeding range, and the GWWA Working Group has identified the non-breeding season as a primary research need for the conservation of this species. Despite apparent high reproductive success across much of their breeding range and

availability of abundant breeding habitat in many areas, GWWA populations appear stationary in a few areas, are declining precipitously in some areas, and expanding their range to the north and west in Canada. Declines in some populations of GWWA are reportedly linked to hybridization with closely related Blue-winged warblers (*V. cyanoptera*; hereafter BWWA) although the dynamic relationship between these two species is still poorly understood. Nest success estimates from GWWA populations in Michigan, New York, North Carolina, Tennessee, and West Virginia suggest that those populations may have high productivity (although post-fledging survival rates are unknown), but are all declining at concerning rates. An intensive study of fledging success and fledgling survival in Minnesota found that those apparently stationary populations are reproducing at levels that should support very strong population growth. That same study found that GWWA in southeastern Manitoba are reproducing at levels too low to explain the observed population growth and range expansion in that province. This mismatch between productivity and population growth suggests that differences in population trends may be associated with differential survival along population-specific migratory routes, or on wintering grounds, and that low-productivity populations may be supplemented by high-productivity populations.

The winter range of GWWA includes tropical forests from central Honduras to central Colombia and Venezuela, a range across which anthropogenic land-use patterns have changed dramatically over the past few decades and within which new agricultural lands are developed primarily by clearing tropical forest. It is also possible that climate change is driving GWWA to expand their breeding range to

higher latitudes and wintering range to higher altitudes into lower-quality habitat that supports lower reproductive success and lower winter survival.

Several currently available technologies (e.g., satellite transmitters, global positioning system [GPS] transmitters, and geolocators) are capable of collecting data with the spatial resolution required to answer questions about migratory and population connectivity, though most of these powerful tracking tools remain too massive for deployment on the majority of small passerines, including GWWA. However, recent technological advances now allow attachment of geolocators to songbirds as small as 9 g, the size of GWWA, and collect greater amounts of data with finer spatial and temporal resolution than alternative methods available for birds of that size (e.g., band-recovery and stable isotope analysis). Geolocators are light-sensing data-loggers carried by birds throughout their annual cycle and retrieved for data download when birds return to the breeding territories, or some other location where they can be recaptured. By recording day length and time of solar mid-day and midnight, geolocators continuously record data that allow estimation of daily global position.

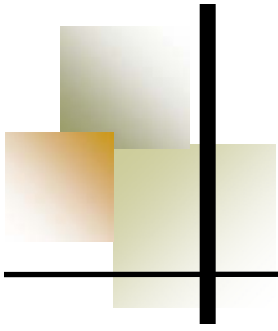
GWWA offer a unique opportunity for a range-wide study of migratory connectivity using geolocators because (1) they have high nesting territory fidelity (i.e., surviving adults usually return to nest in the same territory in successive years), thereby ensur-



ing retrieval of a high proportion of geolocators, (2) adult males are relatively easy to capture with call broadcast and mist nets, allowing for tissue collection and geolocator attachment and retrieval, (3) there were >10 ongoing collaborative studies of GWWA across their North American breeding range when we began this study, which greatly reduces logistical costs compared to initiating a large-scale study independently, (4) hundreds of GWWA have been monitored with radio telemetry and at least 18 successfully carried geolocators for a full year, confirming the species' ability to carry devices weighing up to 5.5% of their body mass without significant effects, and (5) BWWA breed with, and alongside GWWA at many sites offering a rare opportunity to gather detailed information about the migratory behaviors and wintering locations of two closely related, declining species.

We will use geolocators to (1) identify connections between GWWA breeding populations and specific wintering grounds to test hypotheses that could

explain declining GWWA populations and facilitate targeted management efforts for full-life-cycle conservation, (2) evaluate how breeding populations of GWWA and BWWA interact during the non-breeding season to benefit focused, population-specific management strategies, (3) combine genetic analyses of GWWA, BWWA, and GWWA x BWWA hybrids with information about their migratory routes and the geographic locations of their wintering sites to provide unprecedented information regarding the genetics related to migration and the relationship between these two species, and (4) assess the potential impact of continued anthropogenic changes, including climate change, on *Vermivora* warblers on both the breeding and wintering grounds to help inform realistic long-term goals for the conservation of these species.



Ongoing Research



Human Dimensions, Management,
and Conservation



Airspace as Habitat: Methods for Assessing Use by Animals

Investigator: James Perry (Cooperating faculty)
Collaborator: Douglas H. Johnson (U.S. Geological Survey - retired)
Duration: March 2014 to June 2018
Funding source: U.S. Geological Survey —Geosciences & Environmental Change Science Center
Project Location: University of Minnesota, Twin Cities Campus
Upper Midwest

“Habitat” is a fundamental unifying concept in ecology and evolutionary biology. Scientists in these fields seek to understand how species’ survival and reproductive strategies are shaped in relationship to the habitats on which they depend. The habitat concept is also foundational to conservation and policy strategies that address human impacts on species’ survival. Currently, the role of environmental factors in shaping species’ life history strategies is viewed almost entirely in terms of terrestrial and aquatic habitat. For many of the 1,000 bat, 9,000 bird, and 900,000 insect species on Earth, the focus on land and water environments considers only part of the full suite of habitat requirements. Technological and methodological innovations are enabling scientists to better observe how these animals use four-dimensional airspace to perform many critical life tasks. These considerations are advancing the notion that airspace is in fact habitat and should be treated similarly to terrestrial and aquatic habitats. Concurrent is a growing urgency to understand animal use of the aerial environment as human use and development of this same airspace is rapidly increasing, especially its use for wind energy development.

Wind energy development is occurring at a rapid pace and is expected to increase dramatically under the U.S. objective of producing 20% of the Nation’s energy from wind by 2030. Although wind provides a renewable source of energy, concerns exist about the effects on wildlife, particu-

larly migratory birds and bats. Migratory birds and any endangered bats are trust species of the Federal government, and any “take” of such animals is of concern. The federal government has also made extensive investments in national wildlife refuges, waterfowl production areas, and wetland and grassland easements, primarily for the protection and production of migratory birds. It is important to understand the extent to which wildlife values associated with these investments may be compromised by wind energy development.

The focus of this research is on assessing the intensity of flight activity by animals, spatially and temporally. Historically, locations used by animals were determined from visual detections, actually seeing where animals were. The use of markers, such as leg bands on birds, sometimes allowed animals to be recorded at two or more locations and facilitated speculation about the route taken between subsequent locations. In recent decades, the use of telemetry tracking/transmission devices and other data loggers has become widely used for studying animals that use airspace during migration and other movements. The information they can provide is dependent on (1) the type and amount of raw data they collect, (2) the kinds of animals suitable to carry them, and (3) the ability to recover the data. The usefulness of this equipment varies widely, and depends on the physical dimensions, the attachment mechanisms, and the data collection, storage, and recovery technology.

Most recently, satellite receivers have unleashed a flood of information about animal movements and locations, which often led to major surprises about how animals actually move. Fixed-site radar facilities, such as NEXRAD Doppler radar weather monitors, provide information about mass movements of birds and bats, insects, and other flying animals. Mobile radar units can be located wherever desired to assess movements at particular sites.

We are on the threshold of another wave of new technologies that could greatly inform an assessment of wind development effects on wildlife. Acoustic monitors provide information on airspace use by bats and migrating birds, stable isotope analysis sheds light on migration pathways of many species, and photo-sensitive geolocators can record information on approximate latitude and longitude traversed by animals. Other potential tools include genetic markers and thermal cameras. Furthermore, Internet tools such as eBird (ebird.org) and cooperative monitoring projects such as Oldbird

(Oldbird.org) bring citizen science to the task of recording dates and locations of bird observations, with the potential to record movements of birds on a nearly real-time basis.

Specific objectives of this project include:

- 1) Evaluate the potential of the tools mentioned above, and others deemed relevant, for determining the intensity of low-elevation flight of birds, bats, and other flying animals
- 2) Identify if and how currently available tools can be used, most likely in combination, to determine the intensity of flight activity by animals, and how it varies spatially and temporally
- 3) If feasible, propose new tools or extensions of existing tools to address the objective.

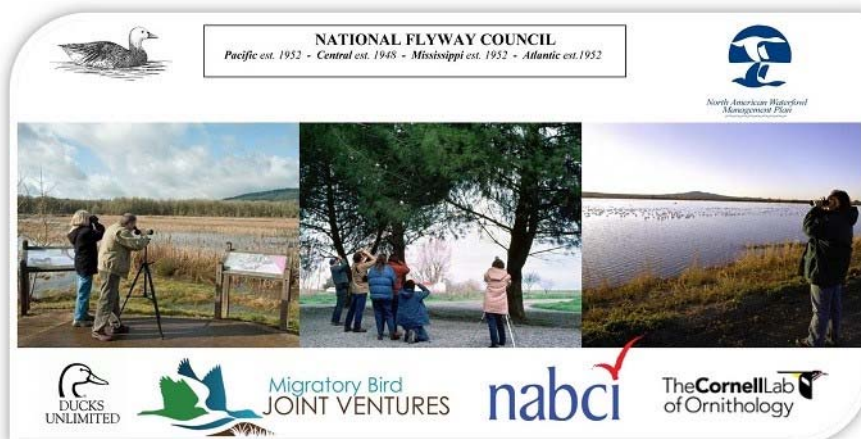
Assessing the Preferences of Stakeholders and Waterfowl Management Professionals to Inform the Implementation of the NAWMP Action Plan

Investigator:	David C. Fulton
Collaborators:	Howie Harshaw (University of Alberta), Andy Raedeke (Human Dimensions Working Group / Missouri Conservation), Rudy Schuster (U.S. Geological Survey)
Staff:	Kristina Slagle, Postdoctoral Scientist (Ohio State University)
Student:	Jason Spaeth, Ph.D. (Natural Resources Science and Management)
Duration:	June 2015 to March 2018
Funding sources:	National Flyway Council, Ducks Unlimited
Project Location:	Minnesota Cooperative Fish and Wildlife Research Unit

This project addresses three key research activities associated with a broader proposal by the National Flyway Council's Human Dimensions Working Group (HDWG) to conduct research involving key stakeholders and the general public in the U.S. and Canada that will inform implementation of the North American Waterfowl Management Plan (NAWMP).

The broader objectives of the proposal are to:

1. Assess what hunters and other waterfowl conservationists (i.e., members of organizations supporting migratory bird conservation including viewers) most desire from their natural resource based management and social settings to inform NAWMP objectives and select habitat and population management alternatives.
2. Establish baseline measures that can be repeated to inform the development of a Public
3. Assess waterfowl hunters' knowledge, preferences, levels of use, and support for waterfowl and wetlands conservation.
4. Assess other waterfowl conservationists' knowledge, preferences, levels of use and support for waterfowl and wetlands conservation.
5. Assess the general public's awareness and



their perceptions regarding the importance of the benefits and values (i.e., Ecological Goods and Services - EGS) provided by waterfowl and wetlands conservation.

6. Assess the general public's participation in waterfowl-associated recreation and how much they support waterfowl and wetlands conservation.
7. Assess waterfowl professionals' perspectives on the levels of waterfowl populations and habitats needed to support hunter and viewer use opportunities.

In summary, two continental U.S.-wide surveys will be conducted with waterfowl hunters and other waterfowl recreationists. The proposed research will be conducted in coordination with other research conducted by the U.S. Geological Survey's Fort Collins Science Center and by researchers in Canada.

Expected outcomes:

1. Quantified waterfowl management professionals' preferences regarding the desired future states relative to the three goals of NAWMP.
2. Quantified stakeholder preferences regarding what they desire in regards to their recreational experiences (hunting and viewing).
3. Foundations to develop explicit and transparent population, habitat, and people objectives (or at least define the tradeoffs) based on the quantified expressed preferences of waterfowl management professionals and stakeholders.
4. Foundations to select management alternatives that are most responsive to stakeholder desires and most likely to help achieve NAWMP objectives relating to people.
5. Segmentation of stakeholder groups based on types of participation (e.g., viewing and/or hunting), geographic location, engagement in conservation, knowledge of waterfowl and/or ecological goods and services of waterfowl habitats, and demographic characteristics.
6. Quantification of the general public's participation in waterfowl and wetlands based activities,

their awareness and perceptions of ecological goods and services, and their evaluation of the importance of those goods and services.

Study Design. The study involves multiple phases and research activities which began in November 2014 with stakeholder workshops that will be used to help design subsequent surveys with stakeholders. The key research will be completed by a collaborative research team at the U.S. Geological Survey's Fort Collins Science Center, the Minnesota Cooperative Fish and Wildlife Research Unit located at the University of Minnesota, and the University of Alberta.

Workshops. Design and implementation of the U.S. stakeholder workshops began in November 2014 and were completed in May 2015. A total of 12 workshops with hunters and with viewers will be completed in key geographic locations across the Flyways to provide a diverse representation of important ecological characteristics and social traditions of the waterfowl hunting and viewing opportunities. A similar approach will be taken in Canada.

Surveys. The project will include three surveys: a waterfowl hunter survey, a waterfowl viewer survey, and a general public survey. The samples will include a minimum of 33,000 waterfowl hunters and 33,000 waterfowl viewers in the U.S. and Canada. The general public survey will be sent to 5,000 individuals in the U.S. A similar general public survey was recently completed in Canada. Each survey will use different methods of sample stratification.

Data will be collected using web-based surveys, with a mailed non-response check. Web-based surveys are being used to help collect data using a stated choice experiment approach. A non-response check will be completed for each of the surveys.

The core portion of the waterfowl hunter and viewer surveys will involve discrete stated choice experiments which will allow identification of key attributes and levels on those attributes that most influ-

ence hunter and viewer preferences for waterfowl hunting and viewing. The stakeholder surveys will include additional questions that address knowledge, preferences, levels of use and involvement, and support for waterfowl and wetlands conservation.

A general public survey with 1200 respondents will also be completed in the U.S. A mail-out survey will be used to collect data using a rural-urban stratified sample across the continental U.S. The study will assess the general public's participation in waterfowl hunting and viewing and their support for wetlands and waterfowl conservation. In addition, the study will assess public awareness of and perceived importance of benefits and values pro-

vided by waterfowl and wetlands.

Information from the workshops will be used to develop the stated choice experiment questions for the waterfowl stakeholder surveys. Design of the surveys was completed in August 2016. Data will be collected in 2016-2017, and final project reports will be completed March 2018.

Status. Through December 2016, the data collection instruments were finalized, the sampling frames identified and samples drawn, and data collection began in the U.S. for waterfowl hunters and birdwatchers.

Deer Goal Setting Surveys and Deer Hunter Attitude Research

Investigator: David C. Fulton
Students: Eric Walberg, M.S. (Natural Resources Science and Management)
Leslie McInenly, Ph.D. (Natural Resources Science and Management)
Duration: May 2014 to August 2017
Funding source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

As Minnesota moved from a more conservative deer (*Odocoileus* spp.) management program toward a more liberal framework based on harvesting antlerless deer, there has been an increased need to gather accurate hunter survey information. Regulations that impose restrictions by requiring antlerless harvest (e.g., earn-a-buck) or protect a segment of the antlered male population (e.g., antler point restriction) likely cannot be implemented without broad public support and a thorough examination of

the policy trade-offs. For example, in 2005, Minnesota deer hunters were surveyed to ascertain knowledge and support of regulations. In general, a majority of hunters wanted to manage for more mature bucks in the deer population but no single regulation achieved more than 49% support. These findings underscored the need for a more comprehensive instrument to collect information concerning both hunter satisfaction and preferred choices for what appear to be unpopular regulatory alternatives. This structured consideration of advantages, disadvantages, and trade-offs may contribute to more effective policy outcomes.



Walters and Green described management by saying, "None would argue that natural resources management is an adaptive learning process, where effects of each management action are complex and uncertain so that experience with the practice of management is necessary to discover better ways of doing it." Given the wicked nature of natural resources management problems, this research may be partially confounded because the unknowns are not fully understood. For example, Kilgore et al. noted a high financial cost associated with acquiring private land access for deer hunting. The access issue is difficult to quantify as there may be a net reduction in regulatory effectiveness if the goal is

to reduce populations and access is restricted. Conversely, increased hunting pressure on public land could result in overharvest of local deer populations and complicate management in the other direction.

Policy is politics and the acceptance of a management policy occurs when solutions and problems are sufficiently credible. This speaks to the concept of wildlife governance, which can be broadly interpreted as what governments do with respect to wildlife policy and management. Within that governance structure, the instruments and mechanisms are available to steer an organization and allow that organization to be effective and responsive to stakeholders. The Minnesota Department of Natural Resources (MNDNR) has been engaging stakeholders for decades through a formalized roundtable meeting and formalized random surveys/public meetings/stakeholder engagement processes. As MNDNR enters a 'next phase' of inquiry that includes re-defining deer populations goals and assessing hunter attitudes statewide, there is continued interest from organized groups and individuals to make the process transparent and inclusive. To complete this work, we will use a mixed modes approach to survey a random sample of deer hunters in five strata throughout the state over a three-year period. For each survey, the first two mailings will be comprised of an invitation to complete a survey online, and the third mailing will be a traditional self-administered mail-back questionnaire.

The 2015-2017 Minnesota deer hunting survey is being conducted to assess hunters':

- participation and activities,
- deer population perceptions and preferences,
- satisfaction,
- attitudes about deer management,
- regulatory preferences,
- relationship with DNR, and
- involvement in agency decision-making.

Surveys were distributed to 25,319 deer hunters in five regions of the state (11,417 after the 2014 deer season, 10,403 after the 2015 season, and 3,499 after the 2016 season); 10,894 completed surveys were used for this analysis. After adjusting for undeliverable surveys and invalid respondents, the response rate was 44.8%.

Survey timing after the 2014 and 2015 seasons was coincident with the two lowest annual harvests in over a decade, a management response to population declines following two consecutive years (2013 and 2014) of moderate-to-severe winter conditions. During this time, MNDNR was also coordinating a public process to revisit deer population goals for most of the deer permit areas (DPAs) in the state.

A summary report is being drafted that contains complete study findings: McInenly, L.E., Cornicelli, L., and Walberg, E. (DRAFT). Minnesota Deer Management: A Study of Deer Hunter Opinions about Deer Populations and Management: Blocks H1-H5 Final Report. University of Minnesota, Minnesota Cooperative Fish and Wildlife Research Unit, Department of Fisheries, Wildlife, and Conservation Biology.

Fishing for Panfish in Minnesota: A Study of Angler Participation and Activities

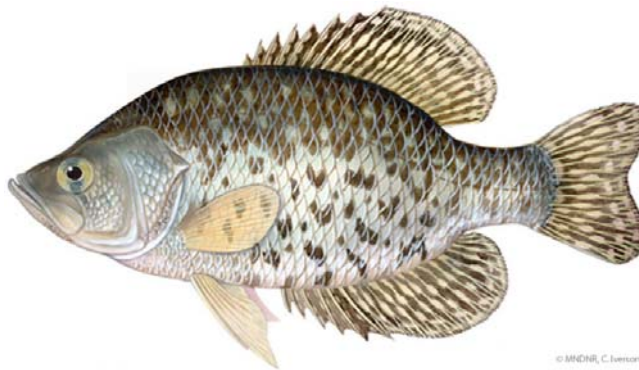
Investigator: David C. Fulton
Staff: Susan A. Schroeder, Ph.D. Research Associate
Duration: July 2016 to March 2017
Funding source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

This study was conducted to characterize the preferred experiences, level of involvement, catch orientations, satisfaction, use histories, management and regulatory preferences, and sociodemographics of Minnesota resident panfish anglers. The population of interest in this study included Minnesota resident anglers who had targeted panfish (*i.e.*, sunfish [*Lepomis* spp.],

crappie [*Pomoxis* spp.], or yellow perch [*Perca flavescens*]) in the state during the previous 12 months. Data were collected using a mail-back survey. A postcard was used to prescreen anglers for participation in panfish angling

in Minnesota. The sample was stratified by region of residence in (a) the seven-county metropolitan area near Minneapolis/St. Paul and (b) Minnesota counties outside the seven-county metropolitan area. The populations of interest in this study included Minnesota resident anglers who returned a postcard indicating that they had fished for panfish during the previous 12 months. Postcards were distributed to a random sample of 10,000 Minnesota resident anglers 18 years of age and older who had purchased a resident fishing license in the state for the 2015 season. The postcard sample was stratified to target 5,000 anglers from metropolitan counties and 5,000 from counties outside the metropolitan

area. The sampling frame used to draw the study sample was the Minnesota Department of Natural Resources' (MNDNR) Electronic Licensing System (ELS). We received 1,056 returned postcards from anglers in metropolitan counties and 1,184 returned postcards from anglers from outside the metropolitan counties.



Data were collected using a mail-back survey following a process to enhance response rates. We constructed a relatively straightforward questionnaire, created personalized cover letters, and made multiple contacts

with the targeted respondents. Potential study respondents were contacted four times between September 2016 and December 2016. For metropolitan counties, we had an adjusted response rate of 55% for full-length surveys, and a total response rate of 68% including nonresponse surveys. For non-metropolitan counties, we had an adjusted response rate of 58% for full-length surveys, and a total response rate of 71% including nonresponse surveys.

A study report summary for the MNDNR is being drafted by Dr. Susan Schroeder, Research Associate, University of Minnesota.

Landowner Attitudes Toward Elk in Northwest Minnesota

Investigator: David C. Fulton
Student: Eric Walberg, M.S. (Natural Resources Science and Management)
Duration: July 2015 to August 2017
Funding Source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Managing the elk (*Cervus elaphus*) population in northwestern Minnesota provides a multitude of challenges ranging from whether or not they should be present at all to how both private and public lands should be managed to benefit elk. This divisiveness has led to strong opinions about both elk and their management. Historically, there has been a lack of information about public attitudes toward elk in northwestern Minnesota, which further complicates the issue. Long-term viability of elk in northwestern Minnesota is largely dependent on public support and the tolerance of private landowners. Minnesota's natural resources provide many benefits to the state's residents, including outdoor recreational activities such as hunting, fishing, and wildlife viewing. Elk are valued for aesthetic and intrinsic reasons, recreation including hunting and viewing, and for revenues derived from recreation associated with elk. Prior to the 1900s, elk ranged over most of the state but were functionally extirpated due to overharvest and habitat loss. Restoration efforts near Grygla, Minnesota in the early 20th century and natural immigration from Manitoba and North Dakota into Kittson County have allowed the northwestern elk population to increase to approximately 150 elk; however, this estimate fluctuates due to population movement across the International Border. Elk currently exist in four localized herds in two areas of northwestern Minnesota, but the population is managed at low levels to reduce human-wildlife conflict. The



long-term vision is to increase the population size and range of the elk population in Minnesota.

We conducted a self-administered mail back questionnaire of landowners in northwestern Minnesota to determine their attitudes and preferences for future elk management. We surveyed 3,000 private landowners in northwestern Minnesota inside the current elk range and the surrounding area to describe landowner attitudes toward elk and preferences for future elk population management.

The overall population of interest was private landowners in parts of Beltrami, Kittson, Marshall, Pennington, and Roseau counties. We selected the boundaries of the study area to correspond with major roads and the Minnesota border with Canada. Within our study area we defined two strata: 1) outside existing elk range,

and 2) inside existing elk range. The strata outside elk range contained habitat suitable for sustaining a future elk population, although elk are not currently present. We identified the inside elk range strata by using the Global Positioning System (GPS) location from radiocollared elk, visual sightings by local Minnesota Department of Natural Resources (MNDNR) staff, and previous elk range estimates that were generated from population surveys.

For both strata, we surveyed individuals who owned at least 0.5 acres. We ultimately conducted a census of landowners inside elk range ($n = 768$) and selected a random sample of landowners outside of elk range ($n = 2,232$) for a total sample size of 3,000. We obtained addresses through publicly available property tax identification lists. We sur-

veyed landowners using a self-administered mail-back questionnaire. We contacted recipients three times between October 2016 and January 2017 using a full-length questionnaire with a cover letter. The survey design was a 12-page questionnaire that was divided into the following categories: (1) land ownership, (2) elk interactions, (3) elk population preferences, (4) attitudes toward elk, (5) tolerance of elk, and (6) recreation. We separated data from the two study groups due to differences in past interactions with elk. A summary report is being completed by Eric Walberg for the MNDNR.

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

Investigator: David C. Fulton
Staff: Susan A. Schroeder, Ph.D. Research Associate
Duration: July 2012 to June 2018
Funding Source: Minnesota Department of Natural Resources
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 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 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 chang-

ing 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. Current completed and on-going specific projects are highlighted elsewhere in this report and include: a study of 2014 Minnesota spring turkey hunters; a study of Minnesota resident anglers preferences for managing trout in inland lakes in north-central Minnesota and in southeastern Minnesota streams; a study of Minnesota angler beliefs and perceptions about fish habitat; a study of hunters' opinions and activities during the 2014 Waterfowl Hunting Season; a study of Minnesota anglers who target panfish; and a study of residents anglers' and spearers' preferences for managing northern pike in Minnesota.

Restoration of Elk to Northeastern Minnesota

Investigators:	David C. Fulton, James Forester III (Cooperating Faculty)
Student:	Eric Walberg, M.S. (Natural Resources Science and Management)
Duration:	July 2016 to June 2019
Funding source:	Legislative-Citizen Commission on Minnesota Resources
Project Location:	Minnesota Cooperative Fish and Wildlife Research Unit

Elk (*Cervus elaphus*) historically occupied most of Minnesota prior to the early 1900s. Although two small populations were re-established in northwestern Minnesota, they are currently managed at low levels to reduce human-wildlife conflict. Forested areas of the state, however, could avoid some of these conflicts and see significant ecological and economic benefits from returning elk to the landscape. Re-establishing this keystone herbivore will help restore the state's traditional wildlife heritage, diversify the large mammal community, increase tourism from wildlife viewers, and eventually provide additional hunting opportunities. Finally, a landscape actively managed for elk will benefit other species adapted to young forests and brushlands. Evidence from other eastern states indicates elk restoration can be successful, but success is dependent on active forest management and public support for elk by local communities.

This research will determine areas of suitable habitat and levels of public support for restoring elk to northeastern Minnesota. Research will be conducted in an area already identified as having local public interest and abundant public forest land (i.e., southern St Louis, Carlton, and northern Pine counties). The research team will build upon existing eastern elk restoration research to address two research goals:

- 1) Identify the amount of public support for a restored elk population by surveying citizens in and around the

prospective restoration sites.

- 2) Determine where suitable habitat exists and how many elk it could sustain. Combine the public support and habitat suitability maps to identify areas likely to support a restored elk population.

Despite potential economic and ecological benefits, care must be taken to determine if suitable habitat exists for elk and if the public will support having elk on the landscape. Our initial interaction with county governments and conservation groups indicates there is great interest in exploring elk restoration; however, we will conduct a quantitative survey of public attitudes to determine levels of tolerance for elk across the study area. To identify locations of suitable habitat, we will compile existing data on land use and land cover and collect field data on forage availability. We will use these data in conjunction with a synthesis of existing elk research in the Midwest to map how habitat suitability varies across



the study area. Finally, we will combine the public support and habitat suitability maps to identify areas most likely to support a successful restoration. This study will provide critical information to wildlife managers and local governments allowing them to make an informed decision regarding habitat suitability and public support for the next steps in elk restoration.

Understanding the public's attitudes and acceptance of elk and their potential impacts are key components of assessing the viability of elk restoration. Long-term management of elk will require an adaptive impact approach in which management objectives and strategies are guided by the preferences of the impacted public. To address this need, we propose conducting surveys and workshops with local citizens.

Three important groups include; private landowners in the potential restoration zone, hunters and the larger conservation community, and the general public residing in or near the potential restoration zone. The completed target sample size for each study group will provide error estimates within 4%. We will contact potential respondents in each target population using current best practices for multi-modal survey contact designs and probability-based sampling approaches. Probability-based samples are essential to allowing generalization of results back to the populations of interest. Initial contacts will be made using address-based sampling designs and mailed paper surveys. Subsequent contacts will be made via e-mail when possible with provision of a web-based response.

We will use county property records to identify and randomly select landowners for inclusion in the study and augment county contact information with available e-mail addresses to allow for direct electronic contact of respondents with e-mail addresses. We will use Address Based Sampling (ABS) utilizing the U.S. Postal Service's Computerized Delivery Sequence File (or 9-1-1 response) addresses to randomly select individual households for participation in the study. This ABS approach provides 100% coverage of owner-occupied and rental resi-

dential addresses and will be augmented with e-mail contact information so that follow-up contacts can be electronic and data collection web-based. We will use the Minnesota Department of Natural Resource's Electronic License System data to randomly select hunters and other conservationists for participation in the study. Up to 30% of individuals in the ELS provide an e-mail contact, and we will append additional e-mail addresses using commercially available services so that an e-mail contact and web-based survey option can be provided to those respondents who prefer electronic contact. This probability-based sampling and multi-modal administration strategy will help to minimize sampling, non-coverage, and response biases.

The primary objectives of the surveys will be to understand citizens'; 1) attitudes toward elk and elk restoration, 2) acceptance and tolerance of potential elk impacts, 3) preference for management objectives concerning elk restoration including elk population size and geographical distribution, and 4) preferences for management strategies to address potential conflicts with elk. Our approach for gathering social survey data will be guided by numerous studies assessing the social aspects of wildlife restoration. Based on our findings, we will develop a spatially explicit map of expected tolerance levels for a restored elk population.

We will also conduct a minimum of six local workshops and webinars after the social survey data have been collected and analyzed so we can better understand the public perceptions of the social survey data and ecological research from Activity 2 and facilitate discussion among the attendees about the research findings. The primary objectives of the workshops are to disseminate research findings and facilitate dialogue concerning the implications of the findings. We will also develop a website and use traditional and social media outlets to distribute information about the project to the public.

Understanding User Preferences and Visitor Numbers at Minnesota Wildlife Management Areas

Investigator: David C. Fulton
Student: Kelsie LaSharr, M.S. (Natural Resources Science and Management)
Duration: July 2015 to August 2017
Funding source: Minnesota Department of Natural Resources
Project Location: Minnesota Cooperative Fish and Wildlife Research Unit

Wildlife Management Areas (WMAs) were established by the Minnesota Department of Natural Resources (MNDNR) to provide quality wildlife habitat and publicly accessible land for hunting and wildlife viewing opportunities. MNDNR staff were interested in understanding how people use the WMA system, which activities they enjoy pursuing, and the number of people recre-



ating during peak seasons. WMAs are historically used most frequently during fall hunting seasons for hunting both big and small game. To achieve our research goals, we intercepted hunters in the field during the 2015-2016 fall hunting season. Publicly accessible properties provide a crucial resource for protecting wildlife resources and providing recreational opportunities.

Hunting opportunities on publicly-owned state land are especially important in the eastern United States for continued hunting participation. Publicly restricted hunting, such as opportunities on private lands, continues to decline as these properties are parceled, sold, and otherwise fragmented. Land that is owned in a checkerboard pattern becomes problematic for hunters when barriers to quality habitat are formed by unpassable private property. As such, it is important to maintain public land for hunters to use, especially when private land is otherwise

not available. Wildlife management agencies can ensure the public obtains benefits from publicly managed, wildlife-producing lands by better understanding desired outcomes and motivations of hunters. In turn, these agencies can help ensure hunters are recruited, retained, and reactivated for generations to come.

The overall goal of this project is to improve the understanding of visitor use at MNDNR WMAs. Specifically, our objectives were to:

1. characterize WMA users through an increased understanding of beliefs, values, and satisfactions they associate with using WMAs
2. determine participation levels by estimating visitor usage during fall hunting seasons (September through December)

The study area covered 43 counties located in

the Prairie Pothole Region of western Minnesota and contained 1,061 WMAs. We divided the study area into two regions (northwestern and southwestern) based on the abundance of WMAs found in these areas. The northern study area is best characterized by larger counties, and fewer but larger WMAs. Conversely, the southern study area has smaller counties and more, albeit smaller WMAs. We created a sampling grid for each region, with grid size being a function of average county size within each region. Within each of the 21 grid blocks we randomly selected one WMA and the nine nearest neighbors to create a cluster of WMAs for sampling visitor usage. Cluster size was modified in some cases because of access issues and to ensure equal sampling effort. The final sample consisted of 228 WMAs organized into 21 driving routes (clusters of WMAs).

We used methods that were previously applied to understand visitation levels at U.S. Fish and Wildlife Service Waterfowl Production Areas in Minnesota that had been modified from techniques recommended the U.S. Forest Service to measure visitor use. Sampling occurred on weekend days (Saturday and Sunday) over an 11-week period from 26 Sep-

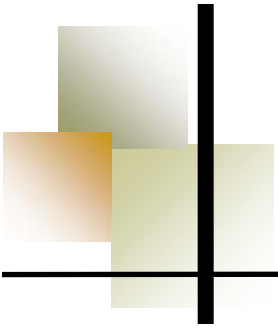
tember 2015 (waterfowl opener) to 6 December 2015. Observers drove a specified route over a set period of four hours, with each sample WMA being surveyed once per weekend day. This resulted in a point-in-time sample of observed WMA user groups. We also surveyed a subset of WMAs intensively (repeated visits from sunrise to sunset) to estimate probability of intercept, which we defined as the average proportion of total user groups per site-day that we intercepted at a random point in time. We then used the probability of intercept to convert observed counts (point-in-time) to expected total user groups per site-day.

Visitor Estimate Analyses. For each of the 1,061 WMAs within our study area, we determined a series of site attributes using GIS data layers obtained from MN Geospatial Commons, <https://gisdata.mn.gov/dataset>, with data processing accomplished using ArcGIS 10.3. We obtained information on WMA name, county locality, area, nearest town, species present (including deer, small game, forest upland birds, sharp-tailed grouse, pheasants, waterfowl, turkey, and doves), managed parking areas, dominant cover types, perimeter length, and easting/northing vectors. We also determined how far each WMA was from various points of interest via Euclidian distance: U.S. Fish and Wildlife Service Wildlife Production Areas (WPAs), other WMAs, major roads, and towns of various densities. We used a linear mixed-effects model to explore the relationship between average car counts/WMA/day and WMA attributes, with the goal of predicting expected mean user groups per weekend day for all WMAs in our sampling frame.

Mail Surveys. Data were collected using mail-back surveys. Respondents were sent questionnaire-booklets with personalized cover letters, and included a business-reply envelope to return their responses. Potential respondents were sent multiple contacts four times between March 2016 and July 2016.

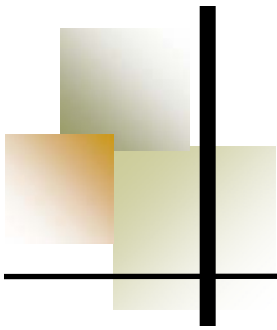
Keslie LaSharr is finalizing a study summary report for the MNDNR and developing two publications for her MS thesis based on the study.





Activities





Publications

Peer-Reviewed

2015

Bruggeman, J.E., T. Swem, **D.E. Andersen**, P.L. Kennedy, and D. Nigro. 2015. Dynamics of a recovering arctic bird population: the importance of climate, density dependence, and site quality. *Ecological Applications* 25:1932-1943.

Bruskotter, J.T., A. Singh, **D.C. Fulton**, and K. Slagle. 2015. Assessing tolerance for wildlife: clarifying relations between concepts and measures. *Human Dimensions of Wildlife* 20(3):255-270.

Daly, K.O., **D.E. Andersen**, W.L. Brininger, and T.R. Cooper. 2015. Radio-transmitters have no impact on survival of pre-fledged American woodcocks. *Journal of Field Ornithology* 86:345-351.

Dolph, C.L., S.L. Eggert, J. Magner, L.C. Ferrington, Jr., and **B. Vondracek**. 2015. Reach-scale stream restoration in agricultural streams of Southern Minnesota alters structural and functional responses of macroinvertebrates. *Freshwater Science* 34(2):535-546.

Fronczak, D.L., **D.E. Andersen**, E.E. Hanna, and T. Cooper. 2015. Annual survival rate estimate of satellite-transmitter-marked Eastern Population greater sandhill cranes. *Journal of Fish and Wildlife Management* 6:464-471.

Mazack, J.E., P. Kranzfelder, A.M. Anderson, R.W. Bouchard, Jr., J. Perry, **B. Vondracek**, and L.C. Ferrington, Jr. 2015. Survivorship and longevity of adult *Diamesa mendotae* Muttkowski, 1915 (Diptera: Chironomidae) at controlled, sub-freezing temperatures. *Aquatic Insects: International Journal of Freshwater Entomology* 36(1):35-42.

Papenfuss, J.T., N. Phelps, **D.C. Fulton**, and P.A. Venturelli. 2015. Smartphones reveal angler behavior: a case study from an Alberta-based fishing app. *Fisheries* 40(7): 318-327.

Peterson, S.M., H.M. Streby, G.R. Kramer, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2015. Geolocators on golden-winged warblers do not affect migration ecology. *Condor* 117:256–261.

Peterson, S.M., H.M. Streby, J.A. Lehman, G.R. Kramer, A.C. Fish, and **D.E. Andersen**. 2015. High-tech or field techs: radio telemetry is a cost-effective method for reducing bias in songbird nest searching. *Condor* 117:386-395.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2015. Tornadoic storm avoidance behavior in breeding songbirds. *Current Biology* 25:1-5.

Streby, H.M., T.L. McAllister, S.M. Peterson, G.R. Kramer, J.A. Lehman, and **D.E. Andersen**. 2015. Geolocators on golden-winged warblers do not affect migration ecology. *Condor* 117:249-255.

2016

Anderson, A.M., E. Mittag, B. Peterson, **B. Vondracek**, and L.C. Ferrington, Jr. 2016. Winter diets of brown trout populations in southeast Minnesota and the significance of winter-emerging invertebrates. *Transactions of the American Fisheries Society* 145:206-220.

Bruggeman, J.E., T. Swem, **D.E. Andersen**, P.L. Kennedy, and D. Nigro. 2016. Multi-season occupancy models identify abiotic and biotic factors influencing a recovering Arctic peregrine falcon (*Falco peregrinus tundrius*) population in a variable climate. *Ibis* 158:61-74.

Carlson A.K., W.E. French, **B. Vondracek**, L.C. Ferrington Jr., J.E. Mazack, J.L. Cochran-Biederman. 2016. Brown trout growth in Minnesota streams as related to landscape and local factors. *Journal of Freshwater Ecology*, Online.

Carlson A.K., W.E. French, **B. Vondracek**, L.C. Ferrington Jr., J.E. Mazack, J.L. Cochran-Biederman. 2016. Recent and historical trends in growth of brown trout (*Salmo trutta*) in Southeastern Minnesota streams. *Journal of Freshwater Ecology* 31(3):421-429.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Finlay, and D.J. Dieterman. 2016. Brown trout (*Salmo trutta*) growth and condition along a winter thermal gradient in temperate streams. *Canadian Journal of Fisheries and Aquatic Sciences* 73:1-9.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Finlay, and D.J. Dieterman. 2016. Winter diet of brown trout (*Salmo trutta*) in groundwater-dominated streams: influence of environmental factors on spatial and temporal variation. *Journal of Fish Biology* 89(5):2449-2464.

Hunt, L. E. Fenichel, **D.C. Fulton** and 5 co-authors. 2016. Identifying multiple pathways for climate change to impact inland recreational fishers. *Fisheries* 41:362-373.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2016. Management implications of brood division in golden-winged warblers. *Studies in Avian Biology* 49:161-171.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2016. Spatially-explicit models of full-season productivity and implications for landscape management of golden-winged warblers in the western Great Lakes region. *Studies in Avian Biology* 49:141-160.

Schroeder, S.A., **D.C. Fulton** and K. DonCarlos. 2016. Clarifying beliefs underlying hunter intentions to support a ban on lead shot. *Society & Natural Resources* 29(7):852-867.

Streby, H.M., Peterson, S.M., and **D.E. Andersen**. 2016. Survival and habitat use of fledgling golden-winged warblers in the western Great Lakes region. *Studies in Avian Biology* 49:127-140.

Streby, H.M., R.W. Rohrbaugh, D.A. Buehler, **D.E. Andersen**, R. Vallender, D.I. King, J.L. Larkin, and T. Will. 2016. Research on golden-winged warblers: recent progress and current needs. *Studies in Avian Biology* 49:217-227.

Book Chapters, Symposium Proceedings

2015

Research Note (Published)

S.A. Schroeder and **D.C. Fulton**. 2015. A replication of a factor analysis of motivations for trapping. *Human Dimensions of Wildlife* 20(3):280-283.

2016

Book Editor (Published)

Streby, H.M., **D.E. Andersen**, and D.A. Buehler. 2016. Golden-winged warbler ecology, conservation, and habitat management. *Studies in Avian Biology*. ISBN 9781482240689.

In Press, Review, or Revision

Bergh, S.M. and **D.E. Andersen**. *In Review*. Estimating density and effective area surveyed for American woodcock. 11th *American Woodcock Symposium*.

Bergh, S.M. and **D.E. Andersen**. *In Review*. Occupancy and detection probability of American woodcock during Singing-ground Surveys. 11th *American Woodcock Symposium*.

Danehy, R.J., K. Nislow, C.A. Dolloff, **Vondracek, B.**, R.M. Newman, C. Blinn, R. Mackereth, M. Young, J. Walter, D. Martin, and M. Wilzbach. *In Review*. Regional specific interactions of forests and fish: Great Lakes Region. Reflections on Forest Management; Can Fish and Fiber Coexist? Editors R. Danehy and A. Dolloff. American Fisheries Society, Bethesda, Maryland.

Dolph, C.L., S.L. Eggert, J. Magner, L.C. Ferrington, Jr., and **B. Vondracek**. *In Press*. Response of secondary production by macroinvertebrates to reach-scale stream restoration in agricultural streams of southern Minnesota. *Fisheries Research*.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Finlay, and D.J. Dieterman. *In Review*. Groundwater buffering increases winter growth and condition of brown trout (*Salmo trutta*) in temperate streams. *Canadian Journal of Fisheries and Aquatic Sciences*.

Fronczak, D.L., **D.E. Andersen**, E.E. Hanna, and T.R. Cooper. *In Revision*. Distribution and migration chronology of Eastern Population sandhill cranes. *Journal of Wildlife Management*.

- Schroeder, S.A., **D.C. Fulton**, L. Cornicelli, and D. Stark. *In Review*. Intolerance among wolf hunters and trappers in Minnesota. *Biological Conservation*
- Kramer, G.R., H.M. Streby, S.M. Peterson, J.A. Lehman, D.A. Buehler, B.P. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. *In Revision*. Nonbreeding isolation and population-specific migration patterns among three populations of Golden-winged Warblers. *Proceedings of the National Academy of Sciences*.
- Manfredo, M., J.T. Bruskotter, T.L. Teel, **D.C. Fulton**, S.H. Schwartz, R. Arlinghaus, S. Oishi, A.K. Uskul, K. Redford, S. Kitayama, and L. Sullivan. *In Press*. Why we can't change values for the sake of conservation. *Conservation Biology*.
- Peterson, S.M., H.M. Streby, G.R. Kramer, and **D.E. Andersen**. *In Revision*. Ecology of brood division in Golden-winged Warblers. *Condor*.
- Pradhananga, A., M. Davenport, **D.C. Fulton**, G. Maruyama, and D. Current. *In Press*. An integrated moral obligation model for landowner conservation norms. *Society & Natural Resources*.
- Reiter, M. E. and **D.E. Andersen**. *In Review*. Impacts of lesser snow goose-mediated habitat alteration on Canada goose nest density. *Avian Conservation and Ecology*.
- Schroeder, S.A., L.J. Cornicelli, **D.C. Fulton**, and S. Merchant. *In Review*. Clarifying how experiences affect hunter satisfaction: importance-performance, importance grid, and penalty-reward-contrast analyses of how specific hunt experiences relate to turkey hunting satisfaction. *Human Dimensions of Wildlife*
- Schroeder, S.A. and **D.C. Fulton**. *In Press*. Voice, perceived fairness, agency trust and acceptance of management decisions among Minnesota anglers. *Society & Natural Resources*.
- Schroeder, S.A., **D.C. Fulton**, L.J. Cornicelli, and S.S. Merchant. *In Review*. Defining management objectives for recreational hunting: modeling season choice for Minnesota turkey hunters. *Journal of Wildlife Management*.
- Schroeder, S.A., **D.C. Fulton**, J.S. Lawrence, and S.D. Cordts. *In Review*. Factors related to waterfowl hunters' attitudes about duck bag limits. *Human Dimensions of Wildlife*.
- Schroeder, S.A., **D.C. Fulton**, E. Alten, H. Baird, D. Dieterman, and M. Jennings. *In Review*. Factors influencing anglers' support for fisheries management strategies: habitat protection and restoration versus stocking in publicly managed waters. *Environmental Management*.
- Walberg, E., L. Cornicelli, and **D.C. Fulton**. *In Review*. Factors impacting hunter access to private lands in southeast Minnesota. *Human Dimensions of Wildlife*.
- Walberg, E., **D.C. Fulton**, L.J. Cornicelli, L. McInly. *In Review*. Capability of cell-by-cell correction to reduce mixed-mode sampling effects for hunter surveys. *Human Dimensions of Wildlife*.
- Wolfson, D., J. Fieberg, J. Lawrence, T. Cooper, and **D.E. Andersen**. *In Revision*. Range overlap between Mid-Continent and Eastern sandhill cranes revealed by GPS-tracking. *Wildlife Society Bulletin*.

Awards and Honors

2016. Conservation Award, Minnesota Chapter of The Wildlife Society.

Cooperating Faculty Publications

Cyr, T. 2015. Gastropod habitat use in relation to moose habitat use and disease transmission. M.S. thesis, University of Minnesota, St. Paul, Minnesota.

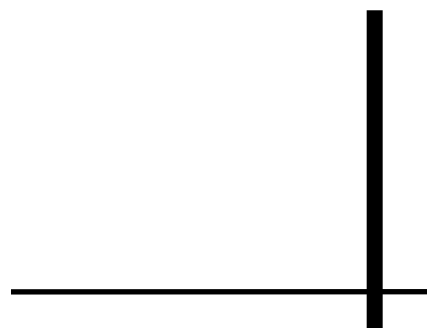
Diffendorfer, J. E., J. A. Beston, M. D. Merrill, J. C. Stanton, M. D. Corum, S. R. Loss, W. E. Thogmartin, D. H. Johnson, R. A. Erickson, and K. W. Heist. 2015. Preliminary methodology to assess the national and regional impact of U.S. wind energy development on birds and bats. U.S. Geological Survey Scientific Investigations Report 2015–5066, 40 pages, <http://dx.doi.org/10.3133/sir20155066>.

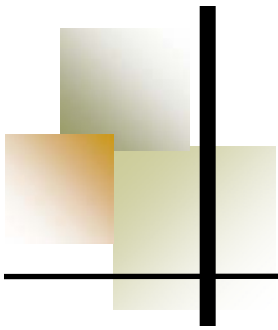
Diffendorfer, J. E., J. A. Beston, S. R. Loss, and D. H. Johnson. 2016. Prioritizing avian species for their risk of population level consequences from wind energy development. PLoS ONE-D-15-15489R2. <http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0150813#sec014>.

Wyman, K.E. and F.J. Cuthbert. *Final Revision Stage*. Black tern (*Chlidonias niger*) breeding site abandonment in U.S. Great Lakes coastal wetlands is predicted by historical abundance and patterns of emergent vegetation. *Wetlands Ecology and Management*.

Wyman, K.E. and F.J. Cuthbert. 2016. Validation of landscape suitability indices for black terns (*Chlidonias niger*) in the U.S. Great Lakes region. *The Condor* 118:613-623.

Claus, A.W., and P. Sorensen. *In Press*. Mixtures of amino acids and unidentified chemical cues mediate feeding behavior in invasive filter-feeding bigheaded carps to a planktonic food mixture. *Journal Chemical Ecology*.





Completed Theses and Dissertations of Minnesota Coop Unit Students

2014

Kevin W. Heist. 2014. Assessing Bat and Bird Fatality Risk at Wind Farm Sites using Acoustic Detectors. Dissertation, University of Minnesota, Saint Paul, Minnesota, USA. 168 pages. (Doug Johnson)

Wind power is a promising clean energy technology that has grown rapidly in recent years (EIA 2013). In spite of its environmentally friendly reputation, industrial wind energy generation can have serious impacts on wildlife. Bat and bird collision fatality rates have been alarmingly high at some wind farms. Proper siting of wind facilities may help minimize collision impacts as the wind energy industry continues to grow. Bat and bird fatality rates vary greatly among sites; however, there is no reliable method for assessing collision risk prior to development. My goal was to develop a method for predicting fatality rates based on nocturnal activity patterns measured by ground-level recording of bat and bird calls. For three years, I monitored bat and bird activity using ultrasonic-acoustic detectors at 160 locations, including eight wind farms and a variety of landscape settings to: 1) examine the capabilities of the detector for use in preconstruction site assessment, 2) evaluate the ability of an automated bat call identification program to identify the species of recorded bat calls, 3) determine how pass rates relate to fatality rates for use in predictive models based on pre-construction recordings, 4) examine variation in pass rates with respect to pre-specified landscape and habitat features, 5) examine how activity patterns might differ before versus after a wind facility is built, and 6) investigate whether bat activity levels are elevated near turbines. Ground-based recording was found to be a useful method for studying near-ground bat activity patterns at multiple scales, but patterns of acoustic activity of birds were less clear and apparent only at the most coarse geographic scale. The automated bat call identification program produced mixed results among species and geographic regions. No relations between bat pass rates and estimated fatality rates among wind farms were found, either for all bats or for migratory tree-roosting species. Large differences in bat and bird activity among geographic regions were found, with highest activity levels near Great Lakes coastlines. Also, bat and bird activity levels near the edge of forested river corridors in agricultural settings in Minnesota were found to be higher than those farther from the edge. Evaluation of a variety of predictive models of pass rates revealed distance to water, distance to trees, and ecoregion as good predictors of bat activity levels. Although some differences in bird activity were evident at the broadest geographic scale, models were of limited usefulness in explaining spatial variation in bird activity. Acoustic activity measured by ground-based recorders was not a good predictor of bat fatalities at wind farms; however, it did reveal local and regional patterns that may be useful for siting wind energy facilities in low-impact areas.

2015

Aaron W. Claus. 2015. Chemosensory control of filter feeding behavior in bigheaded carps. M.S. thesis, University of Minnesota, St. Paul, Minnesota, USA. 65pp. (Peter Sorensen)

Bigheaded carps (silver carp, *Hypophthalmichthys molitrix* and bighead carp, *H. nobilis*) were used to investigate the physiological basis of filter feeding behavior in fish. I developed a new method for assaying chemically based food preferences by tracking the frequency of buccal-pharyngeal pumping behavior before and after a food and food chemical stimuli were presented. Spirulina algae (*Arthrospira spp.*), a cyanobacterium, was the most potent food type releasing BPP behavior. Quality and quantity of chemical cues were important to the BPP response. Moderate responses to a mixture of L-amino acids (common fish feeding cues) confirm their function in this genus but also suggest that there are other highly potent odorants and/or tastants present in the food mix filtrate. BPP behavior was markedly reduced without a functional olfactory sense. These results cumulatively suggest that chemical senses are integral to filter feeding behavior of Bigheaded carp.

Megan Cross. 2015. Applying theory to management: assessing the practicality of Leopold's Land Ethic and the Risk Information and Processing (RISP) model for wildlife management. M.S. thesis, University of Minnesota, St. Paul, USA. 108pp. (David Fulton)

In the United States, natural resources are held in trust for the American people and future generations. Because managers make decisions on behalf of the public, this necessitates an understanding of their preferences, values, and opinions towards the resources being held in trust for them; understanding stakeholder groups helps managers make better decisions on their behalf. This thesis addresses two conceptually related but diverse topics in the realm of natural resource management pertaining to (1) the Risk Information Seeking and Processing behaviors of northwest Minnesota deer hunters after bovine tuberculosis (*Mycobacterium bovis*) was detected in the local whitetail deer population, and (2) farmers' attitudes towards and motivations for participation in federal conservation programs beneficial to wildlife. The first of these projects found that attitudes exerted the greatest influence on hunters' information seeking behaviors towards bovine tuberculosis in a model that included individual characteristics, personal impacts, trust in the DNR, norms, and information sufficiency. The research on farmers' beliefs about enrollment in conservation programs suggested that a model including knowledge, community, and behavioral obligation dimensions drawn from Leopold's Land Ethic explained 54% of the variance in farmers' perceived environmental responsibilities. Although these studies focus on unrelated topics, they concern the human dimensions of natural resource management, address current issues faced by managers and decision makers, and are theory directed research. Ultimately the information gained through these projects will aid in the development of outreach efforts and design of conservation programs, as well as contribute to cumulative knowledge to better understand social psychological theory applied to resource management.

Jennifer L. Cochran-Biederman. 2015. Seasonal patterns in growth, diet, and prey availability of brown trout *Salmo Trutta* in groundwater-dominated streams in the Driftless Ecoregion of southeastern Minnesota. Ph.D. dissertation, University of Minnesota, St. Paul, Minnesota, USA. 248pp. (Bruce Vondracek)

Groundwater-dominated streams of southeastern Minnesota support highly productive populations of Brown Trout and aquatic macroinvertebrate fauna, but past research has shown that fish growth varies on spatial and temporal scales. As the diet of Brown Trout depends on the availability and abundance of aquatic macroinvertebrate assemblages (e.g. abundance, diversity, distribution) shape patterns in the growth, distribution, fitness and abundance of Brown Trout populations. In particular, there is evidence that suggests spatial and seasonal variation in winter conditions (including water temperature and prey

assemblages) may influence broader patterns of Brown Trout growth in this region. Although studies related to Brown Trout growth, diet, prey availability and selectivity have been conducted in southeastern Minnesota, no research has addressed all of these factors simultaneously over multiple streams, seasons and years. The overall goal of this dissertation was to examine seasonal and spatial patterns in Brown Trout growth, diet, prey selection and in the availability of macroinvertebrate prey in six streams that demonstrate a gradient in fish growth. Chapter 1 examines temporal and spatial differences in the growth and diet of Brown Trout, and identifies associations between area, and channel slope. Although stomach contents were dominated by relatively few taxa, including Chironomidae and *Brachycentrus*, there were significant differences in diet composition among streams and seasons. Overall, fish in most streams demonstrated positive growth during the summer, winter and spring; and winter growth was significantly associated with groundwater input. Chapter 2 addresses seasonal patterns in Brown Trout prey assemblages, including the abundance, diversity, and overlap of macroinvertebrate benthos and drift. Benthic and drift assemblages differed among streams and seasons, with most pronounced differences among streams. Abundance of drift and benthos varied significantly, with the highest availability in spring and summer, and the lowest availability during winter in most streams. Non-metric multidimensional scaling indicated associations between assemblage composition and groundwater input. The goal of the third and final chapter was to identify seasonal and spatial patterns in the availability of selection of macroinvertebrate prey by Brown Trout. Overall density of benthos and drift varied spatially and temporally with a negative relationship between the total proportion of prey available and prey electivity. In general, Brown Trout consistently favored one or two taxa, including *Physella* and *Gammarus* while displaying negative selection for all other prey types. Foraging patterns suggested a preference of benthic feeding. Ultimately, the results of this dissertation will help managers take effective actions in mitigating the effects of climate change on stream communities. In addition to a better understanding of the influence of groundwater control on patterns in Brown Trout growth, foraging, and prey communities, this dissertation identifies key prey taxa associated with the growth of Brown Trout on seasonal and spatial scales. With this knowledge, managers can more accurately predict how climate-induced changes to water temperature and prey communities will alter fish productivity on a stream-by-stream basis. Considering the substantial economic and cultural importance of groundwater-dominated streams in southeastern Minnesota, conserving the integrity and health of stream communities through the development and implementation of science-based management plans should be a priority among natural resource managers, scientist, and policymakers.

2016

Eric Walberg. 2016. Landowner and hunter surveys for white-tailed deer management in Minnesota: factors impacting hunter access to private lands and cell-by-cell correction to reduce mixed-mode survey sampling effects. M.S. thesis, University of Minnesota, St. Paul, Minnesota, USA. 90pp. (David Fulton and Lou Cornicelli)

Surveys of hunters and landowners are an important source of information for wildlife managers in Minnesota. Two separate studies were conducted to examine the topics addressed by this thesis: 1) the identification of variables that impact landowner's decisions to allow public hunting access in southeast Minnesota, and 2) the capability of cell-by-cell correction to reduce mixed-mode sampling effects. The first study was a survey of southeast Minnesota landowners conducted in 2013 to examine variables that influence landowners' decision to allow hunting access to the public. Landowners who own large properties present the greatest potential for improving future public access due to the number of hunters that can be accommodated without crowding and because they are more likely to allow hunting access. The sec-

ond study was a survey of 2015 Minnesota deer hunters using a sequential mixed-mode design with Internet and mail surveys. Mixed-mode designs are increasingly used in efforts to produce more representative results of the population than single survey mode designs, but such designs can introduce the potential for measurement error from mode effects. A cell-by-cell correction can be applied to survey results to adjust for nonresponse error. Applying a cell-by-cell correction caused Internet survey mode results to be significantly different from the combined mixed-mode results and also inflated variance values. There were significant demographic differences between modes for age and residence, and between mailing waves for age. Our results also showed that the fourth mailing wave using a mail survey produced a low response rate and contributed little to the results.

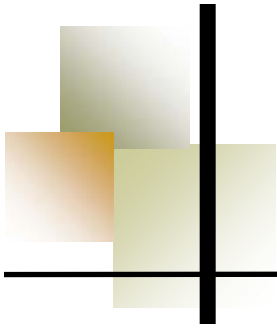
Katherine Wyman. 2016. Dynamic populations, dynamic landscapes: conservation science case studies of colonial waterbirds in the North American Great Lakes. Ph.D. dissertation, University of Minnesota, St. Paul, Minnesota, USA. 130pp. (Francesca Cuthbert)

Colonial animals concentrate locally, presenting different conservation challenges and opportunities than more broadly distributed species. The Double-crested Cormorant (*Phalacrocorax auritus*) and the Black Tern (*Chlidonias niger*) in the North American Great Lakes provide two contrasting case studies of the challenges and opportunities for conservation and management of colonial waterbirds. I used a combination of historical datasets, new field studies, and statistical modeling to investigate issues surrounding conservation and management of these two birds in Great Lakes. The Double-crested Cormorant, focus of the first case study, has experienced extreme population growth and is now subject to population management at a majority of U.S. Great Lakes colony sites; effects of cormorants and their management on co-nesting waterbird species have remained largely unknown. I observed that nesting among Double-crested Cormorants increased frequency of agonistic interactions for Great Blue Herons (*Ardea herodias*), particularly when nesting on the ground. My research also showed that Black-crowned Night-Heron (*Nycticorax nycticorax*) colony growth rates have responded negatively to Double-crested Cormorant abundance and management, while Herring Gull (*Larus argentatus*) and Ring-billed Gull (*Larus delawarensis*) growth rates have responded positively. The Black Tern, subject of the second case study, has been declining for over half a century due to unknown causes, although wetland loss and degradation have likely contributed. I found a positive relationship between increasingly clumped vegetation in Great Lakes coastal wetlands and historical Black Tern colony abandonment. Under current conditions in the region, wetland type and area were critical parameters in delineating wetlands that were unsuitable for Black Terns from potentially suitable ones. In the ever-changing landscape of the North American Great Lakes, my investigations provide important results to inform future conservation and management actions for these two very different species.

STUDENT AWARDS

Gunnar Kramer. 2015. Best Student Presentation, Minnesota Chapter of The Wildlife Society.

Gunnar Kramer. 2016. Student Presentation Award, American Ornithologists' Union Council.



Presentations

Invited Presentations

2015

Kennedy, P.L., J.E. Bruggeman, T. Swem, **D.E. Andersen**, and D. Nigro. 2015. Dynamics of a recovering Arctic bird population: the importance of climate, density dependence, and site quality. Murdoch University, Perth, Australia.

Kennedy, P.L., J.E. Bruggeman, T. Swem, **D.E. Andersen**, and D. Nigro. 2015. Dynamics of a recovering Arctic bird population: the importance of climate, density dependence, and site quality. University of Western Australia, Perth, Australia.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2015. The spatial ecology of golden-winged warblers. University of California, Berkeley, Wildlife, Fisheries, and Conservation Biology Seminar Series, Berkeley, California, USA.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2015. Evacuation migration: tornadic storm avoidance behavior in breeding warblers. American Ornithologists' Union and Cooper Ornithological Society 2015 Annual Meeting, Norman, Oklahoma, USA.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, and **D.E. Andersen**. 2015. Tracking long-distance migration in tiny songbirds using tiny technology. University of California, Davis, Animal Behavior Graduate Group Winter Seminar Series, Davis, California, USA.

2016

Buehler, D.A., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.J. McNeil, J.L. Larkin, **D.E. Andersen**, P. Wood, and H.M. Streby. 2016. New insights into the migration ecology and full life cycle conservation of golden-winged warblers. Chattanooga Chapter of the Tennessee Ornithological Society, Chattanooga, Tennessee, USA.

Fulton, D.C. 2016. Values translated into objectives: engaging waterfowl stakeholders. North American Duck Symposium. Special Session: Implementing the 2012 NAWMP Revision: Management Decisions to Integrate Multiple Objectives at Varying Scales. Annapolis, Maryland, USA.

Fulton, D.C., S.A. Schroeder, D. Stark, and L. Cornicelli. 2016. Attitudes and motivations of wolf hunters and trappers in Minnesota. North American Congress of Conservation Biology, Madison, Wisconsin, USA.

Moore, J.D., **D.E. Andersen**, T.R. Cooper, and D.G. Krentz. 2016. Migratory connectivity and migration phenology of American woodcock. 2016 State of Stopover Symposium, Milwaukee, Wisconsin, U.S.A.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. 2016. Tracking golden-winged warbler migration with geolocators reveals population specific timing, routes, and wintering areas. Black Swamp Bird Observatory Fall Warbler Workshop, Oregon, Ohio, USA.

Schroeder, S.A. and **D. C. Fulton**. 2016. Tolerance and intolerance among wolf hunters and trappers in Minnesota. International Symposia for Society and Resource Management. Houghton, Michigan, USA.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2016. Evacuation migration: tornadic storm avoidance behavior in breeding warblers. Forestry and Natural Resources Seminar Series, Purdue University, West Lafayette, Indiana, USA.

Contributed Presentations

2015

Andersen, D.E., H.M. Streby, D.A. Buehler, P.B. Wood, S.M. Peterson, G.R. Kramer, and J.A. Lehman. 2015. Golden-winged warbler migration connectivity and ecology derived from geolocators. Iowa Chapter of The Wildlife Society Annual Meeting, Ames, Iowa, USA.

Andersen, D.E., H.M. Streby, D.A. Buehler, P.B. Wood, S.M. Peterson, G.R. Kramer, and J.A. Lehman. 2015. Golden-winged warbler migration connectivity and ecology derived from geolocators. 75th Midwest Fish and Wildlife Conference, Indianapolis, Indiana, USA.

Bruggeman, J.E., T. Swem, **D.E. Andersen**, P.L. Kennedy, and D. Nigro. 2015. Dynamics of a recovering arctic bird population: the importance of climate, density dependence, and site quality. The Wildlife Society 2015 Annual Conference, Winnipeg, Manitoba, Canada.

Carlson, A.K., and **B. Vondracek**. 2015. Synthesis of ecology and human dimensions for predictive management of bighead and silver carp in the United States. 75th Midwest Fish and Wildlife Conference, Indianapolis, Indiana, USA.

Carlson, A.K., W.E. French, **B. Vondracek**, L.C. Ferrington, Jr., J.E. Mazack, J. Cochran-Biederman. 2015. Recent and historical trends in brown trout growth in southeastern Minnesota streams. 75th Midwest Fish and Wildlife Conference. Indianapolis, Indiana, USA.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Findley, and D. Dieterman. 2015. Winter growth of brown trout in southeastern Minnesota streams: the effects of groundwater buffering and trout diet. 75th Midwest Fish and Wildlife Conference, Indianapolis, Indiana, USA.

Kennedy, P.L., J.E. Bruggeman, T. Swem, **D.E. Andersen**, and D. Nigro. 2015. Dynamics of a recovering Arctic bird population: the importance of climate, density dependence, and site quality. Annual Meeting of the Ecological Society of Australia, Adelaide, Australia.

Kramer, G.R., H.M. Streby, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. 2015. Migration and movement ecology of golden-winged warblers derived from light-level geolocators. 2015 American Ornithologists' Union and Cooper Ornithological Society Joint Annual Meeting, Norman, Oklahoma, USA.

Kramer, G.R., H.M. Streby, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, and **D.E. Andersen**. 2015. There and back again: migratory behaviors of golden-winged warblers discovered using geolocators. Joint Minnesota/Wisconsin Chapters of The Wildlife Society Annual Meeting, Duluth, Minnesota, USA.

Wolfson, D., **D.E. Andersen**, T. Cooper, J. Lawrence, and J. Fieberg. 2015. Spatial ecology of sandhill crane populations in Minnesota. Joint Minnesota/Wisconsin Chapters of The Wildlife Society Annual Meeting, Duluth, Minnesota, USA.

2016

Adkins, K.I., **D.E. Andersen**, C. Roy, and R. Wright. 2016. The relationship between grasslands, Conservation Reserve Program (CRP) enrollments, and greater prairie-chicken (*Tympanuchus cupido pinnatus*) populations in Minnesota. Annual Meeting of The Minnesota Prairie Chicken Society, Fertile, Minnesota, USA.

Fronczak, D.L., **D.E. Andersen**, E.E. Hannah, and T.R. Cooper. 2016. Distribution, migration chronology, and survival estimate of Eastern Population sandhill cranes. 76th Midwest Fish and Wildlife Conference, Grand Rapids, Michigan, USA.

Fulton, D.C., S.A. Schroeder, and L.J. Cornicelli. 2016. Hunting as a social-ecological system: the case of turkey hunting. 23rd Annual Conference of The Wildlife Society. Raleigh, North Carolina, USA.

Hill, N., T.R. Cooper, D.H. Johnson, and **D.E. Andersen**. 2016. Secretive marshbird response to wetland management in western Minnesota. 2016 Annual Meeting of the Minnesota Chapter of The Wildlife Society, Mankato, Minnesota, USA.

Kramer, G.R., H.M. Streby, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. 2016. Wintering grounds and migratory routes of golden-winged warblers discovered using light-level geolocators: implications for full life-cycle management. 76th Midwest Fish and Wildlife Conference, Grand Rapids, Michigan, USA.

Kramer, G.R., H.M. Streby, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. 2016. Nonbreeding isolation and population specific migration routes among three populations of golden-winged warblers. North American Ornithological Conference, Washington, DC, USA.

Kramer, G.R., **D.E. Andersen**, D.A. Buehler, P.B. Wood, S.M. Peterson, J.A. Lehman, K.R. Aldinger, L.P. Bullock, B. Gray, S. Harding, J.A. Jones, D.I. King, J.L. Larkin, J.P. Loegering, D.J. McNeil, D.B. Miles, C. Smalling, R. Vallender, and H.M. Streby. 2016. Range-wide assessment of wintering distributions and migration routes of golden-winged warblers using geolocators. The Wildlife Society Annual Conference, Raleigh, North Carolina, USA.

LaSharr, K., **D.C. Fulton**, and L.J. Cornicelli. 2016. Investigating visitor trends and management preferences at Minnesota Wildlife Management Areas. 23rd Annual conference of The Wildlife Society. Raleigh, North Carolina, USA.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, P.B. Wood, D.J. McNeil, J.L. Larkin, and **D.E. Andersen**. 2016. Tracking golden-winged warbler migration with geolocators reveals population specific timing, routes, and wintering areas. Inland Bird Banding Association Annual Meeting, Connersville, Indiana, USA.

Walberg, E.M, L.J. Cornicelli, and **D.C. Fulton**. 2016. Factors impacting hunting access to private lands in southeastern Minnesota. 23rd Annual Conference of The Wildlife Society, Raleigh, North Carolina, USA.

Wolfson, D., **D.E. Andersen**, T.R. Cooper, J. Lawrence, and J. Fieberg. 2016. Spatial ecology of sandhill crane populations in Minnesota. 76th Midwest Fish and Wildlife Conference, Grand Rapids, Michigan, USA.

Wolfson, D., **D. E. Andersen**, J. Lawrence, T. Cooper, D. Fronczak, and J. Fieberg. 2016. Minnesota sandhill crane population affiliation and migration ecology. Minnesota Prairie Chicken Society Annual Meeting, Fertile, Minnesota, USA.

Cooperating Faculty Presentations

2014

Arnold, T.W. 2014. Estimating annual survival from band recovery data. *Frontiers in Modeling Bird Populations*. American Ornithologists' Union. Estes Park, Colorado, USA.

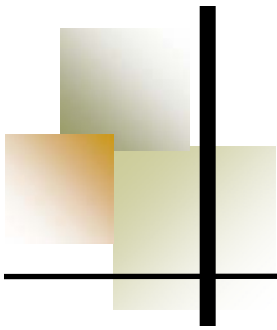
2015

Olson, B., S.K. Windels, R. Moen, and N. McCann. 2015. Moose modify bedsites in response to high temperatures. Joint Minnesota/Wisconsin Chapters of The Wildlife Society Annual Meeting, Duluth, Minnesota, USA.

Rigby, E.A., and D.H. Johnson. 2015. Comparing methods of inference for avian count data with a simulation of the detection process. Patuxent Wildlife Research Center, Laurel, Maryland, USA.

2016

Claus, A. and P. Sorensen. 2016. Chemically-mediated feeding behavior in bigheaded carps. 76th Midwest Fish and Wildlife Conference, Grand Rapids Michigan.



Unit News

During the last two years (2015-2016), the Minnesota Cooperative Fish and Wildlife Research Unit has experienced some significant changes, notably the retirement of Dr. Bruce Vondracek (Assistant Leader – Fisheries) in May 2015. Bruce had a long and distinguished career in the Cooperative Research Units Program, most of it at the Minnesota Coop Unit. He continues to maintain an office on the St. Paul Campus, but also manages to travel around the globe in search of giant salmonids. Bruce and his wife, Lynn, travel around the Upper Midwest during

spring and summer and spends most of the winter in Texas. Bruce's retirement has left a vacancy that we have so far been unable to fill due to lack of resources at the national level. For the past several years, only Leader positions and positions at Coop Units where there is only one federal scien-

tist have been filled, and both fortunately and unfortunately, the Minnesota Coop Unit hasn't made that list. However, our capacity to meet the needs of our cooperators in the aquatic realm has been diminished following Bruce's retirement and our ongoing vacancy.

Both David Fulton (Assistant Leader- Wildlife) and David Andersen (Leader) continue to have active research programs that support M.S. and Ph.D. graduate students and postdoctoral research associates. We completed a

number of research projects during 2015-2016, and initiated several new projects. As you can see in this report, our students continue to present their research results at professional conferences and in the peer-reviewed literature at an impressive rate. During the last two-year period, we are also happy to report that we have increased the number and scope of projects we are working collaboratively on with the Minnesota Department of Natural Resources. Following the vacancy resulting from Bruce Vondracek's retirement, we were concerned that

our collaboration with the Minnesota Department of Natural Resources might become less robust, but that, gladly, has not turned out to be the case.

There are some challenges ahead, however. As I write this summary in spring 2017, it is not clear how the Cooperative Research Units Program will fare in the

current federal administration. The future of federal funding for natural resources research is anything but clear, and the current practice of operating on continuing resolutions until late into the federal fiscal year makes it difficult for federal agencies to commit funds they do have to research. In addition, without increases to the Cooperative Research Units Program budget, it is likely that the program, including the Minnesota Coop Unit, will continue to carry vacancies for the foreseeable



future. On the state side, budgets in both fisheries and wildlife have shrunk, and the Minnesota Department of Natural Resources is facing significant financial challenges in the absence of increase in revenue, which makes research collaboration more challenging. Finally, the University of Minnesota, like many institutions of higher education, faces ongoing financial challenges that affect availability of resources to support departmental operations. Over the more than 25 years the Minnesota Coop Unit has been in existence, the last 10 or more years have seen constant downward pressure of department budgets, which influences institutional support for our program. So, perhaps as much as ever, we need support from our cooperators, collaborators, former students, colleagues, and friends to champion what we do and the contributions we have made. If you have the opportunity, please put in a good word on our behalf! Throughout all the changes and pressures, however, we continue to “make it work.”



Finally, a quick update on some of the activities of Minnesota Coop Unit scientists and staff. David Fulton continues to work closely with the Minnesota Department of Natural Resources to address their information needs, and Sue Schroeder continues to assist him in these efforts in her position as a Research Associate. David is currently working on a national project evaluating waterfowl hunters’ motivations and attitudes, which is the first of its kind on such a grand scale. David Andersen continues projects with golden-winged warblers, sandhill cranes, peregrines, American woodcock, secretive marsh-birds, and greater prairie-chickens, and has been able to work with collaborators to fund Jason Bruggeman as a postdoc. Finally, Hattie Saloka, who as everyone familiar with the Minnesota Coop Unit knows, continues to keep everything humming along. As a busy mother of two growing boys, she’s got her hands full at home in addition to keeping all of us in line.