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## BIENNIAL REPORT

JANUARY 2013—DECEMBER 2014



U.S. Geological Survey

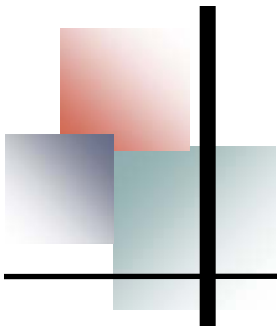
University of Minnesota

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 as part of the Cooperative Research Units Program and is hosted by the Department of Fisheries, Wildlife, and Conservation Biology at the University of Minnesota. 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 and economic aspects of both game and nongame fisheries and wildlife management in the context of maintenance of biological diversity, and integrity and sustainability of ecosystems.

This is the thirteenth biennial report produced by the Minnesota Coop Unit and summarizes Unit activities during 2013 and 2014. Over the past two years, support for the Unit program in general, and for our Unit in particular, has remained strong, even in light of difficult economic conditions and budget pressures at the federal, state, and University levels. We are currently fully staffed, although Dr. Bruce Vondracek has announced that he will retire in 2015, and we enjoy continued support from our Minnesota Department of Natural Resources, University of Minnesota, Wildlife Management Institute, and U.S. Fish and Wildlife Service partners. We continue 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 the Cooperative Research 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.

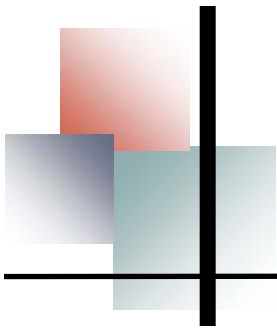
Sincerely,

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Leader

Dr. Bruce Vondracek  
Assistant Leader - Fisheries

Dr. David C. Fulton  
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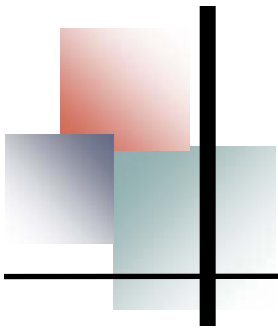




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# PERSONNEL AND COOPERATORS

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Gerald Ankley (adjunct)	Daniel Larkin
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Przemyslaw Bajer (research faculty)	Jeff Lawrence (adjunct)
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Yosef Cohen	L. David Mech (adjunct)
James Cooper (emeritus)	Loren Miller (adjunct)
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Ralph J. Gutiérrez	Edward B. Swain (adjunct)
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James Kitts (emeritus)	Tom Will (adjunct)
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### Faculty as Principal Investigator in Unit Research

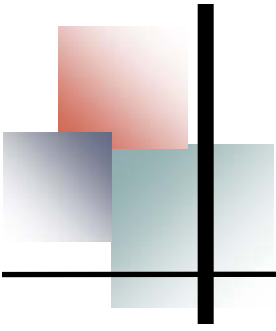
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## Cooperating University of Minnesota Academic Units

College of Food, Agricultural and Natural Resource Sciences  
Conservation Biology Graduate Program  
Department of Entomology  
Department of Fisheries, Wildlife, and Conservation Biology  
Department of Forest Resources  
Department of Genetics, Cell Biology and Development  
Integrated Biosciences Graduate Program (University of MN—Duluth)  
Natural Resources Science and Management Graduate Program  
University of Minnesota Graduate School  
Water Resources Science Graduate Program

## Cooperating Organizations

Legislative Citizens Committee on Minnesota Resources  
Minnesota Department of Natural Resources  
University of Minnesota, Duluth  
    Natural Resources Research Institute  
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  
    Malheur National Wildlife Refuge  
    Tamarac National Wildlife Refuge  
    Webless Migratory Gamebird Research Program  
U.S. Geological Survey  
    Columbia Environmental Research Center  
    Geosciences & Environmental Change Science Center  
    Northern Prairie Wildlife Research Center  
    Science Support Partnership  
    West Virginia Cooperative Fish and Wildlife Research Unit  
U.S. National Park Service  
Voyageurs National Park



# Completed Research



# Applied Ecology





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# Assessment of Techniques for Evaluating American Woodcock Population Response to Best Management Practices Applied at the Demonstration-Area Scale

**Investigator:** David E. Andersen  
**Student:** Kyle Daly, M.S. (Natural Resources Science and Management)  
**Duration:** April 2011 to December 2013  
**Funding Source:** U.S. Fish and Wildlife Service—Webless Migratory Gamebird Research Program; U.S. Geological Survey  
**Project Location:** Tamarac National Wildlife Refuge, Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

American woodcock (*Scolopax minor*) have experienced significant long-term population declines in the Eastern and Central Management Regions (0.8 % per year) since Singing-ground Surveys (SGS) were first implemented in the mid-1960s. Declines in population trend coupled with declines in woodcock recruitment (indexed through immature:adult female ratios derived from wing-collection surveys) are widely believed to be caused by the loss or alteration of early succession forest and shrubland land-cover types throughout the breeding range. However, trends in woodcock abundance (SGS counts) have remained stationary in Minnesota for the period covered by the SGS (1968 – present), even though the amount of land-cover types important to American woodcock has increased from historic conditions in the Minnesota portion of Bird Conservation Region 12.

In response to declining trends in SGS counts at regional levels, the Migratory Shore and Upland Game Bird Working Group of the Association of Fish and Wildlife Agencies formed the Woodcock Taskforce to develop a conservation plan with a goal to stabilize and ultimately reverse declines in woodcock populations. The taskforce completed the American Woodcock Conservation Plan, which contains both population and habitat goals, in 2008. Under the leadership of the Wild-



life Management Institute, partners have formed five regional woodcock initiatives to begin implementing the habitat goals of the conservation plan. After considering alternative courses of action, initiative cooperators believed that the best way to influence landscape change and ultimately increase woodcock populations was to develop a system of demonstration areas where

specific best management practices (BMPs) are applied throughout the woodcock breeding range.

Biologists familiar with woodcock habitat requirements developed BMPs for each initiative with the assumption that BMPs applied at the demonstration-area scale ( $\approx 200 - 800$  ha) will result in positive growth in local woodcock populations. This assumption has not been tested. Our objective was to evaluate woodcock population responses to BMPs applied at the demonstration-area scale by focusing on four metrics: displaying male abundance, female habitat use and survival, and recruitment. However, techniques for evaluating these responses have not been fully assessed. To evaluate woodcock population responses at other areas where BMPs are applied in the future, it is necessary to first assess the efficacy of techniques to describe male and female woodcock habitat use and estimate vital rates.

Our specific objectives were:

- 1) Assess response of displaying male American woodcock to BMPs at the demonstration-area scale by comparing abundance of displaying male American woodcock on Tamarac National Wildlife Refuge (a demonstration area in west-central Minnesota) with abundance in the surrounding landscape, as measured by routes that are part of the American Woodcock SGS.
- 2) Evaluate radio-telemetry as a tool to measure female wood-

cock response to application of BMPs at the demonstration-area scale.

- 3) Estimate adult female, nest, and juvenile survival and relate these parameters to habitat and other variables that may affect survival at the demonstration-area scale.
- 4) Estimate recruitment using night-lighting and mist-net capture techniques on summer roosting fields at Tamarac National Wildlife Refuge, and evaluate these techniques as a means to assess recruitment.
- 5) Develop and assess techniques for radio-marking American woodcock juveniles to estimate juvenile survival and document brood habitat use.

We completed field work on this project in 2012 and submitted our final report in 2014. We observed no measurable effect of transmitters on juvenile woodcock survival rates, estimated vital rate parameters for woodcock in areas where BMPs had been applied, and concluded that neither night-lighting nor mist-netting woodcock at roosting fields adequately represented recruitment, when compared to estimating vital rates directly. Results of this work are available as an M.S. thesis (Daly 2014) and to date, one manuscript describing a lack of effect of transmitters on juvenile woodcock survival rates has been accepted for publication.



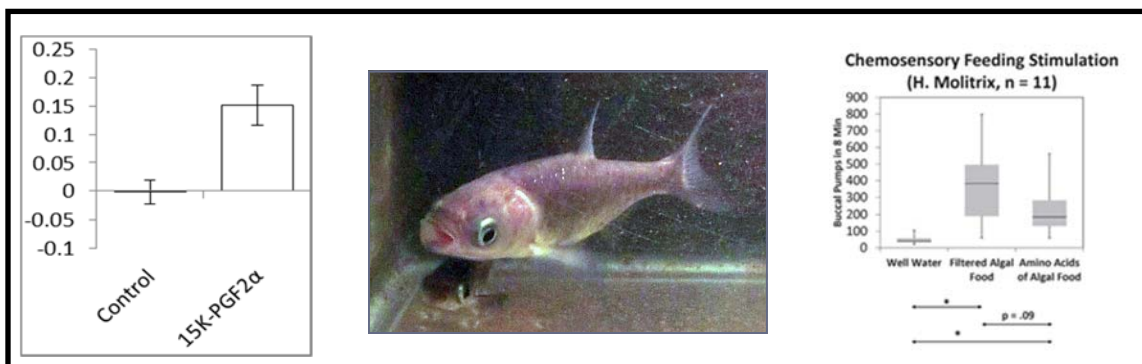


# Determining the Olfactory Sensitivity of Asian Carp (*Hypophthalmichthys* spp.) to Putative Hormonal Sex Pheromones—II. Behavioral Responsiveness

**Investigator:** Peter W. Sorensen (Cooperating Faculty)  
**Staff:** Joseph Leese, Postdoctoral Researcher  
**Students:** Elizabeth Fox, B.S. (Molecular and Cell Biology)  
Aaron Claus, B.S. (Fisheries and Wildlife, subplan Fisheries)  
**Duration:** January 2012 to July 2013  
**Funding Source:** U.S. Geological Survey —Columbia Environmental Research Center  
**Project Location:** University of Minnesota

Many fishes rely upon their senses of taste and smell to find food and mates, the latter of which is achieved using species-specific sex pheromones. Our previous USGS-funded studies demonstrated that the olfactory systems of both silver (*Hypophthalmichthys molitrix*) and big-head carp (*H. nobilis*) detect unique suites of sex steroids and F prostaglandins in highly sensitive and species-specific manners, which suggested that they use these unique products as sex pheromones. The present study is exploring the functional significance of this finding while examining the possibility that these invasive carps may also detect their planktivorous food using novel tastants. Initial behavioral tests using circular mazes demonstrated that 15keto-prostaglandinF<sub>2a</sub> is attractive to masculinized (androgen-treated) silver carp allowing us to

conclude it is a sex pheromone. Studies now focus on feeding stimulants in both bigheaded species. These studies have shown that both species exhibit reflexive ingestion behaviors (via a process known as buccal pumping) when exposed to food. These responses appear to be stimulated by the olfactory system in combination with a unique structure known as the epi-branchial organ located alongside their gills. Interestingly, this structure is innervated by the vagus nerve and is chemosensitive; it is specifically and uniquely stimulated by chemicals released by certain types of plankton. Amino acids appear to be part but not all of this cue. Future studies will identify the unique components that stimulate ingestion as they could prove useful in control.



**Figure 1.** a). Behavioral attraction (% time) to a sex pheromone; b) buccal pumping; c) rate of buccal pumping

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# Determining Possible Side Effects of Local Fish Species on Recruitment Dynamics of Common Carp in the Malheur National Wildlife Refuge

**Investigators:** Przemyslaw G. Bajer and Peter W. Sorensen (Cooperating Faculty)  
**Duration:** March 2012 to December 2013  
**Funding Source:** U.S. Fish and Wildlife Service—Malheur National Wildlife Refuge  
**Project Location:** Malheur National Wildlife Refuge, Oregon

There have been several attempts to control the population of common carp (*Cyprinus carpio*) in Malheur Lake over the last few decades using rotenone (a fish toxin). These efforts resulted in brief periods of clear water, abundant vegetation and numerous waterfowl, but none lasted more than a few years before the carp rebounded. Whereas these efforts provided additional evidence that excessive carp biomass is indeed responsible for the lack of vegetation and high water turbidity in Malheur Lake, they also illustrated the challenges of sustainable carp management in that system. One possible strategy to reduce carp population abundance in a more sustainable way is to increase the density of small predatory fish that were once abundant in Malheur Lake and which might prey on carp eggs and larvae. Such a natural control strategy has been recently developed in Minnesota lakes where abundant populations of small egg-eaters, such as bluegill (*Lepomis macrochirus*), have been shown to be able to control the recruitment of carp in most lakes allowing for sustainable carp management. The aim of this study was to conduct an experiment to test whether local fish species found within the refuge consume carp eggs and could potentially play a role in reducing carp recruitment, at least in some areas of the refuge, if their numbers were to be increased.

To test this possibility, equal numbers of carp eggs were placed in mesh enclosures that were



*Experimental enclosures in Benson Pond at Malheur National Wildlife Refuge*

either fishless (controls) or stocked with one of six species of local fish. Egg predation was quantified over the first 24 h and the experiment was repeated three times. Predation on carp eggs was highest in enclosures stocked with spotted dace (*Rhinichthys osculus*) and black bullheads (*Ameiurus melas*) in which 60% to 80% of eggs disappeared within the first 24 h, a rate signifi-

cantly higher than that of the controls. Disappearance rates of carp eggs in enclosures stocked with other species (tui chub [*Gila bicolor*], redbreasted sunfish [*Richardsonius balteatus*], rainbow trout [*Oncorhynchus mykiss*], and pumpkinseed sunfish [*Lepomis gibbosus*]) were not statistically different from the controls suggesting that these species do

not forage on carp eggs. Our results suggest that at least two species of local fish forage on carp eggs and might play a role in controlling carp recruitment. Further experiments are now needed to test whether local fish also prey on carp larvae and juveniles to test if a fish-based biocontrol scheme might have potential as it does in the Midwest.



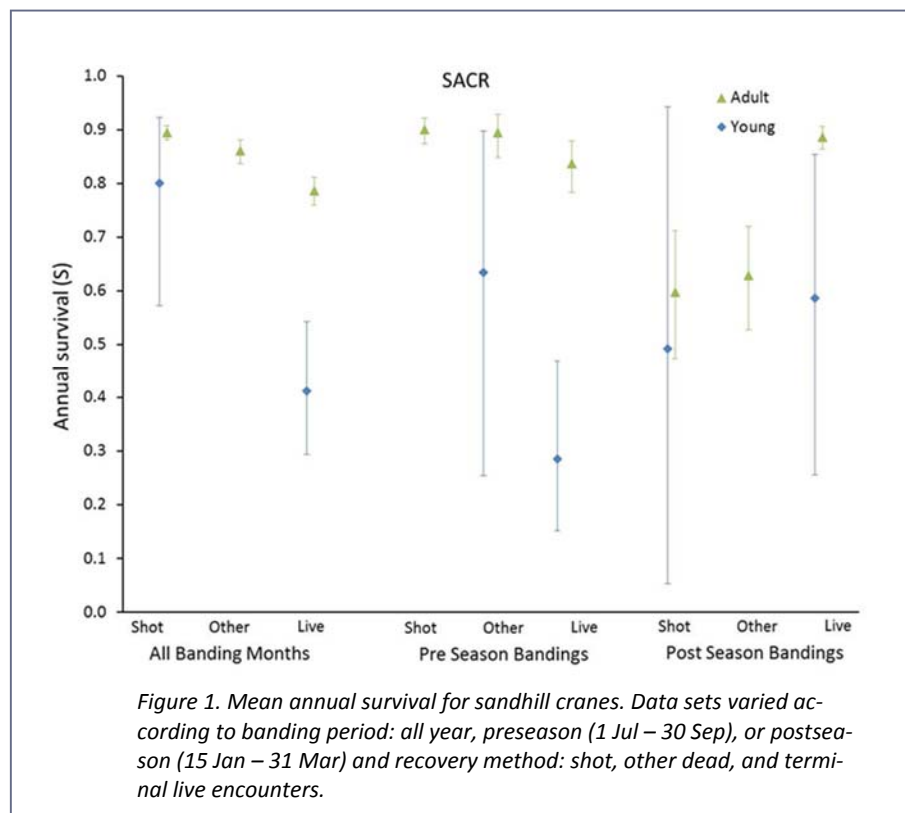
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# Survival and Recovery Rates of Webless Migratory Game Birds

**Investigator:** Todd Arnold (Cooperating Faculty)  
**Student:** Hannah Specht, Ph.D. (Conservation Biology)  
Seth Stapleton, Ph.D. (Conservation Biology)  
**Research Associate:** Cristina de Sobrino  
**Duration:** July 2012 to June 2014  
**Funding Source:** U.S. Geological Survey  
**Project Location:** University of Minnesota

This project had two major objectives. The first was to summarize existing band recovery and recapture data for webless migratory game birds to determine which species met necessary sample sizes for survival analysis. For sora (*Porzana carolina*), Virginia rail (*Rallus limicola*), king rail (*R. elegans*), and purple gallinule (*Porphyrio martinicus*), recovery data were too sparse, and low encounter rates suggested that no reasonable amount of future banding effort would ever lead to sufficient samples. But for Amer-

ican coots (*Fulica americana*), common moorhens (*Gallinula chloropus*), clapper rails (*R. longirostris*), sandhill cranes (*Grus canadensis*), and Wilson's snipe (*Gallinago delicata*), we were able to generate some of the first survival estimates based on statistically robust methods (reliable



estimates have already been published for mourning doves [*Zenaida macroura*], white-winged doves [*Z. asiatica*], band-tailed pigeons [*Patagioenas fasciata*], and American woodcock [*Scolopax minor*]).

Estimated annual adult survival using year-round bandings and recoveries of dead birds (shot plus other mortality sources) was 0.884 (SE 0.006) for sandhill cranes, 0.583 (SE 0.008) for American coots, 0.508 (0.025) for clapper rails (Gulf and Atlantic Coast populations only), and 0.653 (SE 0.020) for Wilson's snipe. Juvenile survival was 0.325 (SE 0.025) for American coots, 0.368 (SE 0.070) for clapper rails, and 0.372 (SE 0.077) for Wilson's snipe but we could not obtain reliable estimates of

juvenile survival for sandhill cranes (Fig. 1). Trend models were deemed unreliable for survival rates given sparse data, but recovery rates of adult sandhill cranes have increased through time, whereas recovery rates of the remaining three species have declined, suggesting that harvest pressure is diminishing.

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# Moose Habitat Use and Activity in Voyageurs National Park

**Investigator:** Ron Moen (Cooperating Faculty)  
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**Duration:** June 2012 to June 2014  
**Funding Source:** U.S. Geological Survey—Northern Prairie Wildlife Research Center  
**Project Location:** Voyageurs National Park  
University of Minnesota—Duluth

The decline of moose (*Alces alces*) in Minnesota is of management concern. In this research project we deployed Global Positioning System (GPS) collars on moose in Voyageurs National Park to evaluate changes in habitat use as related to changes in ambient temperature. These GPS collars collected locations at 20 minute intervals and transmit those locations via Argos satellite network. We collected about 300,000 locations from 25 different moose. We used these GPS locations to characterize moose home range size and cover-type composition in Voyageurs National Park in northeastern Minnesota. Home range size did not change over the 15-year period. Summer home range area estimates for the 1995-1997 deployment were  $12.0 \pm 7.2 \text{ km}^2$  for 95% kernel and  $19.9 \pm 9.9 \text{ km}^2$  for 95% MCP. Home range estimates for the 2010-2012 deployment were  $10.3 \pm 6.6 \text{ km}^2$  for 95% kernel and  $17.2 \pm 6.9 \text{ km}^2$  for 95% MCP. These home range areas fit within the broad range of summer home-range size estimates of other studies in North America and Scandinavia (mean:  $23.7 \text{ km}^2$ , min:  $0.9 \text{ km}^2$ , max:  $141 \text{ km}^2$ ), as well as in northern Minnesota (mean:  $28.5 \text{ km}^2$ ). Michael Joyce is preparing this manuscript for publication.



As ambient temperature increased above 20° C moose spent proportionally more time in the wet bog cover type and increased the proportion of time they were inactive. We also used the GPS collar data to evaluate moose risk of acquiring brainworm (*Parelaphostrongylus tenuis*) and liver fluke parasites. The location data are also being used to evaluate a thermal landscape model developed by Bryce Olson.



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# Summarizing Data and Developing Conservation Practices for Eagle Nesting and Concentration Areas in the Midwest Region

**Investigators:** David E. Andersen  
**Staff:** Jason E. Bruggeman, Postdoctoral Research Fellow  
**Duration:** November 2010 to September 2013  
**Funding Source:** U.S. Fish and Wildlife Service  
**Project Location:** U.S. Western Great Lakes region

Although bald eagles (*Haliaeetus leucocephalus*) were delisted pursuant to the Endangered Species Act in 2007, both bald and golden eagles (*Aquila chrysaetos*) remain protected from harassment and disturbance under the Bald and Golden Eagle Protection Act (Eagle Act). The Eagle Act defines Important Eagle Use Areas as, “an eagle nest, foraging area, or communal roost site that eagles rely on for breeding, sheltering, or feeding, and the landscape features surrounding such nest, foraging area, or roost site that are essential for the continued viability of the site for breeding, feeding, or sheltering eagles” (50 CFR §22.3). Foraging, communal roosting, and wintering areas (hereafter called “concentration areas”) are often harder to locate and protect than nests, but may be equally important to the survival of these species. Consequently, a violation of the Eagle Act can occur if human activity at or near these concentration areas agitates eagles to the extent it causes a loss of productivity, injury, or death.

Adequate protection of eagle nesting and concentration areas is contingent upon accurate



location data; however, there is currently no database of eagle concentration areas. Much information regarding eagle concentration areas is known but disparate in consistency and quality; locations may be known to one party but not shared with another. Additionally, the frequency of updating nest location and nest productivity data varies among parties. Databases of nest locations are frequently managed by state agencies and not readily shared between or among states. A significant amount of information on eagle concentration areas, nest disturbance, and disturbance minimization measures is in the form of “gray” literature including unpublished graduate theses, technical reports, annual monitoring reports, etc. These data need to be com-

piled and summarized so biologists and managers may benefit from this information. For efficient and meaningful protection of eagles, gaps in information need to be filled and existing knowledge compiled, summarized, and shared. With these improvements, the U.S. Fish and Wildlife Service and other agencies can make conservation decisions grounded in scientific rationale. These conservation decisions need to be compiled into a set of Advanced Conservation Practices (ACPs), which will be tailored to various industries (wind, electric) to ensure effective eagle management and population growth. ACPs are scientifically-supportable measures approved by the U.S. Fish and Wildlife Service that represent the best-available techniques to reduce eagle disturbance and/or ongoing mortalities to a level where remaining take is unavoidable.

The objectives of this project were to:

- 1) Compile existing data on bald eagle nests and concentration areas from eight states in the

Midwest Region and incorporate that information into one database;

- 2) Produce Geographic Information System (GIS) layers and an atlas of maps for each of the eight states detailing the bald eagle locations;
  - 3) Write ACPs for bald eagles and golden eagles addressing the topics of wind energy development, power lines, communication towers, transportation networks, and buildings and windows; and
  - 4) Identify information gaps and research needs that can be addressed through future work.
- We completed all four objectives and provided products to the U.S. Fish and Wildlife Service for their use in future eagle management.

All project products have been delivered to the U.S. Fish and Wildlife Service.



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# The Use of Satellite Telemetry to Evaluate Migration Chronology and Breeding, Migratory, and Wintering Distribution of Eastern Population Sandhill Cranes

**Investigators:** David E. Andersen and Douglas H. Johnson (Cooperating Faculty)  
**Student:** David Fronczak, M.S. (Natural Resources Science and Management)  
**Duration:** August 2009 to August 2014  
**Funding Source:** U.S. Fish and Wildlife Service—Webless Migratory Gamebird Research Program  
**Project Location:** Eastern North America

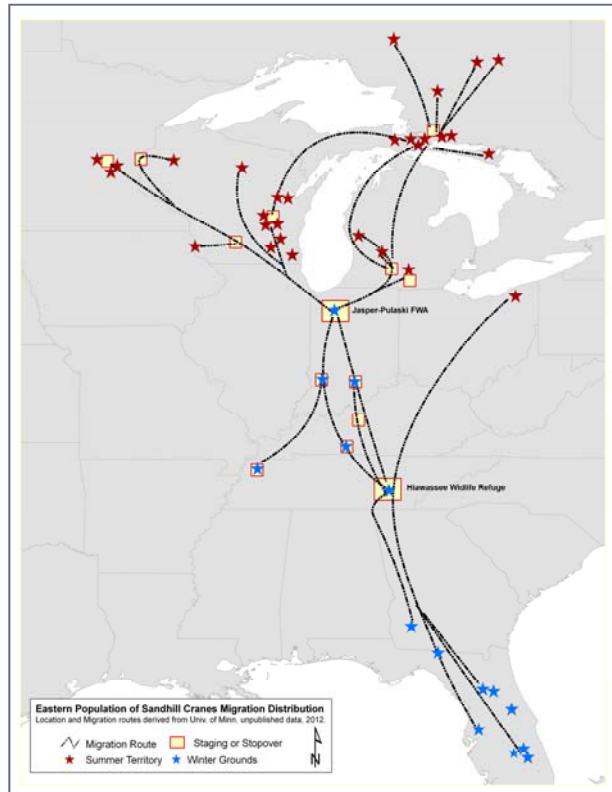
The Eastern Population (EP) of sandhill cranes (*Grus canadensis*) is rapidly expanding in size and geographic range. The core of EP breeding range occurs in Wisconsin, Michigan, and southern Ontario; however, the EP range has expanded in all directions as the population has grown and the current geographic extent of breeding and wintering ranges of EP cranes is unknown. In addition, little is known about migration chronology including when fall/spring migration commences or how long birds remain at staging areas.



Migratory game bird managers require better data about crane movements to delineate the current extent of the population, identify potential overlap with neighboring migratory and non-migratory populations, and identify important habitats used by EP sandhill cranes throughout the year. In 2009, the Association of Fish and Wildlife Agencies' Migratory Shore and Upland Game Bird (MSUGB) Support Task Force organized a workshop to identify the priority information needs for the six populations of migratory sandhill cranes. Representatives from government conservation agencies (state, provincial, and federal agencies) and university researchers

and private conservation organizations were invited to this workshop. Priority needs identified at the workshop focused on initiating or enhancing monitoring efforts and estimating vital rates during the annual cycle for the various populations of cranes.

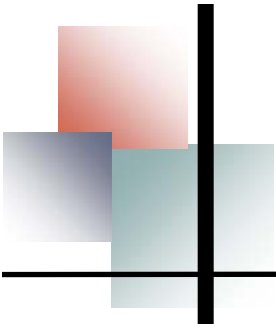
The objectives of this project were based on the priority information needs set by the MSUGB Support Task Force. Our first objective was to use satellite telemetry to delineate breeding range and migration patterns of EP sandhill cranes. Our second objective was to evaluate existing survey protocols used to monitor population size.



From December 2009 through January 2012 we trapped and deployed solar Global Positioning System (GPS) Platform Transmitting Terminals (PTTs) on 29 sandhill cranes, primarily in known fall and winter concentration areas, to assess movements throughout the year. Marked EP cranes settled on

summer areas beginning mid-March in Minnesota (11%), Wisconsin (36%), Michigan (29%), and Ontario (21%). On average, PTT-tagged cranes arrived at their winter terminus beginning mid-December in Indiana (29%), Kentucky (11%), Tennessee (79%), Georgia (11%), and Florida (32%). Twenty-three marked cranes returned to their summer area's calculated mean center after a second spring migration. The average linear distance between individual estimated mean activity centers for a summer area was 1.34 km (range: 0.01 – 7.82 km). EP cranes used fall and spring migration routes similar to those previously documented. We estimated annual survival rates (from October through September) of 0.921 (2010-2011; SE = 0.058) and 0.913 (2011-2012; SE = 0.087) using the known fates platform in Program MARK .

The final products for this project (M.S. thesis, Fronczak 2014) have been submitted and one manuscript reporting survival rates of EP cranes has been accepted for publication.



## Completed Research



Human Dimensions, Management,  
and Conservation





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# Assessing the Cumulative Impacts to Near-shore, In-water Habitat

**Investigator:** Bruce Vondracek  
**Students:** Jennifer Keville, M.S. (Water Resources Science Program)  
Jessie Lepore, M.S. (Conservation Biology Program)  
**Duration:** July 2010 to June 2013  
**Funding source:** Environment and Natural Resources Trust Fund as recommended by the  
Legislative Citizens Committee on Minnesota's Resources  
**Project Location:** Northern Minnesota  
Minnesota Cooperative Fish and Wildlife Research Unit

Expansion of residential development along lakeshores has led to habitat modification that may alter lake fish communities. Littoral habitat is a critical component of lake ecosystems. Aquatic macrophytes and coarse woody structure (CWS) provide refuge, foraging area, and spawning substrate for many fish species. Previous studies have linked lakeshore development to reductions in abundance of aquatic vegetation and CWS; however, few studies have quantified the specific influence of riparian alterations and docks on aquatic habitat structure. The lack of knowledge on the cumulative effects of human activities on aquatic habitat, water quality, and fish populations has hindered regulatory authorities and lake managers who need better information to guide landowners toward lower impact practices. We assessed the extent of near-shore vegetation and fish along a gradient of shoreline development and developed a framework to assess cumulative impacts on 30 whole-lake systems. We used aerial photos and existing Minnesota Department of Natural Resources (MNDNR) data to measure whole-lake disturbances of 114 lakes in the Northern Lakes and Forests Ecoregion. We investigated effects of lakeshore development at randomly selected sites on four structural habi-



tat components, CWS, and three measures of macrophyte abundance in Minnesota lakes, using docks as an index of development in 10 lakes. We used the MNDNR's Score Your Shore (SYS) survey to assess development intensity in 28 lakes relative to the four structural habitat components and fish species richness and a Fish Index of Biological Integrity. All four structural habitat components were significantly influenced by distance to the nearest dock structure. Coarse woody structure and emergent and floating-leaf vegetation were reduced at developed sites. Score Your Shore score was a significant factor in models of most macrophyte community variables, supporting the hypothesis that site-scale

development intensity affects littoral vegetation. Site -level abundance of CWS and presence of emergent species were significantly and negatively related to lake-wide dock density, indicating that these habitat components are particularly vulnerable to development. We also assessed abundance of 18 individual fish species, a nearshore Index of Biological Integrity (NSIBI), and four components of the NSIBI, and a lake-wide Fish Index of Biological Integrity (FIBI) relative to dock density in 28 Minnesota lakes. We found that a number of fish species

were more abundant in lakes with less than ~ 12 docks/km. However, several species were abundant over a range of up to 25 docks/km. Our data will provide a tool to guide lake managers toward sustainable near-shore, in-water development.



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# Deer Management on Private Lands in Southeast Minnesota

**Investigator:** David C. Fulton and Mae Davenport (Cooperating Faculty)  
**Students:** Amanda Sames, M.S. (Natural Resources Science and Management)  
Amit Pradhananga, Ph.D. (Natural Resources Science and Management)  
**Duration:** May 2012 to June 2013  
**Funding Source:** Minnesota Department of Natural Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

The Minnesota Department of Natural Resources (MNDNR) has conducted several studies of hunter attitudes and acceptance of hunting regulations to assist the agency in designing regulations that achieve biological goals yet are socially acceptable. Although the agency has done extensive work in understanding the perspectives of deer hunters in southeastern Minnesota, the perspectives of private landowners around white-tailed deer (*Odocoileus virginianus*) management issues has not been studied. Thus, private landowners' experiences, attitudes, and actions regarding deer hunting and land management in southeastern Minnesota are poorly understood. Yet, private landowners play a key role in controlling hunter access to deer populations. Understanding landowner perspectives will further assist the agency in designing hunting regulations and in developing landowner assistance programs in southeastern Minnesota.

The main purpose of this study was to understand private landowners' perspectives on deer hunting and deer management in southeastern Minnesota. This study gathered information from private landowners about their perceptions of deer hunting, deer regulations, and management options in southeastern Minnesota. In addition, this survey also gathered information from landowners about farming practices, wildlife damage, posting, and leasing their land for deer hunting.

The specific objectives of this study were to:

- 1) Determine the level of estimated crop damage due to deer and other species in southeastern Minnesota.
- 2) Determine private landowners' opinions about deer hunting including reasons for leasing property to hunters.
- 3) Determine private landowners' reasons for posting property.
- 4) Determine private landowners' opinions regarding deer population.
- 5) Describe land-owning hunters' deer hunting experiences in the 2011 deer hunting season including permit area hunted and the type of land hunted on.
- 6) Determine private landowners' and hunters' opinions regarding deer hunting regulations including support for the regulation changes that were implemented in 2010.
- 7) Determine private landowners' perceptions about deer management including their perspectives on strategies to lower deer population.

The population of interest in this study included private landowners within the southeastern Minnesota counties of Goodhue, Wabasha, Winona and Houston who own a minimum of 40 acres in rural areas. Data were collected using a self-administered mail-back questionnaire based on an adapted Dillman's tailored design method. Participants were contacted multiple times (three times between October 2012 and January 2013) to enhance response rates.

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# Effects of Imperfect Detectability on Inferences from Monitoring

**Investigators:** David E. Andersen and Douglas H. Johnson (Cooperating Faculty)  
**Student:** Elizabeth Rigby, Ph.D. (Natural Resources Science and Management)  
**Duration:** August 2009 to July 2014  
**Funding Source:** U.S. Geological Survey —Northern Prairie Wildlife Research Center  
**Project Location:** University of Minnesota

The value of bird monitoring has come under increasing scrutiny recently due to concerns about imperfect detectability. The probability of detecting a bird in a surveyed area is often less than one, due to environmental, behavioral, and observational factors. If bird detectability is constant over time, the number of birds counted in a survey provides an index to abundance,

$$E(C) = pN,$$

where  $E(C)$  is the expected count of a species made during a survey,  $N$  is the true number of that species in the surveyed area at the time of the survey, and  $p$ —detectability—is the proportion of the true number that is recorded. If detectability is not constant or has a trend over time, the value of  $C$  as an index to abundance is uncertain. Detectability can also be decomposed into four parts,

$$E(C) = p_s p_p p_a p_d N^*,$$

where  $N^*$  is the superpopulation, all birds whose territories or home ranges lie at least partially within the area of inference;  $p_s$  is the spatial probability that a bird's home range or territory at least partly overlaps a survey area;  $p_p$  is the probability that a bird is present at a survey area during the survey period;  $p_a$  is availability, the probability that a bird is available to be detected



during the survey (e.g., it vocalizes); and  $p_d$  is perceptibility, the probability that an available bird is detected by the observer.

Several analysis methods have been introduced to explicitly account for certain components of detectability in bird surveys, including double observer methods, distance sampling methods, removal detection methods, and replicate counts. All of these methods introduce additional assumptions and require gathering additional information during the survey, e.g., the distance from the observer to each bird for distance sampling. The detectability estimated by different methods also differs, and abundance estimates from surveys using different methods may not be directly comparable.





In light of these issues, this project addressed detectability questions in a simulated context. Graduate student Elizabeth Rigby constructed a computer simulation of the bird survey process, taking into account factors affecting detectability at three levels: spatial factors, factors affecting availability, and factors affecting perceptibility.

Variation in abundance at survey sites was modeled via a covariate for the proportion of the study site covered by habitat (as opposed to matrix). This relationship allowed flexibility to model abundance patterns for generalist or specialist species, as well as common or rare habitats. Locations of birds during the surveys were modeled by assigning a bivariate normal (elliptical) territory for each simulated bird. Bird moved within their territories throughout simulated surveys, allowing birds to enter or exit the observable range around the observer. Bird vocalizations were modeled with Markov chains at two scales. At the coarse scale, birds switched into and out of a Singing Mode. If not in Singing Mode, birds did not sing. If in Singing Mode, birds sang with a predictable frequency (fine scale) based on recordings of live birds. Detection of vocalizing birds within the range of the observer

were modeled using existing estimates of an observer's ability to detect recorded bird songs (previous work performed by researchers at North Carolina State University).

Simulations were parameterized using empirical data whenever possible. The flexibility of the model allows the user to analyze a wide variety of biological situations. As a test case, we simulated surveys for black-throated blue warblers (*Setophaga caerulescens*) over 30 years, using five different survey techniques (index methods, distance sampling, multiple observer, replicated counts, and removal methods). Counts from index methods underestimated true abundance (as expected) but were highly correlated with true abundance. Replicated count methods produced highly inflated estimates of abundance when estimated probability of detection was  $< \sim 0.2$ . Distance sampling methods produced abundance estimates that were less biased than index methods, but were not as highly correlated with true abundance. Removal and multiple observer methods did not reduce bias or improve correlation with true abundance when compared with index methods.

In addition to the computer simulation, Elizabeth conducted a field study on factors affecting detectability of recorded bird songs in prairie. By using recordings, it is possible to know the true number of songs available to be detected in a field situation. Similar field simulations have been conducted in hardwood and pine forests, but not in grasslands. The study included songs of 10 grassland species played in random order from a speaker while an observer was 30-150 m from the sound source. Distance from the sound source and wind speed and direction were the primary factors affecting correct detection of songs. The area around the sound source where songs could be detected was asymmetrical, with higher detection rates downwind of the source. The sizes of these "detection zones" were constricted at high wind speeds. Observers ( $n = 4$ ) differed in their ability to detect songs, with inexperienced observers having an odds of detection of 26% of the primary observer.

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# Identifying Risks to Migratory Birds and Bats from Wind Development

**Investigators:** James A. Perry and Douglas H. Johnson (Cooperating Faculty)  
**Student:** Kevin Heist, Ph.D. (Conservation Biology)  
**Duration:** August 2009 to August 2014  
**Funding Sources:** U.S. Fish and Wildlife Service  
U.S. Geological Survey —Northern Prairie Wildlife Research Center  
**Project Location:** Upper Midwest, Great Lakes Region, and Texas

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, particularly 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 goal of this study is to explore methods to assess risks to migratory birds and bats posed by wind energy development at local and regional levels. Specific project objectives include:

- 1) Evaluate the ability of dual acoustic-ultrasonic recorder to capture nocturnal calls of birds and bats at current and potential wind power sites.
- 2) Relate nocturnal call activity for birds and bats to results of fatality searches at operating wind farms.
- 3) Evaluate whether call activity varies in relation to prominent landscape features. We will test the hypothesis that nightly call counts vary in predictable relations to specified physiographic and landscape features.
- 4) Measure changes in bird and bat activity before and then after a wind farm is constructed. We will test the hypothesis that the development of a wind farm does not affect activity patterns at the site by recording call rates in the same locations before and after a wind farm is constructed.
- 5) Examine whether bat activity varies with dis-





tance from turbines. We will test the hypothesis that bat activity does not depend on proximity to a turbine by recording call rates at predetermined distances from the base of turbines.

During the winter of 2009-2010, we examined a variety of recording equipment that could be used to monitor bird and/or bat vocalizations at multiple remote field locations. We selected an autonomous acoustic/ultrasonic recorder, the Wildlife Acoustics Song Meter 2 Bat+ (SM2), which is easily deployable and capable of recording bird and bat calls simultaneously.

To address the specific objectives above, we selected particular field sites and placed multiple acoustic/ultrasonic recorders throughout each site to examine patterns of bird and bat activity both within and among sites. A full list of field sites is in the table below. To address objective (2), we selected wind farms at which bird or bat fatality studies had been conducted or were currently being conducted independently of this study (e.g., by conservation groups, university teams, or other researchers), and placed recorders throughout the area of the

wind farm included in the fatality study. To address objective (3), we selected locations with particular physiographic and landscape features that may influence bird and bat abundance during migration, including riparian corridors and grasslands under federal and state protection, and placed recorders at various distances from the edge of these features. To address objective (4), we selected sites where wind farms were expected to be constructed within the next two years. We placed recorders throughout the prospective wind farm sites, and kept the recorders in the same locations after the wind farm was constructed. To address objective (5), we placed recorders at specified distances (50, 200, and 500 m) from the base of turbines. Although each site was selected to address one of the objectives directly, data from most of the sites will be applicable to multiple objectives.

A collaborative effort with the U.S. Fish and Wildlife Service (FWS) was established in the spring of 2011 to focus on monitoring migratory activity of birds and bats along Great Lakes coastlines with a combination of radar and acoustic recording. FWS personnel at field offices in Wisconsin, Michigan, Pennsylvania, Ohio, and New York maintained and operated SM2 recorders at coastal and inland sites (including collocation with 2 FWS radar units), and shipped data cards to us in St. Paul, Minnesota for data storage and processing. In addition to providing information about bird and bat activity around the Great Lakes, this collaboration also expanded the geographic range of our study and helps us address our landscape objective (3).

Data collection at all field sites has been completed. Approximately 70TB of raw data were collected. Data processing has been completed. Over 2.6 million bird and bat passes were extracted from the raw data.

Speciation of bird calls was not possible for a variety of reasons, including reduced clarity and extraneous noise in sub-ultrasonic recordings, a lack of useful software for automated call identification, and the diversity of call patterns, both among and within species. Bat call species analysis was completed by a two-step process consisting of auto-

mated computer analysis and visual verification of sub-samples of bat calls. Results from the visual verification process were used to adjust output from the computer program to produce an estimate of the proportion of each set of bat calls attributable to each species occurring within the geographic range where the calls were collected.

Data analyses have been completed. Statistical analyses included comparisons of bird and bat activity (using pass counts as an index of activity) among various recording locations to address each objective. All bird analyses were carried out using total bird pass counts in the absence of species-

specific counts. Several analyses of bat data included both total bat passes and species-specific bat pass counts.

*Objective 1:* The recorder we selected was capable of capturing both bat and bird vocalizations over field deployments of up to 10 days. Malfunctions were relatively rare, but did result in lost data for some periods at some locations. Even given much shorter detection range (15 vs. 200 m for bats and birds, respectively), the recorder was more effective for measuring relative bat activity (differences in vocalization rates over time between recording locations) than relative bird activity. We were able

Site Name (Collaborator)	Location	Objective	Number of Recorders	Seasons Recorded (x = recorded)					
				Spring 2010	Fall 2010	Spring 2011	Fall 2011	Spring 2012	Fall 2012
Barton WF	Northern Iowa	2	3	x	x	x	x	x	
Martin County	Southern Minnesota	3	4	x	x	x	x		
Jackson County	Southern Minnesota	3	4	x	x	x	x		
Blue Mounds	Southwest Minnesota	3	4	x	x	x	x		
Tall Grass	Southwest Minnesota	3	4	x	x	x	x		
Prairie Rose	Southwest Minnesota	4	4		x	x	x		
Paynesville	Central Minnesota	4	4		x	x	x	x	x
Wolf Ridge WF (TCU)	Northern Texas	2	4		x		x		x
Top of Iowa WF	Northern Iowa	2	4			x	x	x	x
Buffalo Ridge WF	Southwest Minnesota	2	4			x	x	x	x
Oak Glen WF	Southeast Minnesota	4	4			x	x	x	x
Cedar Ridge WF	Eastern Wisconsin	2	4			x	x	x	x
Blue Sky WF	Eastern Wisconsin	2	4			x	x	x	x
Penascal WF (BCI)	Southern Texas	2	8				x		
Casselman WF (BCI)	Southwest Penna.	2	8				x		
Great Lakes (FWS)	Lake Mich. and Erie	3	varied				x	x	x
Paynesville 2	Central Minnesota	3	4					x	x
Rockville Park	Central Minnesota	3	4					x	x
Grand Meadow WF	Southeast Minnesota	5	12						x
Fowler Ridge WF (USGS, BCI)	Western Indiana	2,5	12						x

**Table1.** Field sites for bird and bat acoustic recording. WF = wind farm. Collaborators at various sites are in parentheses: TCU = Texas Christian University, BCI = Bat Conservation International, FWS = U.S. Fish and Wildlife Service, USGS = U.S. Geological Survey. Objective refers to the specific project objective listed above for which the location was selected, but data from many sites may be used to address multiple objectives. "Great Lakes" is a group of recording locations along the eastern and western shores of Lake Michigan and the southern shore of Lake Erie resulting from collaboration with the FWS as part of the Great Lakes Restoration Initiative. The number of recording locations varied by season, from as few as 24 to as many as 47. Generally, spring recording took place from March 15 to June 1, and fall recording took place from August 1 to November 15, but often when working with collaborators we recorded only during their data collection period.

to identify the species composition of bat recordings, but not bird recordings.

*Objective 2:* We found no relationship between fatality rates and acoustic activity rates for either bats or birds. Possible explanations for, and implications of these findings are numerous. They are discussed in Kevin Heist's Ph.D. dissertation, and will be discussed further in forthcoming publications.

*Objective 3:* We found a strong and fairly consistent relationship between bat activity and distance from edges of wooded areas. Bat activity was found to be higher within 200 m of wooded edges, with no observed effects of the edge at farther distances (up to 5 km). No effects of grassland edges were detected for bats. No consistent patterns in bird activity with respect to distance from wooded or grassland edges were observed.

Recording sites along Great Lakes coasts had much higher bat and bird activity than inland field sites. For bats, this was consistent with an overall regional trend: low activity at sites in southwest Minnesota, moderate activity at inland sites in central Minnesota, Iowa, and eastern Wisconsin, and high ac-

tivity near Great Lakes coasts (within 20 km of shoreline).

*Objective 4:* We found some evidence of avoidance for birds at wind farm sites after (but not before) the turbines were installed. The data supporting this avoidance are limited, so no strong conclusions could be drawn. We found no effect of wind farm installation on bat activity.

*Objective 5:* We found no consistent differences in bat activity among pre-specified distances from turbines. As this objective focused on the hypothesis that bats are attracted to wind turbines, birds were not considered for this portion of the study.

Kevin Heist's defense and dissertation were completed in the summer of 2014. A manuscript "Elevated bat activity in the Great Lakes and implications for wind energy development" is being revised for re-submission for publication. A second paper on the evaluation and verification of automated bat species identification software (Kaleidoscope) output is being written.

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

**Investigator:** David C. Fulton  
**Student:** Susan A. Schroeder, Ph.D. Research Associate  
**Duration:** January 2011 to December 2013  
**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 changing over time. This project provides a unique contribution nationally by providing a long-term research program with consistent measurement that will allow examination of long-term trends in values, attitudes, and behavior from a theory-directed perspective. Current completed and on-going specific projects are highlighted elsewhere in this report and include: a statewide general angler study; a statewide study of bass management and anglers; a study of coldwater fisheries management and anglers; two statewide waterfowl hunter studies (2010 and 2011 seasons); a study of wolf hunting and trapping; and a study of deer hunter behavior and management preferences in southeastern Minnesota.



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# Minnesota Deer Hunters Participating in the 2012 3A and 3B Firearm Seasons

<b>Investigator:</b>	David C. Fulton
<b>Staff:</b>	Susan A. Schroeder, Ph.D. Research Associate
<b>Duration:</b>	June 2012 to June 2013
<b>Funding Source:</b>	Minnesota Department of Natural Resources
<b>Project Location:</b>	Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota is home to over about 1.6 million sportspeople, including 500,000 deer (*Odocoileus* spp.) hunters (U.S. Department of the Interior, Fish and Wildlife Service, 2006). Approximately 13% of Minnesota residents (16 years and older) hunt for deer. This study sought to gather information from hunters about deer hunting in southeast Minnesota. Specifically, the purpose of this study was to better understand deer hunting participation in southeastern Minnesota, along with opinions about deer management in that part of the state. Survey recipients were selected based on their purchase of a 2012 Minnesota firearm deer hunting license and indication that they intended to hunt in southeastern Minnesota during the 3A or 3B season. The survey sample was drawn from the Minnesota Department of Natural Resources' (MNDNR) electronic licensing system (ELS). We drew samples of 2,000 each of Minnesota residents who purchased a 2012 Minnesota firearm deer hunting license and indicated that they intended to hunt in southeastern Minnesota during the 3A and 3B seasons. Both seasons are nine days long with the 3A season occurring earlier in November than the 3B season. An individual cannot hunt both the 3A and 3B seasons, therefore season participants are mutually exclusive. Data were collected using mail-back surveys following the process outlined by Dillman to enhance response rates. We constructed two relatively straightforward questionnaires, created personalized cover letters, and made multiple contacts

with the targeted respondents. Potential study respondents were contacted four times between November 2012 and March 2013. The data collection instrument for deer hunters in both regions was a self-administered survey with four sections of questions. The questionnaire included the following subjects:

- Your 2012 3A or 3B Minnesota deer hunting season;
- Experiences and opinions regarding your 2012 3A or 3B Minnesota deer hunting season;
- Deer populations and harvest management strategies in southeastern Minnesota;
- Opinions about alternative deer regulations

Hunters participating in the 3A season reported hearing or seeing more legal bucks while hunting, and reported greater satisfaction with the number of legal bucks, and the quality of bucks. Hunters participating in the 3A season reported greater support for the continuing the 4-point per side antler point restriction.

Hunters participating in both seasons reported opposition to regulatory changes including: delaying the 3A season, consolidating the 3A and 3B seasons, and allowing archery hunters or muzzleloader hunters to tag an additional buck.

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# Minnesota Wolf Hunters and Trappers 2012

**Investigator:** David C. Fulton  
**Staff:** Susan A. Schroeder, Ph.D. Research Associate  
**Duration:** June 2012 to June 2013  
**Funding Source:** Minnesota Department of Natural Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

Minnesota's wolves (*Canis lupus*) transitioned from federal protection under the Endangered Species Act to state management by the Minnesota Department of Natural Resources (MNDNR) on 27 January 2012. The 2012 Minnesota Legislature passed and the governor signed a bill providing additional direction and authorities for conducting the state's first-ever wolf hunting and trapping season. The MNDNR implemented a regulated hunting and trapping season between 3 November 2012 and 3 January 2013.

The agency was interested in surveying wolf hunters and trappers to obtain quantitative information about participation, opinions, and motivations to inform management decisions. This study sought to gather information from wolf hunters and trappers in Minnesota. Specifically, the purpose of this study was to identify hunter and trapper preferences/opinions relative to their satisfaction, success, motivations, and opinions/preferences on other wolf hunting and management issues. The survey sample was drawn from the MNDNR electronic licensing system (ELS). We drew a total sample of 1,200 individuals who participated in the wolf season, including 518 early-season hunters, 232 late-season hunters, and 450 trappers. Sample sizes were determined to provide an adequate number of respondents to generalize to the populations of hunters and trappers. Hunter sample

sizes were further based on the relative proportions of hunters participating in the early and late wolf seasons.

Data were collected using mail-back surveys following the process outlined by Dillman to enhance response rates. We constructed two relatively straightforward questionnaires, created personalized cover letters, and made multiple contacts with the targeted respondents. Potential study respondents were contacted four times between February 2013 and May 2013.

About one-third of trappers harvested a wolf, compared to less than 10% of hunters. Over 70% of respondents felt that the wolf population in the areas they hunt deer was too high or way too high, and substantive majorities thought the population should be reduced. On average, respondents agreed that wolves are an important part of the Minnesota environment, and that it was important to maintain a wolf population in Minnesota, but they also agreed that wolves compete too much with hunters for deer (*Odocoileus virginianus*). Respondents disagreed that they would be happier if there were no wolves in Minnesota.



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# Predicting and Mitigating Vulnerability of Trout Streams

<b>Investigators:</b>	Bruce Vondracek, Leonard Ferrington Jr., and James A. Perry (Cooperating Faculty)
<b>Students:</b>	Jennifer Cochran-Biederman, Ph.D. (Conservation Biology Program) William French, Ph.D. (Conservation Biology Program) Jane Mazack, M.S. (Water Resources Science Program)
<b>Duration:</b>	July 2010 to June 2013
<b>Funding source:</b>	Environment and Natural Resources Trust Fund as recommended by the Legislative Citizens Committee on Minnesota's Resources
<b>Project Location:</b>	Southeastern Minnesota Minnesota Cooperative Fish and Wildlife Research Unit

Trout require streams with excellent water quality that are fed by groundwater, which keep streams cold in summer but ice-free in winter. The trout sport-fishing industry is vulnerable to global climate changes that can increase stream temperatures, alter the cold-adapted aquatic insects that form trout diets, and affect trout



reproduction. Increasing air temperatures are predicted to increase the maximum water temperatures during summer, but also are very likely to dramatically change winter thermal conditions in trout streams. Our objectives were to: (1) develop air-water temperature relationships for 40 streams in southeastern Minnesota; (2) determine winter diets and growth of trout populations; (3) determine kinds, abundances, and timing of growth patterns of cold-adapted insects that are essential in winter diets of brown trout (*Salmo trutta*) in 36 streams in the Driftless Area Ecoregion; and (4) quantify drift and inver-

tebrate prey availability and selection by brown trout on a seasonal basis in five streams across three years in southeastern Minnesota. We found that the water temperature in streams with significant groundwater input remained relatively isothermal relative to significant annual fluctuations of air temperature. Brown trout grew during winter and had higher growth rates in winter in streams that remained relatively isothermal. Highest growth as achieved by trout in spring. Macroinvertebrate abundance was higher in winter in streams that remained relatively isothermal. However, diet composition varied

by season and stream. Although there was considerable variability in drifting and benthic prey communities within streams and seasons, few taxa were dominant in trout diets and the environment. Similarly, brown trout consistently favored only one or two taxa, including *Physella* and *Gammarus* across seasons. Foraging patterns suggested a preference toward benthic feeding. Overall electivity toward benthos and drift varied spatially and temporally with a negative relationship between the total proportion of prey available and prey

electivity. On a broad scale, there was no relationship between seasonal growth and prey electivity across all streams, but a positive relationship was detected within two of five streams. Understanding such seasonal patterns in prey availability and selection may provide insight into why brown trout demonstrate variable growth across streams with seemingly similar physical characteristics.

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# Survey of Minnesota Trappers

<b>Investigator:</b>	David C. Fulton
<b>Staff:</b>	Susan A. Schroeder, Ph.D. Research Associate
<b>Duration:</b>	June 2013 to May 2014
<b>Funding Source:</b>	Minnesota Department of Natural Resources
<b>Project Location:</b>	Minnesota Cooperative Fish and Wildlife Research Unit

This study sought to gather information from trappers in Minnesota. Specifically, the purpose of this study was to identify trapper preferences/opinions, species targeted, motivations, and opinions/ preferences on management issues. The target population included all individuals who had purchased a 2011-12 or 2012-13 trapping license. We sampled 1,400 individuals who participated in trapping stratified by region of residence (north and south). Sample sizes were determined to provide an adequate number of respondents to generalize to the populations of trappers by region. A total of 614 full-length surveys were returned for a response rate of 45.1% to the first three full-length survey mailings. To examine nonresponse bias, shortened surveys were sent to the individuals who had not responded.

**Participation in Trapping:**—On average, respondents had trapped in Minnesota for about 20 years. About 80% of respondents had trapped in Minnesota during the 2012-2013 season, and those who had trapped had trapped 36-38 days during the season. On average, weather conditions and time off from work or school had the greatest influence on when respondents trapped. Time off from family commitments had a greater influence on when respondents from the south region trapped, compared to those from the north. Observed sign and population of the target species at the location had the greatest influence on where respondents trapped. Abundance of public land had a greater influence

on where respondents trapped in the north region, whereas private land where respondents had permission to trap had a greater influence for respondents from the south region. Respondents from the south trapped most on private land they did not own, whereas respondents from the north region trapped most on private land they owned.

**Species Trapped:**—Statewide, respondents most frequently reported targeting raccoon (*Procyon lotor*; 74.0%), beaver (*Castor canadensis*; 62.5%), muskrat (*Ondatra zibethicus*; 62.5%), and mink (*Neovison vison*; 60.3%) during the 2013-2014 trapping season, but there was great variability in the proportion of trappers who targeted each species by region. Respondents from the south more frequently targeted badger (*Taxidea taxus*), mink, muskrat, opossum (*Didelphis virginiana*), and raccoon. Respondents from the north more frequently targeted beaver, bobcat, (*Lynx rufus*) fisher (*Martes pennant*), marten (*Martes Americana*), otter (*Lontra canadensis*), and weasel (*Mustela* spp.)

**Satisfaction with Trapping:**—Overall, 78% of respondents were slightly to very satisfied with the general trapping experience. Satisfaction with trapping harvest and regulations were lower, with 62% slightly to very satisfied with harvest and 46% slightly to very satisfied with regulations. Relative to respondents from the south region, respondents from the north were signifi-

cantly less satisfied with trapping regulations. Satisfaction was significantly positively related to measures of agency trust.

*Motivations for Trapping:*—Respondents were asked to rate the importance of 25 experiences to their satisfaction with trapping. Exploratory factor analysis identified four factors important to trapping satisfaction: (a) nature and wildlife based recreation, (b) affiliation with friends and family, (c) predator control, and (d) income. All factors other than income were, on average, rated somewhat to very important. All motivations were significantly more important to respondents from the south region.

*Importance of Trapping, Likelihood of Trapping in the Future:*—Respondents were asked to rate how important trapping was to them, using the scale 1 (one of the least important) to 5 (most important). Nearly half of respondents indicated that trapping was “one of the most important” activities. Trapping was slightly, but significantly, more important

to respondents from the south region. Respondents indicated that they were, on average, somewhat to very likely to trap in Minnesota in the future, with respondents from the south rating the likelihood significantly higher. Statewide, 77% of respondents said that it was very likely that they would trap in the future. The likelihood of participating in the future was significantly positively related to the importance of trapping to respondents and to satisfaction with the trapping experience. However, satisfaction with the harvest and regulations were not related to future participation.

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# Trout Angling in Minnesota

**Investigator:** David C. Fulton  
**Staff:** Susan A. Schroeder, Ph.D. Research Associate  
**Duration:** June 2011 to June 2013  
**Funding Source:** Minnesota Department of Natural Resources  
**Project Location:** Minnesota Cooperative Fish and Wildlife Research Unit

This study sought to gather information from anglers about trout fishing in Minnesota, with emphasis on the rainbow trout (*Onchorynchus mykiss*) fishery (Kamloops and steelhead) in Lake Superior and its tributaries. Specifically, the purpose of this study was to better understand angler participation in trout fishing at various locations, along with opinions about the use of trout stamp funds and willingness to maintain or enhance cold water management programs by increasing the price of a trout stamp. Surveys were sent to 2,500 Minnesota residents who purchased a trout stamp between 1 October 2011 and 30 September 2012. Data were collected using mail-back surveys following the process outlined by Dillman to enhance response rates. We constructed two relatively straightforward questionnaires, created personalized cover letters, and made multiple contacts with the targeted respondents. Potential study respondents were contacted three times between October 2012 and February 2013. A total of 1,202 full-length surveys and 207 non-response postcards were returned for an overall response rate of 59%.

Eighty-five percent of respondents had targeted trout during the 12 months from 1 October 2011 through 30 September 2012. Nearly one-third of respondents who had fished for trout during the noted timeframe had fished in one or more settings on or near Lake Superior. Nearly half of respondents who had fished Lake Superior during the study timeframe had targeted rainbow trout there. Nearly half of these individuals reported

targeting both Kamloops and steelhead, whereas about 20% reported targeting Kamloops exclusively and 34% reported targeting steelhead exclusively. Respondents were asked to indicate the percentage of Minnesota Department of Natural Resources trout stamp dollars they would like allocated to each of four categories: (a) development, restoration, maintenance, and preservation of trout streams and lakes, (b) identification and acquisition of easements and fee title along trout waters, (c) management activities and research for stream trout statewide (other than Lake Superior), and (d) management activities and research for trout and salmon in Lake Superior and its tributaries. Nearly all respondents wanted some funds allocated to development, restoration, maintenance, and preservation of trout streams and lakes, whereas about three-fourths of respondents wanted some funds allocated to: identification and acquisition of easements and fee title along trout waters, management activities and research for stream trout statewide (other than Lake Superior), and management activities and research for trout and salmon in Lake Superior and its tributaries. Of the three-fourths of respondents who indicated that some funds should be allocated to trout management for Lake Superior and its tributaries, most wanted funds evenly divided for management of Kamloops, steelhead, lake trout (*Salvelinus namaycush*), salmon (*Onchorynchus* spp.) and brook trout (*S. fontinalis*).

Respondents were asked to indicate their willingness to pay additional funds for: (a) a trout

stamp for maintaining management of trout fisheries statewide, (b) a trout stamp if it went specifically for maintaining current management of Kamloops in Lake Superior and its tributaries, and (c) a trout stamp if it went specifically for maintaining current management of steelhead in Lake Superior and its tributaries. Over half of respondents were willing to pay more for a trout stamp for maintaining management of trout fisheries statewide. About 20% were willing to pay more for a trout stamp if it went specifically for maintaining current management of steelhead in Lake Superior and its tributaries, and about 13% were willing to pay more for a trout stamp if it went specifically for maintaining current management of Kamloops in Lake Superior and its tributaries. The most common increase in the amount respondents indicated they would be willing to pay for a trout stamp was \$5.

Based on the 85,825 Minnesota resident anglers who purchased trout stamps during the study timeframe, we estimated numbers of anglers fishing different locations and potential trout stamp revenues. Based on our estimates, 26,177 Minne-

sota resident trout anglers fished in Lake Superior or its tributaries during the study timeframe. Rainbow trout anglers numbered 12,530 with 2,575 exclusively targeting Kamloops, 4,291 exclusively targeting steelhead and 5,664 targeting both Kamloops and steelhead. Estimates of Minnesota resident trout anglers targeting different fish species in Lake Superior and its tributaries ranged from 3,004 for pink salmon (*O. gorbuscha*) to 16,822 for lake trout. Most anglers had fished for multiple species.

Based on our willingness to pay calculations, the most common increase in the amount respondents were willing to pay for trout stamps was \$5. Assuming the same number of trout stamps are purchased, a \$5 increase in a trout stamp to maintain management of trout fisheries statewide could raise an additional \$429,125 (i.e., 85,825 resident trout anglers x \$5). This is likely an overestimate because a \$5 increase could price some anglers out of the market.

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# Trout Fishing in Minnesota 2013-14

<b>Investigator:</b>	David C. Fulton
<b>Staff:</b>	Susan A. Schroeder, Ph.D. Research Associate
<b>Duration:</b>	July 2013 to December 2014
<b>Funding Source:</b>	Minnesota Department of Natural Resources
<b>Project Location:</b>	Minnesota Cooperative Fish and Wildlife Research Unit

Approximately 90,000 to 100,000 Minnesota residents participate in trout fishing in the state of Minnesota each year. The primary objective of the social survey was to collect information generalizable back to the population of adult resident trout anglers who targeted streams in southeastern Minnesota and lakes in northcentral Minnesota. The target population included all Minnesota residents 18 years of age or older who purchased a stamp to pursue coldwater fish species, including trout, within the state of Minnesota. We used the public database of all licensed trout stamp purchasers in Minnesota for the 2013-2014 season ( $n = 94,293$ ) as the sampling frame. We drew a stratified, random sample from the database so that both genders and all ages are proportional to the population of study. The target final sample size was  $n = 1000$ , with two strata of  $n = 600$  and  $n = 400$  representing the inland lake anglers and southeast stream anglers in Minnesota.

The survey instrument collected information on:

- Trout fishing participation and experience in previous years
- Current trout fishing participation including number days, equipment used, and areas and species targeted in the state
- Satisfaction with trout fishing
- Motivations for trout fishing
- Involvement in trout fishing
- Catch orientation
- Attitudes toward trout management and stream easements

We developed a summary report for each of the two study strata.

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# Walk-in Access User Study

<b>Investigator:</b>	David C. Fulton
<b>Student:</b>	Megan Cross, M.S. (Natural Resources Science and Management)
<b>Duration:</b>	September 2012 to June 2014
<b>Funding Source:</b>	Minnesota Department of Natural Resources
<b>Project Location:</b>	Minnesota Cooperative Fish and Wildlife Research Unit

The Walk-In Access (WIA) program provides public access to private land and pays landowners by the acre to allow hunting access. The program is currently in its second year of a three-year Walk-In pilot program. The program has grown to more than 15,000 acres giving hunters access to more than 150 sites across 21 counties. Feedback indicates that the WIA program is working for both hunters and landowners.

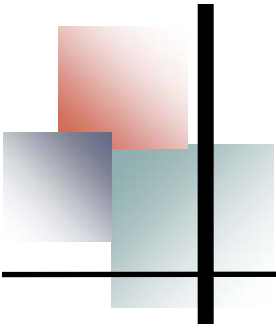
The majority of WIA acres are enrolled for multiple years and are also enrolled in a federal or state conservation program designed to maintain cover on the acres. The U.S. Department of Agriculture (USDA) funded the first two years of the program and the Minnesota Legislature has approved additional funding for WIA. Hunter support is key to the program. Using the land, respecting the land and identifying a method to fund the program for the long term will be essential to build the future of the program.

Objectives of the study were to:

- 1) Develop a survey instrument and self-administered mail back questionnaire to WIA users to determine basic attitudes and support for the WIA program
- 2) Develop a dataset for analysis so that data can be presented at Legislative hearings, public meetings, and to wildlife staff

The majority of participants in the WIA program targeted pheasant (*Phasianus colchicus*), waterfowl, and deer. Most were satisfied with their experiences at WIAs, supportive of the program, and wanted to see it expand. About 75% indicated they would pay an annual fee for access to WIAs, with the average amount slightly less than \$10.





# Ongoing Research



# Applied Ecology





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# Delineating Sandhill Crane Populations in Minnesota

<b>Investigators:</b>	David E. Andersen and John Fieberg (Cooperating Faculty)
<b>Collaborators:</b>	Tom Cooper (U.S. Fish and Wildlife Service), Jeff Lawrence (Minnesota Department of Natural Resources), Dave Fronczak (U.S. Fish and Wildlife Service)
<b>Students:</b>	David Wolfson, M.S. (Natural Resources Science and Management)
<b>Duration:</b>	May 2014 to June 2017
<b>Funding source:</b>	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-Citizens Committee on Minnesota Resources
<b>Project Location:</b>	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 (*Grus 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 19<sup>th</sup> 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-west 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. Yet, 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.





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# 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 southeast 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 ma-

tured 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 habitat 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 is scheduled for completion in early 2015. A companion project on migratory connectivity and full-life-cycle ecology is ongoing.

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# 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. A manuscript is now preparation for the *Journal of Chemical Ecology*. Studies in the upcoming year will examine other algal secondary metabolites as feeding stimuli and attractants.

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# 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. Historical causes of colony site abandonment may include changing lake levels, spread of invasive wetland plants, and encroachment of human development or agriculture. Aerial photographs and remote sensing data provide a historical record of site conditions before and after breeding colony sites were abandoned.

Study of current black tern-habitat relationships is being conducted through validation and refinement of a landscape suitability index for black terns. The existing index was developed by the regional Joint Venture in 2007 as part of its Waterbird Habitat Conservation Strategy and has not been tested previously. Surveys were conducted in June and July of 2013 and 2014 at sites with a range of landscape suitability index scores. Results of the 2013 surveys suggested that the existing index was basically correct in structure, but that re-scaling and incorporation of additional landscape variables would lead to



an index with greater predictive ability. An alternative index was developed in the winter of 2014, and 2014 field surveys occurred at sites with a range of suitability scores according to the new index as well as the old. The final products of this project will include publications on the findings, as well as a map depicting spatial variation in landscape suitability for black tern nesting that can be used as a tool for conservation planning.

The planned two seasons of field surveys for black tern presence have been completed to address project questions about current black tern-habitat relationships. Data analysis last fall suggested that both models of habitat relationships under consideration are equally able to predict



black tern colony presence. This fall, interpretation of these results will continue. All datasets necessary for analyzing historical black tern habitat relationships have been compiled and statistical analysis for this component of the project is ongoing.



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# 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 2016  
**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 (U-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 Indianan

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.

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# 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)

**Students:** 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 northwest Minnesota.

The Prairie Pothole Region, an important breeding area for many marshbird species, is facing seri-

ous 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 interspersion 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.

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

<b>Investigator:</b>	David E. Andersen and Henry M. Streby (National Science Foundation Post-doctoral Fellow)
<b>Collaborators:</b>	David A. Buehler (University of Tennessee) and Petra B. Wood (West Virginia Cooperative Fish and Wildlife Research Unit)
<b>Students:</b>	Gunnar R. Kramer, M.S. (Natural Resources Science and Management)
<b>Duration:</b>	July 2013 to December 2016
<b>Funding source:</b>	U.S. Geological Survey, Science Support Partnership
<b>Project Location:</b>	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 midday 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 geo-



locators because (1) they have high nesting territory fidelity (i.e., surviving adults usually return to nest in the same territory in successive years), thereby ensuring 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 geocator 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.

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# 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

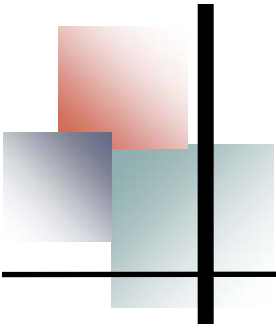
The Colville River Special Area (CRSA) was designated in 1977 to protect nesting and foraging habitat of the then-endangered arctic peregrine falcon (*Falco peregrinus tundrius*). The CRSA is approximately 2.44 million acres, and provides nesting habitat for approximately one-fourth of Alaska's arctic 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.





## Ongoing Research



Human Dimensions, Management,  
and Conservation





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# 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. A survey following the 2010 season is currently being analyzed. In addition, a se-

ries 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 conducted a surveys following the 2010 and 2011 waterfowl seasons. This study will allow continued long-term monitoring of trends in hunter satisfaction and attitudes toward management.

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# Airspace as Habitat: Methods for Assessing Use by Animals

**Investigator:** James Perry (Cooperating faculty)  
**Collaborators:** Douglas H. Johnson  
**Duration:** March 2014 to December 2016  
**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 1000 bat, 9000 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, con-

cerns exist about the effects on wildlife, particularly 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 productions 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 have 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](http://ebird.org)) and cooperative monitoring projects such as Oldbird ([Oldbird.org](http://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

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# 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 community.

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 FBCP 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).



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# Deer Goal Setting Surveys and Deer Hunter Attitude Research

**Investigator:** David C. Fulton  
**Collaborators:** Eric Walberg, M.S. (Natural Resources Science and Management)  
Leslie McInenly, Ph.D. (Natural Resources Science and Management)  
**Duration:** May 2014 to December 2016  
**Funding source:** Minnesota Department of Natural Resources

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 goal of our study is to enhance our understanding of deer hunter attitudes and perceptions of deer populations, hunter motivations and satisfaction, agency trust, governance, and other policy issues related to deer population management

statewide. Although statewide issues vary geographically, the specific objectives of this study are to:

- Perfect a mixed-mode survey design that can be implemented in other surveys
- Use study results to implement regulatory harvest changes that achieve population objectives

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# 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 2015  
**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 wolf hunting and trapping; and a study of deer hunter behavior and management preferences in southeastern Minnesota; and a statewide study of coldwater anglers in Minnesota; a study of Minnesota trappers; a study of trout coldwater anglers in southeast and central Minnesota; and a study of Minnesota spring turkey hunters.

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# Minnesota Fisheries Habitat Study

<b>Investigator:</b>	David C. Fulton
<b>Staff:</b>	Susan A. Schroeder, Ph.D. Research Associate
<b>Duration:</b>	June 2014 to December 2015
<b>Funding Source:</b>	Minnesota Department of Natural Resources
<b>Project Location:</b>	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 was 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 ( $M = 3.2$ ). 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 Im-*

*prove 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 totally 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.

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# 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, we have been moving from conservative management 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 we hunt turkeys in Minnesota now that the state is essentially fully occupied and populations in many areas have reached social or biological carrying capacities.

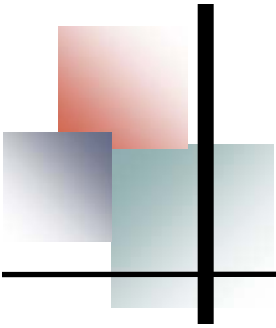
As most of the administrative changes have been made, a comprehensive survey is needed of turkey hunters before additional changes can be considered. A random survey of turkey hunter attitudes toward possible regulatory changes and further expansion of turkey hunting opportunity is needed to take this 'next step' in Minnesota turkey hunting season management.

The goal of our study is to enhance understanding of turkey hunter attitudes and perceptions of regulatory alternatives. Specific objectives of this study are to:

- 1) Critically evaluate Minnesota's spring turkey hunting season and determine if changes are appropriate
- 2) Examine alternatives that provide more opportunity, improve hunter satisfaction, remain safe, and sustain the population at the goal level
- 3) Use study results to implement regulatory harvest changes that achieve hunter and turkey population objectives



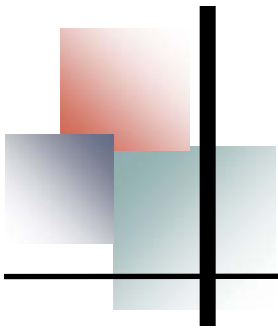




# Activities







# Publications

## Peer-Reviewed

### 2013

Beck, M.W., **B. Vondracek**, and L.K. Hatch, and J. Vinje. 2013. Semi-automated analysis of high-resolution aerial images to quantify docks in Upper Midwest glacial lakes. *ISPRS Journal of Photogrammetry and Remote Sensing* 81:60–69.

Beck, M.W., **B. Vondracek**, and L.K. Hatch. 2013. Between- and within-lake responses of macrophyte richness metrics to shoreline development. *Lake and Reservoir Management* 29:179–193.

Beck, M.W., **B. Vondracek**, and L.K. Hatch. 2013. Environmental clustering of lakes to evaluate performance of a macrophyte index of biotic integrity. *Aquatic Botany* 108:16-25.

Bruggink, J.G., E. Oppelt, K.E. Doherty, **D.E. Andersen**, J. Meunier, and R.S. Lutz. 2013. Fall survival of American woodcock in the western Great Lakes region. *Journal of Wildlife Management* 77:1021-1030. DOI: 10.1002/jwmg.547

Krider, L.A., J.A. Magner, J. Perry, **B. Vondracek**, and L.C. Ferrington, Jr. 2013. Air - water temperature relationships in the trout streams of southeastern Minnesota's carbonate - sandstone landscape. *Journal of the American Water Resources Association* 49:896-907.

Loomis, J.H., H.L. Schramm, Jr., **B. Vondracek**, P.D. Gerard, and C.J. Chizinski. 2013. Effect of simulated live-release walleye tournaments on survival and three indicators of physiological stress. *Transactions of the American Fisheries Society* 142:868-875.

Nelson, M.R. and **D.E. Andersen**. 2013. Do singing-ground surveys reflect American woodcock abundance in the western Great Lakes region? *Wildlife Society Bulletin* 37:585-595. DOI: 10.1002/wsb.288

Reiter, M.E. and **D.E. Andersen**. 2013. Evidence of territoriality and inter-specific interactions from point-pattern analyses of arctic-nesting geese. *PLoS ONE* 8(12): e81029. DOI:10.1371/journal.pone.0081029

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Schroeder, S.A., **D.C. Fulton**, J.S. Lawrence, and S.D. Cordts. 2013. Identity and specialization as a waterfowl hunter. *Leisure Sciences* 35:218-234.

Schroeder, S.A. and **D.C. Fulton**. 2013. Public lakes, private lakeshore: modeling protection of native aquatic plants. *Environmental Management* 52:99-112.

Schroeder, S.A. and **D.C. Fulton**. 2013. Comparing catch orientation among walleye, northern pike and bass anglers. *Human Dimensions of Wildlife* 18:355-372.

Streby, H.M. and **D.E. Andersen**. 2013. Movements, cover-type selection, and survival of fledgling ovenbirds in managed deciduous and mixed-coniferous forests. *Forest Ecology and Management* 287:9-16. DOI: 10.1016/j.foreco.2012.08.046

Streby, H.M. and **D.E. Andersen**. 2013. Survival of fledgling ovenbirds: influences of habitat characteristics at multiple spatial scales. *Condor* 115:403-410. DOI: 10.1525/cond.2013.110178

Streby, H.M. and **D.E. Andersen**. 2013. Testing common assumptions in studies of songbird nest success. *Ibis* 155:327-337. DOI: 10.1111/ibi.12018

Streby, H.M., S.M. Peterson, C.F. Gesmundo, M.K. Johnson, A.C. Fish, J.A. Lehman, and **D.E. Andersen**. 2013. Radio-transmitters do not affect seasonal productivity of female golden-winged warblers. *Journal of Field Ornithology* 84:316-321. DOI: 10.1111/jfo.12032

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## 2014

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

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**Vondracek, B.**, J.D. Koch, and M.W. Beck. 2014. A comparison of survey methods to evaluate macrophyte index of biotic integrity performance in Minnesota lakes. *Ecological Indicators* 36:178-185.

## Book Chapters, Symposium Proceedings

Dolph, C.L., S.L. Eggert, J. Magner, L.C. Ferrington, Jr., and **B. Vondracek**. *Accepted*. Reach-scale stream restoration in agricultural streams of southern Minnesota alters structural and functional responses of macroinvertebrates. *Freshwater Science*.

Manfredo, M.J., T. Teel, M. Gavin, and **D. Fulton**. 2014. Considerations in representing human individuals in social ecological models. Pages 137-158 in Manfredo, M.J., Vaske, J.J., Reckemmer, A., Duke, E.A. (editors). *Understanding Society and Natural Resources: Forging New Strands of Integration Across the Social Sciences*. Springer, New York, New York.

## In Press, Review, or Revision

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

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Bruskotter, J.T., A. Singh, **D.C. Fulton**, and K. Slagle. *In Press*. Assessing tolerance for wildlife: clarifying relations between concepts and measures. *Human Dimensions of Wildlife*.

Papenfuss, J.T., N. Phelps, **D.C. Fulton**, and P.A. Venturelli. *In Press*. Smartphones reveal angler behavior: a case study from an Alberta-based fishing app. *Fisheries*.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. *Accepted*. 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*.

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

Peterson, S.M., H.M. Streby, J.A. Lehman, G.R. Kramer, and **D.E. Andersen**. *In Review*. Ecology of brood division in golden-winged warblers. *Animal Behavior*.

Pradhananga, A., M. Davenport, **D.C. Fulton**, G. Maruyama, and D. Current. *In Review*. An integrated moral obligation model for landowner conservation behavior. *Society & Natural Resources*.

Schroeder, S.A. and **D.C. Fulton**. *In Press*. A replication of a factor analysis of motivations for trapping. *Human Dimensions of Wildlife*.

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Streby, H.M., D.A. Buehler, and **D.E. Andersen** (editors). *In Press*. Ecology and conservation of golden-winged warblers. *Studies in Avian Biology*.

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

Streby, H.M., R.W. Rohrbaugh, D.A. Buehler, **D.E. Andersen**, R. Vallender, D.I. King, J.L. Larkin, and T.



Will. *In Review*. Research on golden-winged warblers: recent progress and current needs. *Studies in Avian Biology*.

## Awards and Honors

2012 Minnesota Award, Minnesota Chapter of The Wildlife Society (D.E. Andersen—2013)

Cooperative Research Units Program “Excellence in Science Award” (2013)

Award of Excellence, Minnesota Chapter of the American Fisheries Society (Bruce Vondracek—2014)

### 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.

Cyr, T., S.K. Windels, R. Moen, J. Warmbold. 2014. Diversity and abundance of terrestrial gastropods in Voyageurs National Park: implications for risk of individual moose to *Parelaphostrongylus tenuis* infection. *Alces* 50:121-132.

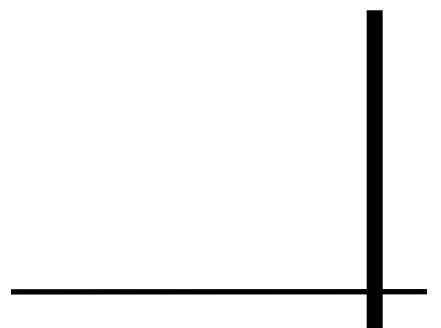
Hansen, A., R. Ghosal, J. Caprio, A.W. Claus, and P.W. Sorensen. 2014. Anatomical and physiological studies of bigheaded carps demonstrate that the epibranchial organ functions as a pharyngeal taste organ. *Journal of Experimental Biology* 217:3945-3954

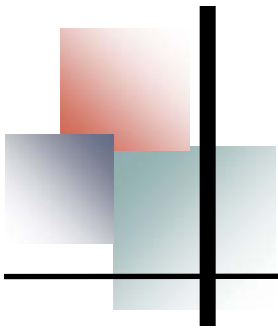
Olson, B. 2014. Characteristics and modeling of the thermal landscape for moose at Voyageurs National Park . M.S. thesis, Bemidji State University, Bemidji, Minnesota.

Olson, B., S.K. Windels, M. Fulton, R. Moen. 2014. Fine-scale temperature patterns in the southern Boreal Forest: implications for the cold-adapted moose. *Alces* 50:105-120.

VanderWaal, K.L., S.K. Windels, B.T. Olson, T. Vannatta, R. Moen. 2015. Landscape influence on spatial patterns of meningeal worm and liver fluke infection in white-tailed deer. *Parasitology* 142:706-718.

Wyman, K. E., and F. J. Cuthbert. 2014. Black tern habitat in the North American Great Lakes region: Aamodel validation study [Abstract]. Wader Study Group Bulletin 121:39.





# Completed Theses and Dissertations of Minnesota Coop Unit Students

**2013**

**Beck, M. W.** 2013. Minnesota macrophytes: linking aquatic plants, lake health, and human activities. Ph.D. Dissertation, University of Minnesota, St. Paul, Minnesota, USA. 215 pp. (Bruce Vondracek)

Aquatic plants (macrophytes) are an undervalued but critically important component of Minnesota's lakes. The macrophyte Index of Biotic Integrity (IBI) was developed to evaluate lake health using metrics that describe the condition of the aquatic plants. However, a detailed evaluation to determine whether the index can explicitly link lake condition with activities that negatively impact lake resources has not been conducted. This information is necessary before the IBI can be used to develop biological standards required under the federal Clean Water Act. The goal of this dissertation was to develop and implement a framework for identifying the strengths and weaknesses of the index to inform biological assessment. Four chapters describe research to fulfill this goal. The first chapter identifies comparable groups of lakes using a set of environmental variables that influence macrophyte community composition. The second chapter describes the development and application of semi-automated techniques for quantifying potential stressors of aquatic macrophytes in nearshore areas of lakes, such as docks and boat lifts. The third chapter provides a complementary analysis to chapter two by examining the relationships of shoreline development at different spatial scales with metrics describing macrophyte richness. The fourth and final chapter develops modeling techniques to quantify the relative effects of multiple stressors on the IBI. Specifically, I have used artificial neural network models that can 'learn' inherent data structures and are especially useful for modeling noisy data with non-linear relationships. Outcomes from my dissertation will inform management agencies on the most appropriate use of the index, which will ultimately facilitate the protection and restoration of Minnesota's lakes.

**Keville, J.** 2013. Effects of residential shoreline development on near shore aquatic habitat in Minnesota lakes. M. S. Thesis, University of Minnesota, St. Paul, Minnesota, USA. 47 pp. (Bruce Vondracek)

The littoral zone contains all of the vegetation within a lake and is critical to the physical and biological integrity of lentic water bodies. Aquatic macrophytes stabilize the shoreline and support macroinvertebrate and fish communities by providing spawning substrate, feeding area, and refuge from predators. Riparian alterations associated with shoreline residential development have been shown to decrease aquatic vegetation and coarse woody structure (CWS). As the extent of lakeshore development increases, understanding the consequences of site- and lake-level shoreline alterations is necessary to better guide management decisions. The intensity and type of alterations may be an important factor regarding the extent of effects on littoral habitat. We investigated site-scale effects of lakeshore development on near-shore habitat

across 10 northern Minnesota lakes using the Minnesota Department of Natural Resources's Score Your Shore (SYS) survey, to assess development intensity. We also examined lake-wide effects of development density. Study lakes were of similar size, class, and geology and represented a range of shoreline development. Developed sites had significantly lower macrophyte species richness than undeveloped sites. Emergent and floating-leaf macrophyte biovolume was also lower at developed sites. Coarse woody structure (CWS) density was lower at developed sites than undeveloped sites. SYS score was a significant factor in models of most macrophyte community variables, supporting the hypothesis that site-scale development intensity is related to littoral vegetation. Negative effects of lake-wide development were not detected in whole lake macrophyte and fish community metrics.

**Lepore, J.** 2013. Local and cumulative influences of docks on littoral habitat structure. M. S. Thesis, University of Minnesota, St. Paul, Minnesota, USA. 58 pp. (Bruce Vondracek)

Littoral habitat is a critical component of lake ecosystems. Aquatic macrophytes and coarse woody structure provide refuge, foraging area, and spawning substrate for many fish species. The expansion of residential development along Minnesota lakeshores has led to substantial habitat modification, and is considered a threat to lake fish communities. Previous studies have linked lakeshore development to reductions in abundance of aquatic vegetation and coarse woody structure; however, few studies have quantified the specific influence of docks on aquatic habitat structure. We assessed coarse woody structure and three measures of macrophyte abundance across three scales of development in 11 Minnesota lakes, using docks as an index of development. All four structural habitat components were significantly influenced by distance to the nearest dock structure. Coarse woody structure and emergent and floating-leaf vegetation were reduced at sites where docks were present. Site-level abundance of coarse woody structure and presence of emergent species were significantly and negatively related to lake-wide dock density, indicating that these habitat components are particularly vulnerable to development. These findings suggest that management of lake fish habitat should address both local and lake-wide scales of development. In addition, dock size restrictions could minimize impacts to critical habitat structure.

**Mazack, J.E.** 2013. Emergence, survival, and longevity of adult *Diamesa mendotae* Muttkowski (Diptera: Chironomidae) in groundwater-fed streams. M. S. Thesis, University of Minnesota, St. Paul, Minnesota, USA. 32 pp. (Bruce Vondracek)

Groundwater-fed streams, which remain cold in summer but ice-free in winter, provide ideal habitat for ultra-cold stenotherm insects. *Diamesa mendotae* Muttkowski (Diptera: Chironomidae) is a winter-active species common to groundwater-fed streams in Minnesota. In order to improve the understanding of the winter dynamics of this species, we studied the influence of temperature on its emergence, survival, and longevity. The winter emergence dynamics of *D. mendotae* and other winter-active chironomids were documented by collecting surface-floating pupal exuviae samples from 24 groundwater-fed streams in southeastern Minnesota. Early, mid, and late winter samples were collected from each stream, and average weekly water temperatures at collection were estimated using air-water temperature regressions. The results of this assessment indicate that *D. mendotae* abundance is related to both groundwater inputs and water temperature. Additionally, emergence patterns of other genera were also related to estimated water temperatures, showing significant thermal partitioning within the chironomid community. Field collections of adult *D. mendotae* were used to determine survivorship under long-term exposure to controlled sub-freezing conditions. Batches of specimens were placed into a controlled treatment chamber at -5°C after collection for between 7 and 70 days. Survivorship of sub-freezing treatment was negatively related to treatment length, although some individuals survived sub-freezing temperatures for 70 days. Post-treatment longevity decreased with increased exposure to sub-freezing temperatures; howev-

er, total longevity increased with treatment time. These studies indicate that *D. mendotae* are well adapted to the cold winter-weather conditions across southeastern Minnesota, suggesting that adults may be able to survive long periods of extreme temperature conditions in the winter to increase their ability to successfully reproduce.

## 2014

**Kyle O. Daly.** 2014. Assessment of techniques to evaluate American woodcock population response to Best Management Practices applied at the demonstration area scale. M.S. thesis, University of Minnesota, St. Paul, Minnesota. 98pp. (David Andersen)

American woodcock (*Scolopax minor*; hereafter, woodcock) have experienced long-term population declines across their breeding range based on the American woodcock Singing-ground Survey. Wing-collection surveys have also indicated a decline in woodcock recruitment across their range, especially in the Central Management Region. These declines have been widely attributed to loss or alteration of young forest cover types that support woodcock reproduction across their breeding range. In response to these apparent declines in woodcock abundance and recruitment, a system of woodcock habitat demonstration areas is being developed throughout the woodcock breeding range where specific Best Management Practices (BMPs) are applied with the goal to stabilize and ultimately increase populations. Application of BMPs at a demonstration-area scale (~200–800 ha) is designed to positively influence woodcock population growth by improving habitat quality and abundance at a landscape scale. However, how woodcock vital rates are influenced by BMPs applied at a landscape scale is not fully understood, and techniques used to evaluate woodcock populations at the demonstration-area scale have not been assessed. The objectives of our research were to (1) estimate survival of adult females, nests, and juveniles using radio telemetry and assess relationships between survival and vegetation structure resulting from BMPs, life history traits, and weather, (2) directly estimate a measure of woodcock recruitment (juveniles/adult female during late summer) at a landscape scale by using survival estimates in a population model, and use direct estimates of recruitment to evaluate the accuracy and usefulness of indirect estimates of recruitment based on less costly and effort-intensive methods (specifically mist netting and night lighting on summer roosting fields), and (3) test for effects of radio transmitters on juvenile woodcock survival.

In 2011 and 2012, we radio-marked and tracked 41 adult female and 73 juvenile woodcock, and monitored 51 broods and 48 nests. Breeding season cumulative survival for adult females was consistent between years, whereas nest and juvenile survival were related to year. Juvenile survival was also positively related to age, minimum temperature, and stem density, and negatively related to precipitation. We found no effects of radio-marking juvenile woodcock. In July of 2011 and 2012, we captured 204 woodcock using mist nets during crepuscular movements from diurnal feeding cover to roosting fields and 69 woodcock via night-lighting on roosting fields. Our recruitment estimates (juveniles/adult female) derived from our demographic model were higher in 2012 than 2011 due to higher nest and juvenile survival rates during that year, suggesting that nest and juvenile survival, and factors related to nest and juvenile survival, may be key to understanding woodcock population ecology. Our assessment of indirect methods to estimate woodcock recruitment at a landscape scale indicated that the indirect methods we considered of estimating woodcock recruitment at a landscape scale are likely not reliable proxies for estimating recruitment directly.

**French, W.E.** 2014. Winter ecology of Brown Trout in southeastern Minnesota streams. Ph.D. Dissertation, University of Minnesota, St. Paul, Minnesota, USA. 99 pp. (Bruce Vondracek)

Winter has traditionally been considered a period of dormancy for stream dwelling trout in temperate latitudes. Seasonal changes including low water temperatures, ice formation, and reduced prey availability from aquatic and terrestrial sources often contribute to reductions in trout growth and survival. Consequently, winter has rarely been the focus of study by fisheries scientists, and relatively little information is available regarding stream trout during winter. However, because of the potential impact on stream trout growth and survival, winter is an important season for trout populations and of particular interest to fisheries managers. The goal of this dissertation was to examine winter trophic ecology of stream dwelling trout populations, and the potential of groundwater input to buffer stream water temperatures and trout from the environmental conditions typically associated with winter. This dissertation consists of three chapters that contribute towards this goal. The first chapter examines winter diet of Brown Trout by quantifying trout consumption, identifies important winter prey taxa, and compares diet composition among a number of trout populations. The second chapter describes Brown Trout winter growth and condition, and examines the influence of groundwater buffering and trout diet composition on growth and condition. The third and final chapter uses stable isotope analyses to examine seasonal variation in Brown Trout diets, and the position of trout within winter food webs of groundwater dominated streams. My dissertation will help managers predict the potential effects of winter on important recreational stream trout fisheries, and allow informed management decisions incorporating the best available information.

**David L. Fronczak.** 2014. Distribution, migration chronology, and survival rates of Eastern Population sandhill cranes. M.S. thesis, University of Minnesota, St. Paul, Minnesota. 64pp. (David Andersen)

The Eastern Population (EP) of greater sandhill cranes (*Grus canadensis tabida*; hereafter, cranes) is rapidly expanding in size and geographic range. The core of their breeding range is in Wisconsin, Michigan, and southern Ontario, Canada. Little information exists regarding the geographic extent of breeding, migration, and wintering ranges of EP cranes, or migration chronology and use of staging areas. In addition, there are no published estimates of survival rates for EP sandhill cranes. To address these information needs we trapped and deployed solar Global Positioning System (GPS) Platform Transmitting Terminals (PTTs) on 29 sandhill cranes from December 2009 through September 2011, primarily in known fall and winter concentration areas, to assess movements throughout the year. This thesis explores EP sandhill crane distribution during the breeding season and winter, migratory routes, and migration chronology (Chapter 1) and also estimates survival rates during the study period (Chapter 2). EP cranes settled on summer areas beginning mid-March in Minnesota (11%), Wisconsin (36%), Michigan (29%), and Ontario (21%). On average, PTT-tagged cranes arrived at their winter terminus beginning mid-December in Indiana (29%), Kentucky (11%), Tennessee (79%), Georgia (11%), and Florida (32%). Twenty-three marked cranes returned to their summer area's calculated mean center after a second spring migration. The average linear distance between individual estimated mean activity centers for a summer area was 1.34 km (range: 0.01 – 7.82 km). EP cranes used fall and spring migration routes similar to those previously documented. Annual survival rates (from October through September) were estimated at 0.921 (2010-2011; SE = 0.058) and 0.913 (2011-2012; SE = 0.087) using the known fates platform in Program MARK (Chapter 2).

**Lueck, A.** 2014. River and streams conditions of Minnesota, and their impact on aquatic biological communities. M. S. Thesis, University of Minnesota, St. Paul, Minnesota, USA. 46 pp. (Bruce Vondracek)



The Minnesota Pollution Control Agency's (MPCA) biological monitoring has employed probabilistic surveys for two statewide stream surveys. The first survey ran between 1996 through 2005, the second survey was conducted in 2010-2011. During these surveys we collected data on fish communities, aquatic macroinvertebrate communities, water chemistry, stream habitat, riparian conditions, and watershed land use. The probabilistic survey design enabled us to characterize the condition of rivers and streams throughout the entire state of Minnesota by sampling relatively few sites. To add greater definition to this study, Minnesota was divided into three geographic regions. Utilizing these regions we illustrated river condition patterns found between regions, and between each region and statewide conditions. Another valuable step in this process was to then take the data and investigate how these conditions found can influence aquatic communities. Biological data collected from each site was evaluated using MPCA's index of aquatic integrity thresholds and then compared to a condition, such as percent agricultural land use within a sites watershed, using a conditional probability analysis. The conditional probability analysis finds the likelihood of sampling a biological community that meets expectation with a given degree of stress. This study has laid a foundation of conditions for rivers and streams of Minnesota, and has related those conditions to their possible impacts on the biological health.

**Sean M. Peterson.** 2014. Landscape productivity and the ecology of brood division in golden-winged warblers in the western Great Lakes region. M.S. thesis, University of Minnesota, St. Paul, Minnesota. 174pp. (David Andersen)

Brood division in the post-fledging period is a widespread avian behavior that is not well understood. Brood division has been reported in Golden-winged Warblers (*Vermivora chrysoptera*), but it is not known how widespread this behavior is, whether males and females exhibit different strategies related to parental care and habitat use, or how brood division might influence management strategies. I radio-marked fledglings and monitored divided broods of Golden-winged Warblers from fledging until independence from adult care at three sites--two in northern Minnesota, USA and one in southeastern Manitoba, Canada--from 2010-2012 to assess differences in strategies between male and female parents and to consider possible management implications. Male- and female-reared subbroods exhibited significantly different space use during the dependent post-fledging period despite similar fledgling survival, cover type use, and microhabitat use. By independence, female-reared subbroods traveled over twice as far from the nest ( $418 \pm 61$  m) as male-reared subbroods ( $192 \pm 36$  m). Because parental strategies differ between sexes with regard to movement patterns, I suggest incorporating the differences in space use between sexes in future management plans for Golden-winged Warblers and other species that employ brood division. Specifically, management actions might be most effective when they are applied at spatial scales large enough to incorporate the habitat requirements of both sexes throughout the entire reproductive season.

Post-fledging brood division is a poorly understood, yet widespread avian behavior. Brood division has been observed in Golden-winged Warblers (*Vermivora chrysoptera*), although the differences in parental care between adult males and females, the fitness benefits of this behavior, and the mechanisms explaining differences in space use between male- and female-reared subbroods are unknown. From 2010 to 2012, I monitored radio-marked Golden-winged Warbler fledglings from fledging (i.e., leaving the nest) until independence from adult care at three sites in the western Great Lakes region of North America. I assessed differences in parental care between male and female parents and considered the possible evolutionary implications of my observations. I observed no significant difference in provisioning, parental attendance, and fledgling begging between males and females. However, female-reared subbroods exhibited a period of consistent directional movement on days 8 – 10 after fledging, resulting in females raising their subbroods farther from the nest than males. Spatial division in Golden-winged Warblers may be related to extensive crècheing (i.e., association with non-related broods to improve foraging efficiency and

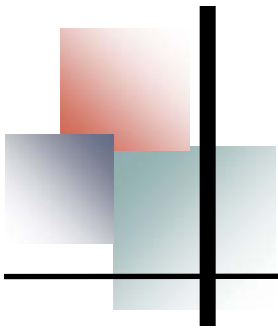
predation defense) in the post-fledging period.

The relationship between landscape structure and composition and full-season productivity (i.e., young raised to independence from adult care) for most birds is poorly understood. For species of high conservation concern, insight into how productivity is related to landscape structure and composition can be used to develop more effective conservation strategies that increase recruitment. I monitored nest productivity and fledgling survival of Golden-winged Warblers (*Vermivora chrysoptera*), a species of high conservation concern, in managed forest landscapes at two sites in northern Minnesota, USA, and one site in south-eastern Manitoba, Canada from 2010 to 2012. I used logistic exposure models to identify the influence of landscape structure and composition on nest productivity and fledgling survival. I used those models to predict spatially-explicit, full-season productivity across my study sites to identify areas of low relative productivity that could be targeted for management. I then used my models of spatially-explicit, full-season productivity to simulate the impact of potential management actions on my study sites with the goal of increasing total population productivity. Unlike previous studies that suggested wetland cover types provide higher-quality breeding habitat for Golden-winged Warblers, my models predicted 14% greater productivity in upland cover types. Simulated succession of a 9-ha grassland patch to a shrubby upland suitable for nesting, increased the total number of fledglings produced by that patch and adjacent upland shrublands by 30%, despite decreasing individual productivity by 13%. Further simulated succession of the same patch described above into deciduous forest reduced the total number of fledglings produced to independence on a landscape by 18% because of a decrease in the area available for nesting. Simulated reduction in the cumulative length of shrubby edge within a 50-m radius of any location in my landscapes from 0.6 km to 0.3 km increased full-season productivity by 5%. My models demonstrated that the effect of any single management action depended on the context of the surrounding landscape. I concluded that spatially-explicit, full-season productivity models that incorporate data from both the nesting and post-fledging periods are useful for informing breeding habitat management plans for Golden-Winged Warblers and that similar models can benefit management planning for many other species of conservation concern.

#### **STUDENT AWARDS**

Henry M. Streby. 2014. Young Professional Award, Cooper Ornithological Society

Kyle O. Daly. 2013. Student Conservationist Award, Minnesota Chapter of The Wildlife Society



# Presentations

## Invited Presentations

### 2013

Cochran-Biederman, J., K. Grimlund, W. French, and **B. Vondracek**. 2013. Diet and growth of brown trout in southeastern Minnesota: seasonal patterns across two years. 6<sup>th</sup> Annual Driftless Area Symposium. LaCrosse, Wisconsin.

Fulton, D.C. 2013. Maintaining a waterfowl hunting tradition and building a tradition of viewing. North American Duck Symposium/Ecology and Conservation of North American Waterfowl. Memphis, Tennessee.

Fulton, D.C. 2013. Choice experiments: understanding preferences and desires of the waterfowl management community. North American Duck Symposium/Ecology and Conservation of North American Waterfowl. Memphis, Tennessee.

French, W.E., **B. Vondracek**, L.C. Ferrington Jr., J. Finlay, and D.J. Dieterman. 2013. Winter diet and growth of brown trout in a groundwater-dominated stream: inferences from stomach content and stable isotope analysis. 6<sup>th</sup> Annual Driftless Area Symposium. LaCrosse, Wisconsin.

Mazack, J.E., L. Krider, **B. Vondracek**, and L.C. Ferrington, Jr. 2013. Overwinter emergence dynamics of adult Chironomidae in groundwater-fed streams of southeastern Minnesota. 6<sup>th</sup> Annual Driftless Area Symposium. LaCrosse, Wisconsin.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2013. Influence of landscape composition on golden-winged warbler full-season productivity. 131<sup>st</sup> Stated Meeting of the American Ornithologists' Union and 83<sup>rd</sup> Annual Meeting of the Cooper Ornithological Society. Chicago, Illinois.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2013. Sex-based differences in strategies of post-fledging parental care in golden-winged warblers. 131<sup>st</sup> Stated Meeting of the American Ornithologists' Union and 83<sup>rd</sup> Annual Meeting of the Cooper Ornithological Society. Chicago, Illinois.

Reiter, M.E. and **D.E. Andersen**. 2013. Sympatric nesting Eastern Prairie Population Canada geese and lesser snow geese on the Hudson Bay Lowlands: nest survival and spatial distribution. Eastern Prairie Population Committee of the Mississippi Flyway Council Technical Section. Webinar.

Streby, H.M., S.M. Peterson, and **D.E. Andersen**. 2013. Golden-winged warbler post-fledging habitat use and survival in the western Great Lakes region. 131<sup>st</sup> Stated Meeting of the American Ornithologists' Union and 83<sup>rd</sup> Annual Meeting of the Cooper Ornithological Society. Chicago, Illinois.

## 2014

**Fulton, D.C.** 2014. Influences on private landowner behaviors to manage wildlife habitat. 79<sup>th</sup> North American Wildlife and Natural Resources Conference. Denver, Colorado.

**Fulton, D.C.**, S. A. Schroeder, L. Cornicelli, and D. Stark. 2014. Attitudes and motivations of wolf hunters and trappers. Human Dimensions Pathways Conference. Estes Park, Colorado.

Peterson, S.M., H. M. Streby, G. R. Kramer, and **D.E. Andersen**. 2014. Recent advances in golden-winged warbler ecology. Minnesota Ornithologists' Union Annual Meeting. Minneapolis, Minnesota.

Streby, H.M., **D.E. Andersen**, S.M. Petersen and G.R. Kramer. 2014. Full-season habitat associations of forest nesting songbirds. Minnesota's forest habitats: managing across the forest continuum. Minnesota Chapter of The Wildlife Society and American Bird Conservancy. Pallasade, Minnesota.

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2014. From Tennessee to Colombia and back again: tracking migration in golden-winged warblers (*Vermivora chrysoptera*). Festival de las Aves. Medellin, Colombia.

## Contributed Presentations

### 2013

Beck, M.W., **B. Vondracek**, B. Wilson, and L.K. Hatch. 2013. Evaluating the utility of a plant-based index of lake condition using neural networks. 98<sup>th</sup> Annual Meeting of the Ecological Society of America. Minneapolis, Minnesota.

Bruggeman, J.E., T. Swem, **D.E. Andersen**, P.L. Kennedy, and D. Nigro. 2013. Multi-scale resource use of arctic peregrine falcons along the Colville River, Alaska. 2013 Annual Meeting of The Wildlife Society. Milwaukee, Wisconsin.

Cochran-Biederman, J., W.E. French, and **B. Vondracek**. 2013. Diet and growth of brown trout in southeastern Minnesota: seasonal patterns across two years. 143<sup>rd</sup> Annual Meeting of the American Fisheries Society. Little Rock, Arkansas.

Daly, K.O., **D. E. Andersen**, and W.L. Brininger, Jr. 2013. Effects of radio transmitters on survival of juvenile American woodcock. 2013 Annual Meeting of the Minnesota Chapter of The Wildlife Society. Walker, Minnesota. (Poster)

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Finley, and D.J. Dieterman. 2013. Pairing of stomach content and stable isotope analysis to examine winter trophic relationships of brown trout *Salmo trutta* in a groundwater-dominated stream. Annual Meeting of the Minnesota Chapter of the American Fisheries Society. St. Cloud, Minnesota.

Lepore, J.A., J.R. Keville, and **B. Vondracek**. 2013. Localized and cumulative impacts of lakeshore residential development on littoral habitat. Annual Meeting of the Minnesota Chapter of the American Fisheries Society. St. Cloud, Minnesota.

Mazack, J.E., **B. Vondracek**, and L.C. Ferrington, Jr. 2013. Overwinter invertebrate community dynamics in groundwater-fed streams of southeastern Minnesota. 61<sup>st</sup> Annual Meeting of the Society for Freshwater Science. Jacksonville, Florida.

Peterson, S.M., H.M. Streby, and **D.E. Andersen**. 2013. Influence of landscape composition on golden-winged warbler full-season productivity. 2013 Annual Meeting of The Wildlife Society. Milwaukee, Wisconsin.

Peterson, S. M., H. M. Streby, T. C. Will, T. R. Cooper, and **D. E. Andersen**. 2013. Golden-winged warblers and the importance of diverse forest landscapes. Zumbro Valley Audubon Society. Rochester, Minnesota.

**Vondracek, B.**, J.D. Koch, and M.W. Beck. 2013. A comparison of survey methods to evaluate macrophyte index of biotic integrity performance in Minnesota lakes. Annual meeting of the Minnesota Chapter of the American Fisheries Society. St. Cloud, Minnesota.

## 2014

Cochran-Biederman, J. and **B. Vondracek**. Seasonal patterns in growth ,diet, and prey availability of brown trout in groundwater-dominated streams. Annual Meeting of the American Fisheries Society. Quebec City, Quebec, Canada.

Cochran-Biederman, J., W. French, J. Mazack, and **B. Vondracek**. 2014. Seasonal ecology of brown trout and aquatic invertebrate communities in groundwater dominated streams of southeastern Minnesota. Joint Aquatic Sciences Meeting. Portland, Oregon. (Presenter)

Daly, K.O. and **D.E. Andersen**. 2014. Are indirect estimates of American woodcock recruitment useful proxies for direct estimates of recruitment? 2014 Midwest Fish and Wildlife Conference. Kansas City, Kansas.

Dustin, D., J. Lepore Schmidt, J. Keville, and **B. Vondracek**. 2014. Impacts of shoreline development on fish and littoral habitat in northern Minnesota. Annual Meeting of the Minnesota Chapter of the American Fisheries Society. Mankato, Minnesota.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Findley, and D. Dieterman. Winter diet and growth of brown trout in a groundwater-dominated stream: inferences from stomach content and stable isotope analysis. Annual Meeting of the Minnesota Chapter of the American Fisheries Society. Mankato, Minnesota. (Best student paper award)

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Findley, and D. Dieterman. 2014. Relative position of brown trout in winter food webs of groundwater-dominated streams using stable isotope analysis. 74<sup>th</sup> Midwest Fish and Wildlife Conference. Kansas City, Missouri.

French, W.E., **B. Vondracek**, L.C. Ferrington, Jr., J. Findley, and D. Dieterman. 2014. Factors influencing winter growth and condition of brown trout in groundwater dominated streams of the Driftless Ecoregion. Annual Meeting of the American Fisheries Society. Quebec City, Quebec, Canada. (Presenter)

Kramer, G.R., H.M. Streby, S.M. Peterson, and **D.E. Andersen**. 2014. What do we know about golden-winged warblers in Minnesota? 2014 Annual Meeting of the Minnesota Chapter of The Wildlife Society. Bemidji, Minnesota.

Mazack, J.E., **B. Vondracek**, L.C. Ferrington, Jr. 2014. Overwinter emergence dynamics of adult Chironomidae (Insecta: Diptera) in groundwater-fed streams of southeastern Minnesota. Joint Aquatic Sciences Meeting. Portland, Oregon.

Mazack, J., **B. Vondracek**, and L.C. Ferrington, Jr. 2014. Overwinter emergence dynamics of adult Chironomidae (Insecta: Diptera) in groundwater-fed streams of southeastern Minnesota. Annual Meeting of the Minnesota Chapter of the American Fisheries Society. Mankato, Minnesota.

Schroeder, S.A. and **D.C. Fulton**. 2014. Small game hunters' intentions to support a ban on lead shot in Minnesota's Farmland Zone: how beliefs relate to attitudes. Annual Meeting of the Minnesota Chapter of The Wildlife Society. Bemidji, MN

Streby, H.M., G.R. Kramer, S.M. Peterson, J.A. Lehman, D.A. Buehler, and **D.E. Andersen**. 2014. Tracking migration in tiny songbirds with tiny technology. University of California, Berkeley, Fisheries, Wildlife, and Conservation Biology seminar series. Berkeley, California.

Streby, H.M., S.M. Peterson, G.R. Kramer, and **D.E. Andersen**. 2014. Post-independence fledgling ecology in golden-winged warblers: implications for breeding-grounds conservation and management. 2014 Midwest Fish and Wildlife Conference. Kansas City, Kansas.

#### Cooperating Faculty Presentations

#### **2013**

Olson, B. and R. Moen. 2013. Moose habitat use patterns in relation to operative temperatures: implications of climate change for moose at the southern extent of their range. The Wildlife Society 20<sup>th</sup> Annual Conference. Milwaukee, Wisconsin.

Rigby, E.A. and D.H. Johnson. 2013. Detection zones of simulated grassland birds: implications for bird surveys. American Ornithologists' Union / Cooper Ornithological Society Meeting. Chicago, Illinois.

Rigby, E.A. and D.H. Johnson. 2013. Detection zones of simulated grassland birds: implications for bird surveys. The Wildlife Society's 20<sup>th</sup> Annual Conference. Milwaukee, Wisconsin.

Specht, H.M. and T.W. Arnold. 2013. Survival and recovery rates of Wilson's snipe. American Ornithologists' Union/Cooper Ornithological Society Annual Meeting. Chicago, Illinois.

Windels, S.K. and R. Moen. 2013. Voyageurs National Park moose project update. 3rd Annual Moose Research Meeting. Cloquet, Minnesota.

Wyman, K.E. (presenter), and F. J. Cuthbert. 2013. Black Tern habitat in the North American Great Lakes region: A model validation study. Oral presentation at the Waterbird Society Annual Meeting. Wilhelms-haven, Germany.

## 2014

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

Cyr, T. and R. Moen. 2014. Risk of *Parelaphostrongylus tenuis* in moose in northern Minnesota based on spatial and temporal abundance of gastropod intermediate hosts. TAnnual Meeting of the Minnesota Chapter of The Wildlife Society. Bemidji, Minnesota.

Cyr, T. and R. Moen. 2014. Spatial and temporal abundance of gastropod intermediate hosts in northern Minnesota with implications for *Parelaphostrongylus tenuis* risk in moose. 48<sup>th</sup> North American Moose Conference and Workshop. Girdwood, Arkansas.

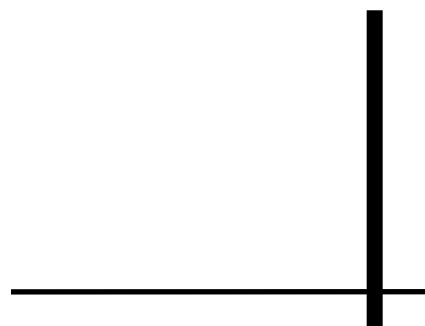
Rigby, E.A., and D.H. Johnson. 2014. Modeling detectability in bird surveys: a new, extensive Ssmulation. American Ornithologists' Union / Cooper Ornithological Society Meeting / Society of Canadian Ornithologists Joint Meeting. Estes Park, Colorado.

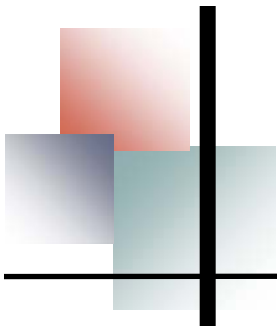
Rigby, E.A., and D.H. Johnson. 2014. Modeling detectability in bird surveys: a new, extensive simulation. Wildlife Society Joint Meeting, Minnesota and Wisconsin Chapters. Duluth, Minnesota.

Heist, K.W., D.H. Johnson, J. Gosse, D. Nolfi, A.C. Peterson, D. Larson, and J.A. Perry. 2014. Bat activity in the Great Lakes region and potential implications for wind energy development. National Wind Coordinating Collaborative (NWCC) Wildlife research meeting X. Broomfield, Colorado. (Poster)

VanderWaal, K. and R. Moen. 2014. Patterns in white-tailed deer density and parasite prevalence in Voyageurs National Park: implications for disease transmission to moose. 48<sup>th</sup> North American Moose Conference and Workshop. Girdwood, Arkansas.







## Unit News

Once again, it's hard to believe that two years have passed since our last biennial report. During that period, we've experienced (or soon will) some significant changes, but continue to work with outstanding graduate students to help address cooperator research priorities. Perhaps of most note, Dr. Bruce Vondracek (Assistant Leader – Fisheries) announced that he will retire in early 2015, so this biennial report is the last in which his research contributions will be highlighted. Bruce has been at the Minnesota Coop Unit since the early 1990s, and it's hard to imagine just how things will be following his retirement. On the positive side, Bruce and his wife, Lynn plan to "hit the road" in their recently purchased recreational vehicle, so keep your eyes open for Bruce on a stream near you.

As is always the case in the Cooperative Research Units Program, we have continued, strong support from our Cooperators that has helped us achieve a high level of scientific productivity. In recognition of

that productivity, we received the Cooperative Research Units Program "Excellence in Science Award" in 2013. On an individual level, Bruce Vondracek was presented with the Award of Excel-

lence by the Minnesota Chapter of the American Fisheries Society in 2014, and David Andersen (Leader) was awarded the Minnesota Award by the Minnesota Chapter of The Wildlife Society in 2013. So, it would seem that we have been able to continue furthering our mission and that of the Cooperative Research Units Program the past two years, and even in light of Bruce's impending retirement, are well positioned to continue to further our mission for the foreseeable future.

On the less positive side, all of our cooperators continue to face financial challenges, and these challenges have influenced how we operate. The Cooperative Research Units Program budget has remained essentially flat the last two years, which means increases in the cost of doing business have

resulted in erosion of funding for operations and research. The Minnesota Department of Natural Resources saw recent license fee increases, but the research program in the Division of Fisheries has experienced recent budget



shortfalls, which affects their ability to support research projects through the Minnesota Coop Unit. However, in the Division of Wildlife, federal aid funding has increased, and for the first time since

the Minnesota Coop Unit was established in the late 1980s, those funds have been used to support Coop Unit research. On the University of Minnesota side, the funding model at the department level has once again changed, which has resulted in deficits and continued cuts in support (e.g., teaching assistantships), and the Coop Unit has had to once again justify to higher levels of administration the necessity of having administrative support. It's a bit discouraging to continue to have to justify the relatively small, but very significant portion of our funding that supports our administrative assistant, but this appears to be a continual job requirement. Throughout all the changes and pressures, however, we continue to "make it work" and continue to benefit from support from the Wildlife Management Institute and the U.S. Fish and Wildlife Service, and work collaboratively with a breadth of partners to find ways to further our mission.

Finally, a quick update on some of the activities of Minnesota Coop Unit scientists and staff. As Bruce Vondracek approaches retirement in early 2015, he continues to be involved in running the fisheries graduate program, now the Fisheries and Aquatic Biology Track in the Conservation Biology Graduate Program. Most of his students have finished or will soon complete their degrees, and Bruce is working

to get things wrapped up before he hits the road. David Fulton (Assistant Leader- Wildlife) 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 Fellow. David also recently became involved in a national project evaluating waterfowl hunters' motivations and attitudes, which is the first of its kind on such a grand scale. David Andersen continues interesting and productive work with golden-winged warblers, sandhill cranes, peregrines, American woodcock, and more recently, secretive marshbirds and greater prairie-chickens, but still has managed to get Q (next iteration in the Star Trek drahthaar line) through puppyhood. 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 young boys, she's got her hands full at home in addition to keeping all of us in line.

